GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

C1

Neural systems underlying curiosity-driven sampling of perceptual information


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Motivation

- We actively sample information from the environment through motor actions such as the adjustment of pupil diameter[1].
- How is active sampling by the pupil controlled and what are the consequences for information processing[2]?

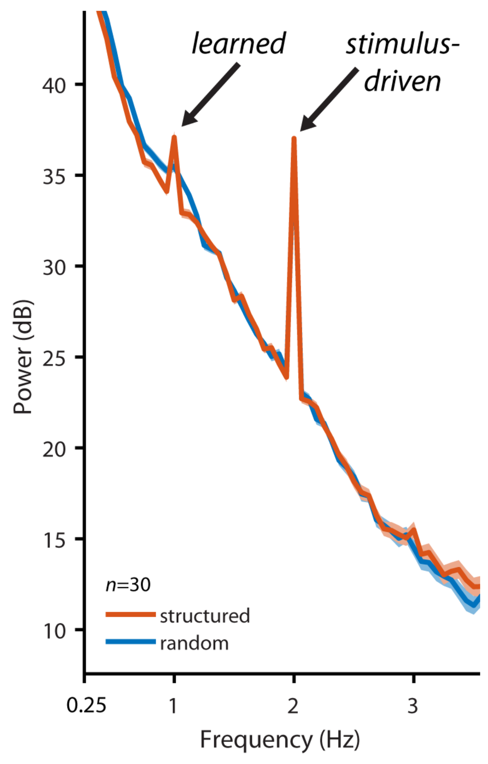

Fig. 1: Pupil entrainment to stimuli and environmental statistics in humans[1].

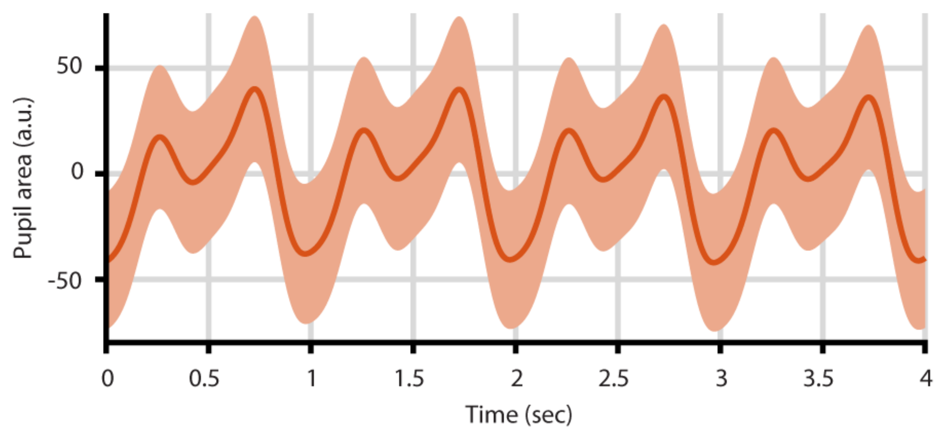

Fig. 2: Pupils are wide during environmentally coherent units and constrict between such units (example data from a single subject[1]).

Objectives

- Does pupil entrainment reflect a general state of sensitivity to incoming information, or a specific adaptation to incoming visual information?
- How does active segmentation of input stream contribute to information sampling?
- Does trait curiosity affect active sampling by pupillary entrainment?

➢ This project will speak to the question **How are we curious?**

➢ By manipulating situational or individual factors that regulate perceptual curiosity, this project will address the question **When are we curious?**

?

What are the neural systems underlying curiosity-driven sampling of perceptual information through motor actions?

Methods

- Video-based eye-tracking, combined with electroencephalography and electroretinography
- Pharmacological manipulation of pupil diameter to separate motor effects from neural effects
- Functional MRI to relate activity of brain regions involved in event segmentation to pupil diameter dynamics
- Curiosity questionnaires to relate trait curiosity to active sampling

Hypotheses

- Pupil diameter may reflect an attentional state or by itself result in behavioural benefits (Fig. 3)
- Brain areas such as the hippocampus may affect pupil diameter because of their role in event segmentation
- More curious subjects may show more pupillary entrainment, reflecting active sampling of the environment

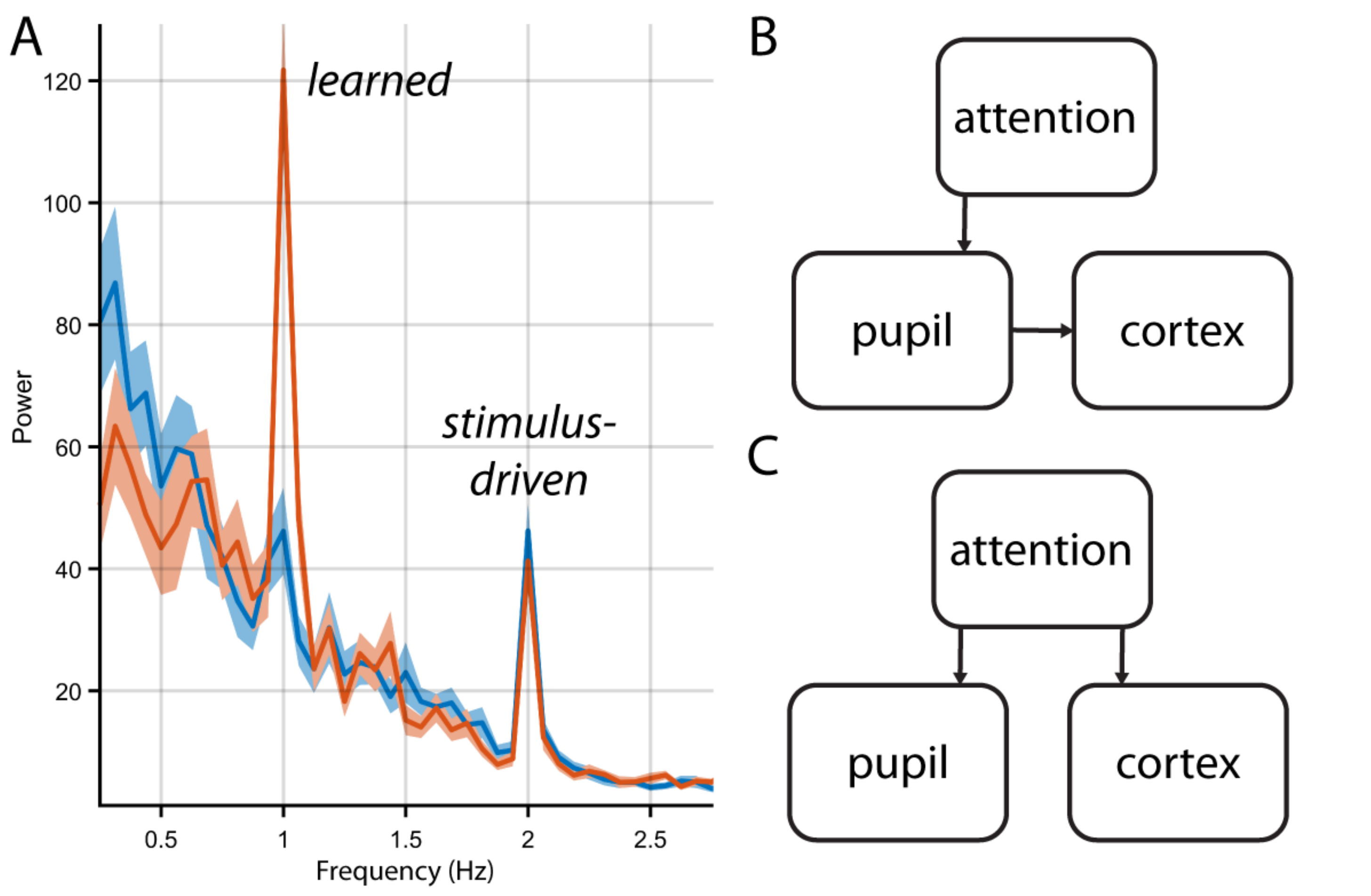

Fig. 3: (A) Stimulus-driven and learned entrainment to environmental structure in ventral visual cortex, recorded with intracranial EEG (orange: structured; blue: no structure). (B) Behavioural benefits of learning environmental structure arise from the effects of attention on pupillary sampling. (C) Attention and/or brain-wide neurotransmitter systems affect pupil diameter and visual cortex activity in parallel. (B) and (C) are not mutually exclusive.

Cross-project collaborations

- Key collaboration with C3 examining curious exploration
- **Methodological synergies** with projects A4 and B1
- Shared focus with A3, A4, B1, and B2 on the impact of **person-specific factors** on curious behaviour
- **Common study cohort** with B1 to investigate trait curiosity

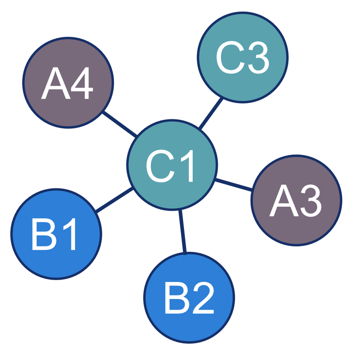

Fig. 4: Key collaboration partners of doctoral researcher working on Project C1

Potential PhD projects

1. Determine whether curiosity-driven sampling of visual information by the pupil is a reflection of a general sensitivity to environmental structure or a specific adaptation to improve visual processing.
2. Investigate how pupillary segmentation of visual input streams according to environmental statistics contributes to information sampling and learning.
3. Dissociate the contribution of trait and situational perceptual curiosity to active sampling of the environment through motor actions.

References

1. **Schwiedrzik, C.M.** & Sudmann, S. S. (2020). Pupil diameter tracks statistical structure in the environment to increase visual sensitivity. *Journal of Neuroscience*, 40(23): 4565-4575.
2. Franke, K., Willeke, K. F., Ponder, K., Galdamez, M., Zhou, N., Muhammad, T., Patel, S., Froudarakis, E., Reimer, J., **Sinz F.H.** & Tolias, A. S. (2022). State-dependent pupil dilation rapidly shifts visual feature selectivity. *Nature*, 610, 128–134.