Quantifying the Metabolic Cost of Prediction During Visual Processing

Summary

We measured absolute oxygen consumption during unpredictable and predictable visual input, revealing a brain-wide increase in the predictable condition.

Conclusion

While valid prediction has been linked to decreased activity compared to prediction errors, we show that predictable inputs come with a significant cost increase over “naive” perception.

André Hechler[1,2], Floris deLange[3], Valentin Riedl[1]

https://valentinriedl.de/

[1]Dept. of Neuroradiology, TUM-Neuroimaging Center; Technische Universität München, [2]Graduate School for Systemic Neurosciences; LMU München, [3]Donders Institute for Brain, Cognition and Behaviour; Radboud University Nijmegen

Task design: Visual statistical learning

Graduate School of Systemic Neurosciences LMU Munich

Technische Universität München

Stimuli

8 predictable object sequences

8 unpredictable object sequences

Note: Objects do not repeat within a sequence.

Fig 1. Example object sequences with possible transitions.

3-day online training phase

Participants (n=21) viewed 20 minutes of object sequences each day. Afterwards, they had to select the correct follow-up object out of five options for incomplete object sequences.

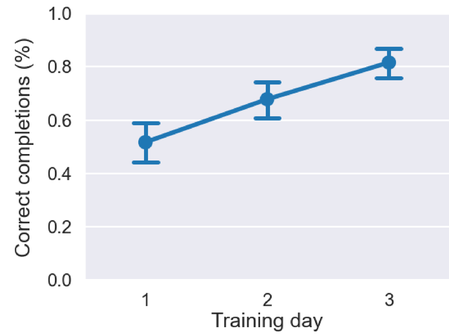

Fig 2. Training phase results. Error bars indicate the 95th CI of the mean.

Methods: Multiparametric quantitative BOLD*

*blood oxygenation level dependency

Oxygen consumption

MR- and blood-derived parameters are combined, yielding the cerebral metabolic rate of oxygen (**$CMRO_2$**) for every voxel (~2mm³).

$CMRO_2$ is an **absolute value** and measured in µmol/100g/minute.

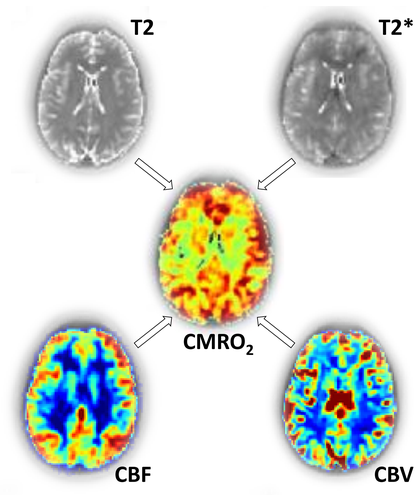

Fig 3. MRI parameters underlying $CMRO_2$ calculation: Blood oxygenation (T2/T2*), blood flow (CBF) and blood volume (CBV).

MR testing phase

Conditions were presented in three 5-minute blocks each while participants performed a cover task to uphold attention.

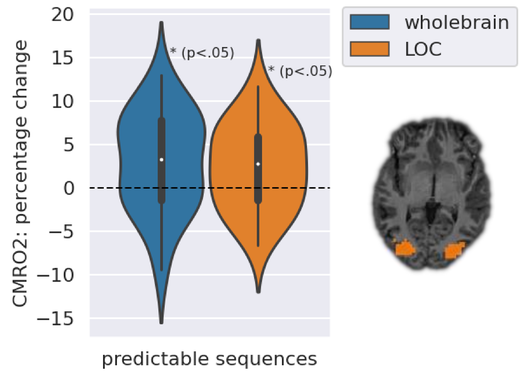

Fig 4. Testing phase results. Values for cortical grey matter relative to unpredictable sequences.