



NAVIGATING THE NOT SO ARTIFICIAL
INTELLIGENCE AT THE WISSEN-
SCHAFTSKOLLEG
STEFAN LEUTGEB

Stefan Leutgeb received a Master's degree from the Paris Lodron University Salzburg (Austria) and a PhD degree from the University of Utah (Salt Lake City, USA). He performed his postdoctoral research with Nobel Laureates May-Britt and Edvard Moser at the Norwegian University of Science and Technology (Trondheim, Norway) before joining the faculty of the University of California, San Diego as an Assistant Professor in 2008. He currently is Full Professor and former Department Chair of the Neurobiology Department at the same university. Throughout his career, Stefan Leutgeb has published more than 50 peer-reviewed articles on neural circuits that support memory computations. He is the recipient of the Sloan Research Fellowship, the Ellison Medical Foundation New Scholar Award in Aging, and the Walter F. Heiligenberg Professorship in Neuroethology and is a Faculty Fellow of the Kavli Institute for Brain and Mind at UC San Diego. – Address: Neurobiology Department, School of Biological Sciences, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0338, USA. E-mail: sleutgeb@ucsd.edu.

For life scientists, the metrics for success are the number of grants and publications, and perhaps, prominence in the field. Before arriving at the Wissenschaftskolleg zu Berlin, I was looking forward to having protected time to focus on writing grants and publications, but was somewhat skeptical about the remainder of the setup. I was unsure whether the model of gathering a diverse group of academics and artists for a year would be inspiring and productive. I did write my share of papers, concluded some projects, moved some projects forward that were stuck, and launched some new ones. However, I feel that

something more foundational transpired, which has resulted in finding more academic freedom and new avenues for approaching my scientific and academic endeavors for the remainder of my career. Many of these benefits may not yet have fully emerged, and it therefore seems premature to write a summary of my time at Wiko. I therefore see this more as a progress report than as a final report. I will first briefly summarize work that is directly related to my Wiko project and then conclude with more general remarks.

The Wiko project. My main goal was to think and write more about the field of spatial navigation, about its history, about the adoption of neural networks to identify computations, and in turn, the field's influence on the development of neural network architectures. This is an extensive and timely topic, and I was able to reinvigorate my interest in theoretical neuroscience and to devote time to learning new mathematical and computational foundations, such as topics in linear algebra, and acquiring programming skills that allow me to design and work with artificial neural networks. Although there is a lot more learning to do on these topics, I was able to devote enough time to these topics to be able to discuss papers, do programming projects, and launch a new collaboration on comparing biological and artificial neural networks for spatial navigation. Here, I benefited from the setup at Wiko in many ways. First, in an unexpected way, by being able to have frequent discussions with the partner of a Fellow, who is a mathematician and an expert in linear algebra. This was extremely valuable in helping me understand the limitations and pitfalls in publications on artificial neural network models for spatial navigation. Second, it was immensely helpful to be able to invite visitors and to have a few days to intensely brainstorm and discuss with colleagues in computational neuroscience. One of these visits launched a collaborative project that is still in its early stages, but has been invigorated by now co-supervising a PhD student. Third, it was immensely valuable to be geographically close to the outstanding computational neuroscience community in Berlin and in other parts of Germany. I was able to have many one-on-one meetings and to attend local and international conferences, such as the 2023 Bernstein Conference in Berlin and a 2024 meeting on NeuroAI in Norway. I was also an invited speaker at the Science of Intelligence at Technische Universität Berlin, at LMU Munich, at the Leibniz Institute for Neurobiology in Magdeburg, and at Heidelberg University, among other institutions.

Other collateral outcomes. As I had anticipated, I was able to focus on reading literature in my field and on writing and revising papers. The setup of having the apartment, the

office, and the hub of the institute in close spatial proximity was ideal and allowed for much more extensive uninterrupted time than what had been available to me at any other time in my career. Furthermore, it was inspiring not just to live in Berlin, but to be in Berlin with a group of colleagues who organized numerous outings to local academic institutions, theaters, music events, lectures, and other events. This was of course ideally complemented by the many in-house and public events at Wiko. These opportunities would already have been inspiring by themselves, but were of course further enriched by the daily interactions and discussions with my Co-Fellows and their partners. Often, exposure to expertise in fields that seemed the most unrelated to my own turned out to be particularly inspiring. As a neuroscientist, I now have a much deeper appreciation of biases, ethics, creativity, and hardship and of the limitations of reductionist approaches. In addition, we had many thought-provoking discussions about the rise of artificial intelligence. I hope that I could contribute to some of these conversations from the perspective of the science behind these systems. More importantly perhaps, I hope that I will be able to make future contributions to educational initiatives on the responsible use and development of these technologies.

In summary, the experience at Wiko was productive and inspiring. The setup of being able to interact with colleagues beyond the traditional academic boundaries was transformative. I anticipate that many of the contacts in Berlin and from my time in Berlin will continue to inspire my academic pursuits and continue to steer my work in new research and educational directions.

Academic Work throughout the Year

Peer-reviewed Publications

Viana da Silva, S., M.G. Haberl, K. Gaur, R. Patel, G. Narayan, M. Ledakis, M.L. Fu, M. de Castro Vieira, E.H. Koo, J.K. Leutgeb, and **S. Leutgeb** (2024). “Localized APP pathology in the hippocampus is sufficient to result in progressive disorganization of the timing of neuronal firing patterns.” *Neuron* 112 (1): 124–140.e6. doi:10.1016/j.neuron.2023.10.001. Epub 2023 Oct 30.

Athanasiadis, M., S. Masserini, L. Yuan, D. Fetterhoff, J.K. Leutgeb, **S. Leutgeb**, and C. Leibold (2024). “Low rate hippocampal delay period activity encodes behavioral experience.” *Hippocampus* 34 (8): 422–437. doi:10.1002/hipo.23619.

- Ahmadi, S., T. Sasaki, M. Sabariego, C. Leibold, **S. Leutgeb**, and J.K. Leutgeb (2025). “Distinct roles of dentate gyrus and medial entorhinal cortex inputs for phase precession and temporal correlations in the hippocampal CA3 area.” *Nat Commun* 16: 13. doi:10.1038/s41467-024-54943-2.
- Yuan L., J.F. Figueroa, A. Khan, G. Narayan, J.K. Leutgeb, and **S. Leutgeb** (2024). “Time cell sequences during delay intervals are not dependent on brain state.” In revision, *Nat Commun*.
- Srikanth, S., D. Le, Y. Hu, J.K. Leutgeb, and **S. Leutgeb**. “Theta oscillations in the prefrontal-hippocampal circuit do not couple to respiration-related oscillations.” In revision, *ELife*. bioRxiv 2021.12.22.473834. doi:10.1101/2021.12.22.473834.

Abstracts

- S. Gonzalez, S., Z. Xiao, S. Kooiman, L. Yuan, L. Yao, B.K. Lim, J. Leutgeb, and S. Leutgeb (2024). “Effects of progressive dopamine loss on movement cessation and initiation: Insights into basal ganglia network dynamics from a genetic model of Parkinson’s disease.” FENS Forum 2024 Abstract.
- Wang, J., Y. Li, W. Li, J.K. Leutgeb, and S. Leutgeb (2024). “Neuronal firing patterns during working memory retention differ between medial prefrontal cortex layers and subregions.” Society of Neuroscience Abstract.
- Li, Y., L. Tong, F. Farouq, W. Li, J. Leutgeb, and S. Leutgeb (2023). “Effects of the persistence of theta oscillations during working memory retention on the information flow between hippocampus and medial prefrontal cortex.” Society of Neuroscience Abstract PSTR301.13
- Wang, M., Y. Zhang, T. Sasaki, S. Leutgeb, and J. Leutgeb (2023). “Theta-associated high-frequency oscillations in the CA3-DG network predict future choices in a dentate-dependent working memory task.” Society of Neuroscience Abstract PSTR301.14.