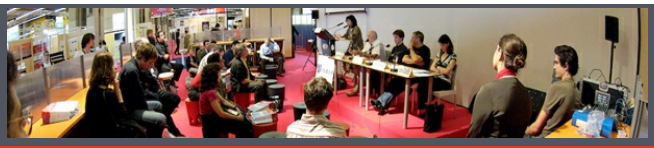
INTERNATIONAL RELATIONS



INTERNSHIP SUBJECT

2876 - Resonances in the retinal network

Project. A major challenge in retina research is the accurate classification of retinal ganglion cells based on their response to various stimuli. Current methods use stimuli with simple spatio-temporal structures, such as full-field, white-noise, and chirp stimuli, which sample a wide range of frequencies and contrasts in the temporal domain but have limited spatial resolution. In addition, the use of "natural" images or movies is problematic because they contain a large amount of information that makes it difficult to determine the specific features of the stimuli to which the cell is responding. There is a need to establish new classes of stimuli and stimulation protocols to properly characterize the spatio-temporal responses of retinal ganglion cells, considering that visual information from the real world is composed of moving objects.
In collaboration with the experimental research teams of A. Palacios (University of Valparaiso) we develop a protocol utilizing a feedback stimulation-control loop to precisely stimulate a ganglion cell in a localized region of space, intersecting its receptive field, with a stimulus varying in time. This enables us to scan the space-time scales of this response and identify potential resonances, corresponding to preferred time or space frequencies. Our objective is to provide a two-dimensional map (space/time scales) to improve the characterization of spatio-temporal stimuli for retinal ganglion cells. This experimental procedure is based on our previous research on the amacrine network, which suggests that the dynamic response of ganglion cells to moving objects induces a retinal wave of activity, helping the brain to not only decipher but also anticipate its trajectory (Souihel & Cessac, 2019). From the theoretical perspective, we will investigate how the structure of the retinal network shapes the wave characteristics (speed, spatial extension, latency), and conversely, the response of ganglion cells to spatio-temporal stimuli can provide insight into the underlying retinal network structure.

Outcomes. On the long term, a significant outcome of this project will be the characterization of retinal ganglion cells in healthy retinas and in genetically modified mice exhibiting symptoms of Alzheimer's disease. In these mice, the accumulation of beta-amyloid in the retina leads to an increase in glutamate for ganglion cells and a decrease of GABA in the inner plexiform layer, resulting in sporadic increases in activity, visible on spike trains. We hypothesize that this will also affect the spatio-temporal response of retinal ganglion cells and that the proper spatio-temporal stimuli we aim to design will enable the diagnosis of early symptoms of Alzheimer's disease from retinal responses.

Involved teams. Dr. Palacios' laboratory was awarded in late 2022 an ANID project in Chile that will allow them to explore the use of various visual stimuli and the analysis of the Electroretinogram signal to estimate the complexity of the response using multiscale entropy methodologies to estimate entropy at different scales as a possible eye biomarker for Alzheimer's type pathologies in humans. This project will be complementary to future collaborative activities between our groups.
The Biovision team develops fundamental research as well as technology transfer around the central theme biological vision and perception, and the impact of low vision conditions. Bruno Cessac is a research director at INRIA, specialized in the modelling and analysis of neuronal models, especially, the retina. This project will establish stronger links between experimentation and modeling in the context of retinal dynamics and Alzheimer's type diagnosis.

Required Skills

We search for a student with a good level in mathematics and computer science, interested in neuroscience and ready to work in collaboration with neuroscience experimentalists.

General Information

- **Research Theme :** Computational Neuroscience and Medicine
- **Locality :** Sophia Antipolis
- **Level :** Master
- **Period :** 9th February 2026 -> 30th April 2026 (3 months)

These are approximative dates. Please contact the training supervisor to know the precise period.

- **Deadline to apply :** 1st July 2025 (midnight)

Contacts

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- **Team Manager :** Bruno Cessac / Bruno.Cessac@inria.fr

More information

- **Inria Team :** BIOVISION
- **Inria Center :** Centre Inria d'Université Côte d'Azur