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How do cortical circuits compose sensory representations, and how does experience reorganize them? In my PhD, I combined two-photon imaging with behavioral training to show that odor identity, novelty and temporal context are jointly encoded in the zebrafish homolog of piriform cortex, and that long term learning induces a geometric restructuring of these representations. Now, I am interested in how such representations are transmitted and transformed between cortical areas.

EDUCATION

- 2019 – 2026
(Defended June '26) **PhD in Neurobiology** – Final grade: 6.0 / 6.0 best, *summa cum laude*
Friedrich Miescher Institute of Biomedical Research (Switzerland)
University of Basel (Switzerland)
- 2016 – 2019 **Master of Science in Biology** – Final grade: 1.3 / 1.0 best
Ludwig Maximilian University of Munich (Germany)
- 2013 - 2016 **Bachelor of Science in Biology** – Final grade: 2.0 / 1.0 best
Ludwig Maximilian University of Munich (Germany)

PREPRINTS

- **Caudullo TC**, van Krugten J, Eckhardt J, Friedrich RW (2026) Joint experience-dependent representations of odors and temporal context in the zebrafish homolog of piriform cortex. Available at: <https://www.biorxiv.org/content/10.64898/2026.08.25.747023v1>

RESEARCH EXPERIENCE

- 2019 – 2026
- Friedrich Miescher Institute of Biomedical Research – Prof. Dr. R. W. Friedrich
PhD Thesis: “*Representational learning on multiple timescales in the zebrafish homolog of piriform cortex*”
 1. Adapted reflective microprism imaging for use in head-fixed adult zebrafish.
 2. Built a 2-photon microscope, multiple setups for behavioral training and tracking, and custom fluidics systems.
 3. Collected and analyzed large scale neural and behavioral data using a custom-written codebase (primarily in MATLAB).
 4. Discovered compositional and flexible olfactory representations in the zebrafish forebrain, and that long term experience restructures the geometry of the cortical odor code.
- 2017 – 2019
- Max Planck Institute for Psychiatry – Dr. A. Attardo
M. Sc. Thesis (Grade: 1.0 / 1.0 best): “*Excitatory and inhibitory connectivity patterns in the stressed mouse hippocampus*”
 1. Applied multiple stress-induction procedures in mice.
 2. Collected a large IHC dataset of inhibitory synapses and excitatory cell bodies across layers of the hippocampal CA1 region.
 3. Developed a custom image-processing toolbox to analyse neuronal morphology and excitatory-inhibitory connectivity patterning, and how they are affected by stress.

- 2016 – 2017
- Ludwig Maximilian University of Munich – Prof. Dr. A. Sirota
B. Sc. Thesis (Grade: 1.3 / 1.0 best): *“Analysis and optogenetic perturbation of the hippocampal output to medial entorhinal cortex”*
 1. Chronic implantation of silicon probes and optical fibers into the rat hippocampus and cortex.
 2. Analysis of LFP signal across brain regions.
 3. Optogenetic experiments probing brain wave coupling in the retrohippocampal pathway during wakefulness and sleep.
- 2014 – 2016
- Earlier research experience
- **Internship:** Ludwig Maximilian University of Munich – Dr. K. Thurley
 - **Internship:** Ludwig Maximilian University of Munich – Prof. Dr. C. Leibold
 - **Research Assistant:** Max Planck Institute for Neurobiology – Prof. Dr. R. Klein
 - **Internship:** Ludwig Maximilian University of Munich – PD Dr. L. Kunz
 - **Research Assistant:** Ludwig Maximilian University of Munich – Dr. A. Schneider
 - **Research Assistant:** Bavarian Zoological State Collection – Dr. A. Hausmann

AWARDS AND FUNDING

- 2023
- TPDA Travel Grant – Society for Neuroscience
- 2016
- “Best Poster” Prize – Munich <interact>
Title: “Analysis and optogenetic perturbation of the hippocampal output to medial entorhinal cortex”

TALKS GIVEN AT CONFERENCES AND INVITED TALKS

- 2026
- “Representational learning on multiple timescales in the zebrafish olfactory cortex” – Workshop “CNCB Basel Neuroscience”
University of Basel – Basel (Switzerland)
- 2024
- **Invited talk:** “Novelty detection and efficient coding in the zebrafish homolog of piriform cortex” – Invited by Dr. Kaspar Podgorski
Allen Institute for Neural Dynamics – Seattle (USA)
- 2024
- “Novelty detection and efficient coding in the zebrafish homolog of piriform cortex” – Symposium “Bench to Bedside”
University of Basel – Basel (Switzerland)
- 2022
- “Neuronal dynamics and function of the zebrafish forebrain in olfactory perception” - “Swiss Zebrafish Meeting”
Basel (Switzerland)

RECENT POSTER PRESENTATIONS

- 2024
- Extended Workshop “Theories of neural computation in the era of large-scale recordings”
Kavli Institute for Systems Neuroscience – Trondheim (Norway)
- 2023
- Conference “Neuroscience”
Society for Neuroscience – Washington DC (USA)
- 2023
- Conference “Zebrafish Neural Circuits”
Cold Spring Harbor Laboratories – New York (USA)
- 2022 - 2023
- Conference “Bernstein Network for Computational Neuroscience”
Berlin (Germany)
- 2022
- Conference “Zebrafish Neural Circuits”
Kavli Institute for Systems Neuroscience – Trondheim (Norway)

TECHNICAL SKILLS

- **Optical physiology:** *In vivo* and *ex vivo* two-photon calcium imaging; chronic and acute preparations in adult zebrafish and rodents; microscope alignment, optical path modification, and acquisition software configuration (ScanImage).
- **Behavior:** Design and construction of freely moving behavioral setups; odor delivery systems; automated training protocols and quantitative behavioral analysis, including markerless pose tracking and spontaneous head-fixed behavior quantification.
- **Electrophysiology and perturbation:** Multi-site high-density extracellular recording; optogenetic stimulation; stereotaxic and cranial-window surgery in rodents.
- **Data analysis:** Linear and non-linear registration (OpticFlow), motion correction and ROI segmentation of large imaging datasets; firing rate inference (CASCADE); dimensionality reduction and geometric manifold analysis (including GLUE); linear decoding and encoding-model fitting; statistical methods.
- **Computing:** Development and maintenance of analysis pipelines for GB-scale datasets on SLURM-based HPC clusters; version control (git); containerized and reproducible analysis environments.
- **Programming:** MATLAB (expert), Python (intermediate); instrument control in Arduino/C++ and LabVIEW. Windows and Linux OS distros.
- **Languages:** Italian (native), English (fluent, C2), German (fluent, C1/C2), Spanish (conversational).

TEACHING AND MENTORING

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| 2019 – 2026 | ▪ FMI Basel – Rainer Friedrich Lab
Trained lab members and visiting researchers in two-photon imaging, surgical procedures, odor delivery, behavioral training and data analysis, including methods I developed; provided ongoing troubleshooting and onboarding support. |
| 2018 – 2019 | ▪ Max Plank Institute for Psychiatry – Dr. A. Attardo
Training of two M. Sc. students on immunohistochemistry, confocal laser scanning microscopy and image analysis |
| 2016 – 2017 | ▪ Max Plank Institute for Neurobiology – Prof. Dr. R. Klein
Training of two M.Sc. students on mouse colony management and genotyping |

OUTREACH

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| 2025 | ▪ Outreach talk: “An informal guide to recognizing objects” – Pint of Science
General public outreach – Basel (Switzerland) |
| 2023 | ▪ “Tage der Genforschung” („Genetic Research Days“)
Friedrich Miescher Institute of Biomedical Research – Basel (Switzerland)
Outreach demonstration and orientation talk for high school (in German) |
| 2022 | ▪ “Zukunftstag” (“Future Day”)
Friedrich Miescher Institute of Biomedical Research – Basel (Switzerland)
Outreach demonstration for middle school (in German) |

REFERENCES (AVAILABLE UPON REQUEST)

- Prof. Dr. Rainer W. Friedrich (PhD supervisor)
Friedrich Miescher Institute of Biomedical Research – Basel (Switzerland)
- Prof. Dr. Andreas Luethi (second PhD supervisor)
Friedrich Miescher Institute of Biomedical Research – Basel (Switzerland)
- Prof. Dr. Hitoshi Okamoto (external PhD supervisor)
RIKEN Center for Brain Science – Saitama (Japan)
- Dr. Alessio Attardo (M. Sc. supervisor)
Leibniz Institute for Neurobiology – Magdeburg (Germany)