CSC-RUB PhD Project Proposal

Title: The neural basis of visual categorization in pigeons: an fMRI-study

Sector of research: Biopsychology

Degree awarded: PhD in Neuroscience

Keywords: visual-associative and prefrontal areas, learning, neural representation, asymmetry

Supervisor of PhD project: Onur Güntürkün, Dept. Biopsychology, Faculty of Psychology

Research focus of supervisor: I'm kept awake with questions like: "Can different kinds of brains produce the same cognition?" or "Why are brains asymmetrically organized?". I spent many years in different universities and science institutions on five continents and work (in descending order of publication numbers) with pigeons, humans, dolphins, crocodiles and magpies as experimental subjects. I would call myself a Cognitive and Comparative Neuroscientist who works with research approaches that reach from field work via highly controlled behavioral studies, single cell recordings, and neuronal tract tracing up to brain imaging at ultrahigh magnetic fields.

Publications: Five relevant papers:

1) Stacho, M., Herold, C., Rook, N., Wagner, H., Axer, M., Amunts, K., Güntürkün, O., A cortex-like canonical circuit in the avian forebrain, Science, 2020, 369: eabc5534.

2) Behroozi, M., Helluy, X., Ströckens, F., Gao, M., Tabrik, S., Tegentoff, M., Otto, T., Axmacher, T., Genc, E. and Güntürkün, O., Event-related functional MRI of awake, behaving pigeons at 7T, Nature Comm., 2020, 11: 4715.

3) Güntürkün, O. and Ocklenburg, S., Ontogenesis of Lateralization, Neuron, 2017, 94: 249-263.

4) Güntürkün, O., Human behaviour: Adult persistence of head turning asymmetry, Nature, 2003, 421: 711, addendum in: Nature, 2003, 422: 834.

5) Wiltschko, W., Traudt, J., Güntürkün, O., Prior, H. and Wiltschko, R., Lateralisation of magnetic compass orientation in a migratory bird, Nature, 2002, 419: 467-470

h-index of the last 5 years (Web of Science): 18; Number of publications of the last 5 years: 112

Summary of research plan

Background: The world surrounding us offers an endless variety of scenes and objects. Just look around. You might see a desk, chairs, books, computers; you instantly recognize them as belonging to a certain category (furniture, electronics, etc.), although your specific desk may be unique to you. The apparent ease of your categorical recognition belies the complexity of this feat: we effortlessly detect and categorize tens of thousands of objects from countless possible angles and distances. And we do so in the blink of an eye. How is this possible? And why do these processes unfold asymmetrically in the left and the right hemisphere of our brain? This project is about fMRI studies that try to solve this question.

Study objective: In this project, we will aim to come up with a comprehensive neurobiological explanation of asymmetries of categorization in pigeons using fMRI in awake and actively discriminating pigeons.

Expected Results: The research plan is geared to test all aspects of a hypothesis outlined in Güntürkün et al. (Learning & Behavior, 2018). I expect several papers to be published of which at least one could hopefully appear in a high-ranking journal.

Methods: Conditioning studies on visual categorization of artificial objects in pigeons using 7T fMRI on actively discriminating pigeons. These studies should reveal a detailed whole-brain view of the representation of object categories and their hemispheric asymmetries in a bird brain. In addition, we will be able to identify alterations of function connectivities between key areas during the process of learning.

Candidate Requirements: Data analysis skills, if possible knowledge of fMRI, cooperative mind-set, good English language skills.

Motivation for CSC application (max 250 words): The Güntürkün laboratory offers an enormously stimulating and highly interdisciplinary as well as international research culture that particularly encourages and supports an independently thinking next generation of scientists (www.bio.psy.rub.de). We study both pigeons as an animal model as well as human subjects. We offer training and conduct of neuroscientific research that is hypothesis-based and uses techniques like (a) highly controlled behavioral methods for cognitive studies in humans and birds, (b) single unit recordings in behaving birds, (c) neuroanatomical studies like immunocytochemistry, tract-tracing, and molecular imaging (immediate early genes), (d) optogenetics, (e) fMRI on 3T- and 7T-systems in both pigeons and humans, (f) mobile and stationary EEG-analyses on human subjects, (g) DTI analyses of fiber tracts in humans and birds. Supervision is always provided by both a postdoc and Prof. Güntürkün. We encourage our PhD-students to present their results in international conferences and to create their own academic network. The lab is integrated into the Ruhr University Research School, for interdisciplinary skills development.