

Lukas Kunz, MD, PhD

Contact

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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, Faculty of Biology, Freiburg, Germany
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, Faculty of Medicine, Bonn, Germany
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 investigates 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)

18. Colmant L, Bierbrauer A, Bellaali Y, **Kunz L**, Van Dongen J, Slegers K, Axmacher N, Lefevre P, Hanseeuw B (2023). Dissociating effects of aging and genetic risk of sporadic Alzheimer’s disease on path integration. *Neurobiology of Aging*; in press.
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. Herweg NA, **Kunz L**, Schonhaut D, Brandt A, Wanda PA, Sharan AD, Sperling MR, Schulze-Bonhage A, Kahana MJ (2023). A learned map for places and concepts in the human medial temporal lobe. *Journal of Neuroscience*; 43, 3538–3547.
15. 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.
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, Oehr 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, Reifensstein 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, 620670.
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, eab1394.
– 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; † denotes corresponding author.

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, 2023/07/12–2024/01/21).
4. Qasim SE, **Kunz L**† (2023). How is single-neuron activity related to LFP oscillations? Book chapter 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. Dissertation. Albert-Ludwigs-Universität Freiburg im Breisgau.
2. **Kunz L**†, Deuker L, Zhang H, Axmacher N (2018). Tracking human engrams using multivariate analysis techniques. Book chapter 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. Dissertation. Universitäts- und Landesbibliothek Bonn.

† denotes corresponding author.

Preprints

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

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.	5/2023–present
• 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 of 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

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

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).