Lukas Kunz, MD, PhD

Contact

University of Bonn Medical Center
Department of Epileptology
Venusberg-Campus 1
53127 Bonn
Germany
E-mail: lukas.kunz@ukbonn.de

Professional

- **Assistant Professor and Junior Research Group Leader: Neural mechanisms of navigation and memory in human health and disease** 5/2023–present

  University of Bonn Medical Center, Bonn, Germany
  Department of Epileptology

- **Walter Benjamin Fellow: Neuronal mechanisms of associative memory formation in the human medial temporal lobe** 3/2021–4/2023

  Columbia University, New York City, NY, USA
  Department of Biomedical Engineering; PI: Prof. Dr. Joshua Jacobs

- **Postdoctoral researcher: The roles of grid and place cells and phase precession in human episodic memory** 1/2018–2/2021

  University of Freiburg, Freiburg, Germany
  Epilepsy Center; PI: Prof. Dr. Andreas Schulze-Bonhage

  - **Visiting scholar: Single-neuron representations of goal-directed navigation in the human medial temporal lobe** 11/2019–1/2020

    Columbia University, New York City, NY, USA
    Department of Biomedical Engineering; PI: Prof. Dr. Joshua Jacobs

Education

- **PhD (Dr. rer. nat.). Thesis: Neural mechanisms underlying spatial navigation in the human medial temporal lobe (*summa cum laude*)** 2019–2022

  University of Freiburg, Freiburg, Germany
  Faculty of Biology
  In the framework of the international PhD program of the Spemann Graduate School of Biology and Medicine (SGBM)
  PI: Prof. Dr. Andreas Schulze-Bonhage

- **MD (Dr. med.). Thesis: Investigation of grid cell–based representations of the entorhinal cortex in adults at genetic risk for Alzheimer's disease (*summa cum laude*)** 2013–2017

  University of Bonn, Bonn, Germany
  Faculty of Medicine
  PIs: Prof. Dr. Nikolai Axmacher, PD Dr. Jürgen Fell

- **Human medicine (state examination)** 2010–2017
  University of Bonn, Bonn, Germany. Final grade: "Very good."
- **Philosophy and German studies (B.A.)** 2011–2018
  University of Bonn, Bonn, Germany. Final grade: "Very good."

Research overview and publication highlights

- My research targets the physiological neural mechanisms underlying spatial navigation and memory in humans. I also identify how these mechanisms are impaired in adults at increased risk for Alzheimer's disease. In my research, I use a combination of behavioral virtual-reality tasks, human single-neuron recordings, intracranial EEG, and functional MRI.
- I discovered that single neurons in the human brain encode directions and distances in the service of spatial navigation (Kunz et al., Neuron, 2021) and I showed how theta oscillations are involved in human goal-directed navigation (Kunz et al., Science Advances, 2019).
- I found that adults at increased risk for Alzheimer's disease exhibit impaired grid-cell activity in their entorhinal cortex (Kunz et al., Science, 2015) and that this neural impairment leads to deficits in spatial behavior (Bierbrauer*, Kunz*, Gomes* et al., Science Advances, 2020).

Publications (peer reviewed)

17. Liu J, Chen D, Xiao X, Zhang H, Zhou W, Liang S, **Kunz L**, Schulze-Bonhage A, Axmacher N, Wang L (2023). Multi-scale goal distance representations in human hippocampus during virtual spatial navigation. Current Biology; 33, 2024–2033.e3.

16. Han CZ, Donoghue T, Cao R, **Kunz L**, Wang S, Jacobs J (2023). Using multi-task experiments to test principles of hippocampal function. Hippocampus; 33, 646–657.

15. Herweg NA, **Kunz L**, Brandt A, Wanda PA, Sharan AD, Sperling MR, Schulze-Bonhage A, Kahana MJ (2023). A learned map for places and concepts in the human MTL. Journal of Neuroscience; 43, 3538–3547.

14. Akan O, Bierbrauer A, **Kunz L**, Gajewski PD, Getzmann S, Hengstler JG, Wascher E, Axmacher N, Wolf OT (2023). Chronic stress is associated with specific path integration deficits. Behavioral Brain Research; 442, 114305.

13. Costa M, Lozano-Soldevilla D, Gil-Nagel A, Toledano R, Oehrn CR, **Kunz L**, Yebra M, Mendez-Bertolo C, Stieglitz L, Sarnthein J, Axmacher N, Moratti S, Strange BA (2022). Aversive memory formation in humans involves an amygdala-hippocampus phase code. Nature Communications; 13, 6403.

12. Chen D, **Kunz L**, Lv P, Zhang H, Zhou W, Liang S, Axmacher N, Wang L (2021). Theta oscillations coordinate grid-like representations between ventromedial prefrontal and entorhinal cortex. Science Advances; 7, eabj0200.

11. Guth TA, **Kunz L**, Brandt A, Dümpelmann M, Klotz KA, Reinacher PC, Schulze-Bonhage A, Jacobs J, Schönberger J (2021). Interictal spikes with and without high-frequency oscillation have different single-neuron correlates. Brain; 144, 3078–3088.

– Scientific commentary by Huberfeld and Le Van Quyen in *Brain*

10. **Kunz L**, Brandt A, Reinacher PC, Staresina BP, Reifenstein ET, Weidemann CT, Herweg NA, Patel A, Tsitsiklis M, Kempter R, Kahana MJ, Schulze-Bonhage A, Jacobs J (2021). A neural code for egocentric spatial maps in the human medial temporal lobe. Neuron; 109, 2781–2796.e10.

– Media discussions: *Nature Reviews Neuroscience*, *Technology Networks*

9. Lachner-Piza D, **Kunz L**, Brandt A, Dümpelmann M, Thomschewski A, Schulze-Bonhage A (2021). Effects of spatial memory processing on hippocampal ripples. Frontiers in Neurology; 12, 237.

8. Manzouri F, Meisel C, **Kunz L**, Dümpelmann M, Stieglitz T, Schulze-Bonhage A (2021). Low-frequency electrical stimulation reduces cortical excitability in the human brain. Neuroimage: Clinical; 31, 102778.

7. Bierbrauer A*, **Kunz L***, Gomes CA*, Luhmann M, Deuker L, Getzmann S, Wascher E, Gajewski PD, Hengstler JG, Fernandez-Alvarez M, Atienza M, Cammisuli DM, Bonatti F, Pruneti C, Percesepe A, Bellaali Y, Hanseeuw B, Strange BA, Cantero JL, Axmacher N (2020). Unmasking selective path integration deficits in Alzheimer's disease risk carriers. Science Advances; 6, eaba1394.

– Media discussions: *Focus Online*, *Technology Networks*, *EurekAlert!*

6. **Kunz L**, Wang L, Lachner-Piza D, Zhang H, Brandt A, Dümpelmann M, Reinacher PC, Coenen VA, Chen D, Wang W, Zhou W, Liang S, Grewe P, Bien CG, Bierbrauer A, Schröder TN, Schulze-Bonhage A, Axmacher N (2019). Hippocampal theta phases organize the reactivation of large-scale electrophysiological representations during goal-directed navigation. Science Advances; 5, eaav8192.

– Media discussions: *ScienceDaily*, *Innovations Report*

5. **Kunz L***, Maidenbaum S*, Chen D*, Wang L, Jacobs J, Axmacher N (2019). Mesoscopic neural representations in spatial navigation. Trends in Cognitive Sciences; 23, 615–630.

– Media discussions: *Neuroscience News*

4. Chen D*, **Kunz L***, Wang W, Zhang H, Wang W, Schulze-Bonhage A, Reinacher PC, Zhou W, Liang S, Axmacher N, Wang L (2018). Hexadirectional modulation of theta power in human entorhinal cortex during spatial navigation. Current Biology; 28, 3310–3315.e4.

3. **Kunz L**, Reuter M, Axmacher N, Montag C (2017). Conscientiousness is negatively associated with grey matter volume in young APOE ε4-carriers. Journal of Alzheimer's Disease; 56, 1135–1144.

2. **Kunz L**, Schröder TN, Lee H, Montag C, Lachmann B, Sariyska R, Reuter M, Stirnberg R, Stöcker T, Messing-Floeter PC, Fell J, Doeller CF, Axmacher N (2015). Reduced grid-cell–like representations in adults at genetic risk for Alzheimer's disease. Science; 350, 430–433.

– Media discussions: *Science*, *Nature*, *Pacific Standard*, *Spektrum*

1. Montag C, **Kunz L**, Axmacher N, Sariyska R, Lachmann B, Reuter M (2014). Common genetic variation of the APOE gene and personality. BMC Neuroscience; 15, 1–5.

* *denotes shared first authorship.*

Publications (other)

5. **Kunz L** (2023). Orientation: Neuroscientific insights into mechanisms, impairments, and relevance. Essay for the exhibition *Building to Heal. New Architecture for Hospitals* at the modern art museum *Pinakothek der Moderne* in Munich (exhibition period, 2023/07/12–2024/01/07).

4. Qasim SE, **Kunz L** (2023). How is single-neuron activity related to LFP oscillations? In *Intracranial EEG. A Guide for Cognitive Neuroscientists*; Springer. Preprint at *PsyArXiv*.

3. **Kunz L** (2022). Neural mechanisms underlying spatial navigation in the human medial temporal lobe. Albert-Ludwigs-Universität Freiburg im Breisgau.

2. **Kunz L**, Deuker L, Zhang H, Axmacher N (2018). Tracking human engrams using multivariate analysis techniques. In *Handbook of Behavioral Neuroscience* (vol. 28, pp. 481–508); Elsevier.

1. **Kunz L** (2017). Untersuchung von „grid cell"-basierten Repräsentationen des entorhinalen Kortex in Erwachsenen mit genetisch erhöhtem Risiko für Morbus Alzheimer. Universitäts- und Landesbibliothek Bonn.

Preprints

4. Estefan DP, Fellner MC, **Kunz L**, Zhang H, Reinacher P, Roy C, Brandt A, Schulze-Bonhage A, Yang L, Wang S, Liu Y, Xue G, Axmacher N (2023). Maintenance and transformation of representational formats during working memory prioritization. Preprint at *bioRxiv*.

3. Khalid IB, Reifenstein ET, Auer N, **Kunz L****, Kempter R** (2022). Quantitative modeling of the emergence of macroscopic grid-like representations. Preprint at *bioRxiv*.

2. **Kunz L**, Staresina BP, Reinacher PC, Brandt A, Guth TA, Schulze-Bonhage A, Jacobs J (2022). Ripple-locked coactivity of stimulus-specific neurons supports human associative memory. Preprint at *bioRxiv*.

1. Yebra M, Jensen O, **Kunz L**, Moratti S, Axmacher N, Strange B (2021). A gradient of electrophysiological novelty responses along the human hippocampal long axis. Preprint at *bioRxiv*.

** *denotes shared last authorship.*

Awards

- Junior Researcher Award for Clinical Neurophysiology of the German Society of Neurophysiology, Jena, Germany. 2023
- Poster Award of the Center for Basics in NeuroModulation of the University of Freiburg, Freiburg, Germany. 2019
- Trainee Professional Development Award (TPDA) for the Annual Meeting of the Society of Neuroscience (SfN), San Diego, USA. 2018
- Travel Award for the Grid Cell Meeting 2018 of the University College London, London, UK. 2018
- BONFOR Research Prize of the BONFOR Research Commission of the Medical Faculty of the University of Bonn, Bonn, Germany. 2016

Funding as principal investigator

Cumulative funding **1,404,850 EUR**

- Return program of the State of North Rhine-Westphalia (NRW Rückkehrprogramm) to establish and lead an independent junior research group at the University of Bonn, Bonn, Germany. **1,250,000 EUR** for personnel and non-personnel costs for a period of 5 years. — Since 5/2023
- Walter Benjamin Programme (WBP) Return Stipend of the German Research Foundation (DFG). **4,000 EUR** for personnel. — 3/2023–4/2023
- Walter Benjamin Programme (WBP) Stipend of the German Research Foundation (DFG). **96,000 EUR** for personnel. — 3/2021–2/2023
- Boehringer Ingelheim Fonds travel grant for a 3-month research stay at Columbia University, New York, USA. **4,850 EUR** for personnel. — 11/2019–1/2020
- 2-year BONFOR Scholarship of the Medical Faculty of the University of Bonn, Bonn, Germany. **25,000 EUR** for personnel. — 7/2013–8/2015
- 7-year Scholarship granted by the German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes). **25,000 EUR** for personnel. — 1/2011–12/2017

Funding as co-investigator

Cumulative funding **5,918,995 USD**

- NIH/NINDS Grant U01 NS113198: Using direct brain stimulation to study cognitive electrophysiology. **1,183,799 USD** annual direct costs (PI: Michael J. Kahana). Project role: co-investigator. — 6/2019–5/2024

Work as a reviewer for international journals

Nature; Neuron; Nature Communications; Science Advances; Neuropsychopharmacology; Neuroscience and Biobehavioral Reviews; Communications Biology; NeuroImage; Journal of Neuroscience; Cerebral Cortex; Journal of the Neurological Sciences; eNeuro; European Journal of Neuroscience; Frontiers in Human Neuroscience; Neuropsychologia; Brain Research.

Work as a reviewer for research agencies

French National Research Agency (ANR).

Society membership

Society for Neuroscience (SfN); Federation of European Neuroscience Societies (FENS); German Neuroscience Society (NWG); ALBA Network for diversity and equity in brain sciences; German Academic International Network (GAIN).