

Lukas Kunz, MD, PhD

Contact

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Professional

- **Walter Benjamin Fellow: Neuronal mechanisms of associative memory formation in the human medial temporal lobe** Since 3/2021
Columbia University, New York City, 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, 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 im Breisgau, 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
PI: 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. I use cutting-edge research methods including 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., 2021, *Neuron*) and I showed how theta oscillations support human goal-directed navigation (Kunz et al., 2019, *Science Advances*).
- I demonstrated that adults at increased risk for Alzheimer’s disease exhibit impaired grid cell activity in their entorhinal cortex (Kunz et al., 2015, *Science*) and that this neural impairment leads to deficits in spatial behavior (Bierbrauer*, Kunz*, Gomes* et al., 2020, *Science Advances*).

Publications (peer reviewed)

Cumulative impact factor	146.3
<p>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. <i>Science Advances</i>; 7, eabj0200.</p> <p>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. <i>Brain</i>; 144, 3078–3088. – Scientific commentary by Huberfeld and Le Van Quyen in <i>Brain</i></p> <p>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. <i>Neuron</i>; 109, 2781–2796.e10. – Media discussions: <i>Nature Reviews Neuroscience</i>, <i>Technology Networks</i></p> <p>9. Lachner-Piza D, Kunz L, Brandt A, Dümpelmann M, Thomschewski A, Schulze-Bonhage A (2021). Effects of spatial memory processing on hippocampal ripples. <i>Frontiers in Neurology</i>; 12, 237.</p> <p>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. <i>Neuroimage: Clinical</i>; 31, 102778.</p>	<p>14.1</p> <p>13.5</p> <p>17.2</p> <p>3.6</p> <p>4.9</p>

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!*

14.1
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*

13.1
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*

15.2
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.

9.2
3. **Kunz L**, Reuter M, Axmacher N, Montag C (2017). Conscientiousness is negatively associated with grey matter volume in young APOE ϵ 4-carriers. **Journal of Alzheimer’s Disease**; 56, 1135–1144.

3.7
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*

34.7
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.

3.0

* denotes equal contribution. Impact factors are from the year of publication.

Publications (other)

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. Qasim SE, **Kunz L** (2022). How is single-neuron activity related to LFP oscillations? Preprint at *PsyArXiv*.

3. 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*.
2. Costa M, Lozano-Soldevilla D, Gil-Nagel A, Toledano R, Oehr C, **Kunz L**, Yebra M, Mendez-Bertolo C, Stieglitz L, Sarnthein J, Axmacher N, Moratti S, Strange BA (2021). Aversive memory formation in humans is determined by an amygdala-hippocampus phase code. Preprint at *medRxiv*.
1. Herweg NA, **Kunz L**, Brandt A, Wanda PA, Sharan AD, Sperling MR, Schulze-Bonhage A, Kahana MJ (2020). A learned map for places and concepts in the human MTL. Preprint at *bioRxiv*.

Funding as principal investigator

- Walter Benjamin Fellowship of the German Research Foundation (DFG). 3/2021–2/2023
113,500 USD for personnel.
- Boehringer Ingelheim Fonds travel grant for a 3-month research stay at Columbia University, New York, USA. 11/2019–1/2020
5,700 USD for personnel.
- 2-year BONFOR Scholarship of the Medical Faculty of the University of Bonn, Bonn, Germany. 7/2013–8/2015
26,000 USD for personnel.
- 7-year Scholarship granted by the German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes). 1/2011–12/2017
30,000 USD for personnel.

Funding as co-investigator

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

Awards

- Poster Award of the Center for Basics in NeuroModulation of the University of Freiburg, Freiburg im Breisgau, 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

Selected presentations at scientific conferences and research institutions

21. Kunz L (2022). Ripple-locked coactivity of object and place cells supports human associative memory. **Selected talk** at the *Context and Episodic Memory Symposium (CEMS)*, University of Pennsylvania, Philadelphia, USA.

20. Kunz L (2022). Neural mechanisms of navigation and memory in human health and disease. **Invited talk** at the *Department of Neurology, University of Chicago, Chicago, USA*.
19. Kunz L (2021). Human hippocampal ripples are associated with the formation and retrieval of spatial memories. *Annual Meeting of the Society of Neuroscience (SfN) 2021, USA*.
18. Kunz L (2021). Neural mechanisms of spatial navigation and memory in human health and disease. **Selected talk** at the *Symposium on Computational Neuroscience, Osnabrück, Germany*.
17. Kunz L (2021). Hippocampal ripples and human spatial memory. **Invited talk** at the *Annual Meeting on Imaging and Electrophysiology in Neurology, Neurosurgery and (cognitive) Neuroscience (AMIE), Bochum, Germany*.
16. Kunz L (2021). A neural code for egocentric spatial maps in the human brain. **Selected talk** at the *Context and Episodic Memory Symposium (CEMS), University of Pennsylvania, Philadelphia, USA*.
15. Kunz L (2020). A neural code for egocentric spatial maps in the human medial temporal lobe. **Selected talk** at the *Human Single-Neuron Meeting, California Institute of Technology (Caltech), Pasadena, USA*.
14. Kunz L (2020). Neural correlates of spatial navigation in the human medial temporal lobe. *Annual Meeting of the German Society for Clinical Neurophysiology and Functional Imaging (DGKN), Germany*.
13. Kunz L (2020). A single-neuron code for egocentric spatial maps in the human medial temporal lobe. *Congress of the German Society of Neurology (DGN) 2020, Germany*.
12. Kunz L (2020). Neural mechanisms for spatial navigation in humans. **Invited talk** at the *Max Planck Institute for Empirical Aesthetics, Frankfurt, Germany*.
11. Kunz L (2020). Neural correlates of spatial navigation in the human temporal lobe. *Annual meeting of the German Society for Epileptology (DGfE), Freiburg im Breisgau, Germany*.
10. Kunz L (2020). Anchor cells in the human medial temporal lobe represent egocentric directions during spatial navigation. **Selected talk** at the *Context and Episodic Memory Symposium (CEMS), University of Pennsylvania, Philadelphia, USA*.
9. Kunz L (2020). A neural code for egocentric spatial maps in the human medial temporal lobe. *Cognitive Neuroscience Society (CNS) Annual Meeting 2020, USA*.
8. Kunz L (2019). Two senses of direction in human medial temporal lobe. *Annual Meeting of the Society of Neuroscience (SfN) 2019, Chicago, USA*.
7. Kunz L (2019). Single neurons in human medial temporal lobe encode ego- and allocentric direction during virtual spatial navigation. *Meeting of the Center for Basics in NeuroModulation of the University of Freiburg, Freiburg, Germany*.
6. Kunz L (2019): Single neuron representations of place and direction in human medial temporal lobe. **Selected talk** at the *Spring Hippocampal Research Conference, Taormina, Italy*.
5. Kunz L (2018). Cortico-hippocampal communication during goal-directed navigation: evidence from functional magnetic resonance imaging and intracranial electroencephalography. *Annual Meeting of the Society of Neuroscience (SfN), San Diego, USA*.
4. Kunz L (2018). Head direction cells in human medial temporal lobe during virtual navigation. *Human Single Neuron Conference at the California Institute of Technology (Caltech), Pasadena, USA*.

3. Kunz L (2018). Path integration and genetic risk for Alzheimer's disease. **Selected talk** at the *Grid Cell Meeting of the University College London, London, UK*.
2. Kunz L (2016). Stimulus specific similarity of neural activity at encoding and retrieval supports memory formation. *International Conference on Memory (ICOM), Budapest, Hungary*.
1. Kunz L (2014). Effects of ApoE polymorphisms on grid like representations in the human entorhinal cortex. *Organization for Human Brain Mapping (OHBM) Annual Meeting, Hamburg, Germany*.

Work as a reviewer for international journals

Nature Communications; Science Advances; Neuropsychopharmacology; Neuroscience and Biobehavioral Reviews; Communications Biology; NeuroImage; Journal of Neuroscience; Cerebral Cortex; Frontiers in Human Neuroscience; eNeuro; Neuropsychologia.

Work as a reviewer for research agencies

French National Research Agency (ANR).

Society membership

- Society for Neuroscience (SfN). 2018–present
- Federation of European Neuroscience Societies (FENS). 2019–present
- German Neuroscience Society (NWG). 2019–present
- ALBA Network for diversity and equity in brain sciences. 2021–present
- German Academic International Network (GAIN). 2021–present

Scientific collaborations

- Collaboration project on the human brain mechanisms underlying associative memory formation with Prof. Dr. Joshua Jacobs, Columbia University, New York, USA. *Weblink*. 2021–present
- Collaboration project on the effects of direct brain stimulation on cognitive electrophysiology with Prof. Dr. Michael J. Kahana, University of Pennsylvania, Philadelphia, USA. *Weblink*. 2019–present
- Collaboration project on the neural correlates of human associative memory with Prof. Dr. Bernhard P. Staresina, University of Oxford, Oxford, UK. 2019–present
- Collaboration project on the function of human theta oscillations with Prof. Dr. Andrew J. Watrous, Baylor College of Medicine, Houston, USA. 2019–present
- Collaboration project on modeling the emergence of grid-like representations with Prof. Dr. Richard Kempter, Humboldt-University of Berlin, Berlin, Germany. 2018–present

- Collaboration project on theta oscillations in the human prefrontal cortex with Prof. Dr. Liang Wang, Chinese Academy of Sciences, Beijing, China. *Publication link.* 2018–2021
- Collaboration project on the roles of grid and place cells and phase precession in human episodic memory with Prof. Dr. Joshua Jacobs, Columbia University, New York, USA; Prof. Dr. Michael J. Kahana, University of Pennsylvania, Philadelphia, USA; and Prof. Dr. Richard Kempner, Humboldt-University of Berlin, Berlin, Germany. *Publication link.* 2018–2021
- Collaboration project on the single-neuron correlates of interictal spikes in the human brain with Prof. Dr. Julia Jacobs, University of Calgary, Calgary, Canada. *Publication link.* 2018–2021
- Collaboration project on the role of brain oscillations in human spatial navigation with Prof. Dr. Joshua Jacobs, Columbia University, New York, USA, and Prof. Dr. Nikolai Axmacher, Ruhr-University Bochum, Bochum, Germany. *Publication link.* 2018–2019
- Collaboration project on the role of theta oscillations in goal-directed navigation with Prof. Dr. Nikolai Axmacher, Ruhr-University Bochum, Bochum, Germany. *Publication link.* 2017–2019
- Collaboration project on theta oscillations in the human entorhinal cortex with Prof. Dr. Liang Wang, Institute of Psychology, Chinese Academy of Sciences, Beijing, China. *Publication link.* 2017–2018
- Collaboration project on the effects of *APOE* polymorphisms on path integration with Jose L. Cantero, Pablo de Olavide University, Seville, Spain, and Prof. Dr. Nikolai Axmacher, Ruhr-University Bochum, Bochum, Germany. *Publication link.* 2016–2020
- Collaboration project on the associations between *APOE* polymorphisms, personality, and brain structure with Prof. Dr. Martin Reuter, University of Bonn, Bonn, Germany, and Prof. Dr. Christian Montag, Ulm University, Ulm, Germany. *Publication link.* 2013–2017
- Collaboration project on grid cell-based representations of the entorhinal cortex in adults at genetic risk for Alzheimer’s disease with Prof. Dr. Christian Doeller, Donders Institute for Brain, Cognition and Behavior, Radboud University, Nijmegen, the Netherlands. *Publication link.* 2012–2015

Teaching and supervision of students

- Part of the course “Disorders in neurosurgery – stereotactic and functional neurosurgery” (04LE57V-WF 31) for medical students at the University of Freiburg. 04/2022–09/2022
- Supervision of Dr. Mohammad Khazali, postdoctoral researcher at the Epilepsy Center, University of Freiburg, Freiburg im Breisgau, Germany. Research project: Single-neuron basis of temporal memory in the human brain. 03/2022–present
- Supervision of Daniel Alfonso Garcia, undergraduate student at Columbia University in The City of New York. Research project: Open publication of human single-neuron recordings acquired during a navigation–and–memory task. 10/2021–present

- Supervision of Dr. Charlotte Roy, postdoctoral researcher at the Epilepsy Center, University of Freiburg. Research project: Using direct brain stimulation to study cognitive electrophysiology. 12/2020–02/2022
- Supervision of Tobias Kraus, master’s student in Neuroscience at the University of Freiburg. Research project: Neural oscillations during human cognition. 11/2020–04/2021
- Organization of the workshop “Microwire recordings: implantation and recording issues” together with Prof. Dr. Dr. Florian Mormann at the *Annual Meeting on Imaging and Electrophysiology in Neurology, Neurosurgery and (cognitive) Neuroscience (AMIE), Bochum, Germany*. 9/2020
- Supervision of Tim Guth, medical dissertation student at the University of Freiburg. Research project: Spike-phase relationships during memory encoding and retrieval in humans. 8/2020–present
- Part of the lecture series “Advanced Topics in Neuroscience I” (09LE03V-NA-1-T1) for master’s students in Neuroscience at the University of Freiburg. 7/2020
- Supervision of Philipp Rebmann, medical dissertation student at the University of Freiburg. Research project: Neural mechanisms of emotional processing in the human brain. 6/2020–12/2020
- Organization of the Satellite Workshop “Neural oscillations in memory and navigation” together with Prof. Dr. Michael J. Kahana at the *Bernstein Conference, Berlin, Germany*. 9/2019
- Supervision of Annabel von Dietze, medical dissertation student at the University of Freiburg. Research project: Assessment of spatial navigation abilities in patients with epilepsy. 12/2018–02/2021
- Supervision of Julia Schipp, master’s student in Neuroscience at the University of Freiburg. Research project: Emotional processing in the human brain. 2/2018–5/2018
- Supervision of Chelsea Nnebe, Fulbright Scholar at the University of Freiburg. Research project: Cognition during subclinical electrographic seizures. 1/2018–7/2018
- Organization of the module “Cognitive Neuroscience” together with Prof. Dr. Nikolai Axmacher for master’s students in Neuroscience at the University of Bonn. 4/2014

New York, June 1, 2022