

Characterization of glutamatergic changes associated with mental fatigue using Magnetic Resonance Spectroscopic Imaging at 7 Tesla

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Introduction

Effortful cognitive activities induce a state of mental fatigue that manifests at the neural level in task-specific brain regions¹.

- Short periods of rest help reduce fatigue state without restoring it entirely².
 - Glutamate accumulation in the extracellular space has been proposed as a neurobiological root of fatigue³.
- Could glutamate concentration be modulated on short timescales by fatigue *and* rest under different levels of cognitive load?

Methods

One population: 50 healthy young adults (18-40 y.o.; both sexes).

Two groups: Fatigue (High Cognitive Load condition, **HCL**) and No-fatigue (Low Cognitive Load condition, **LCL**).

→ Cognitive Load individually calibrated.

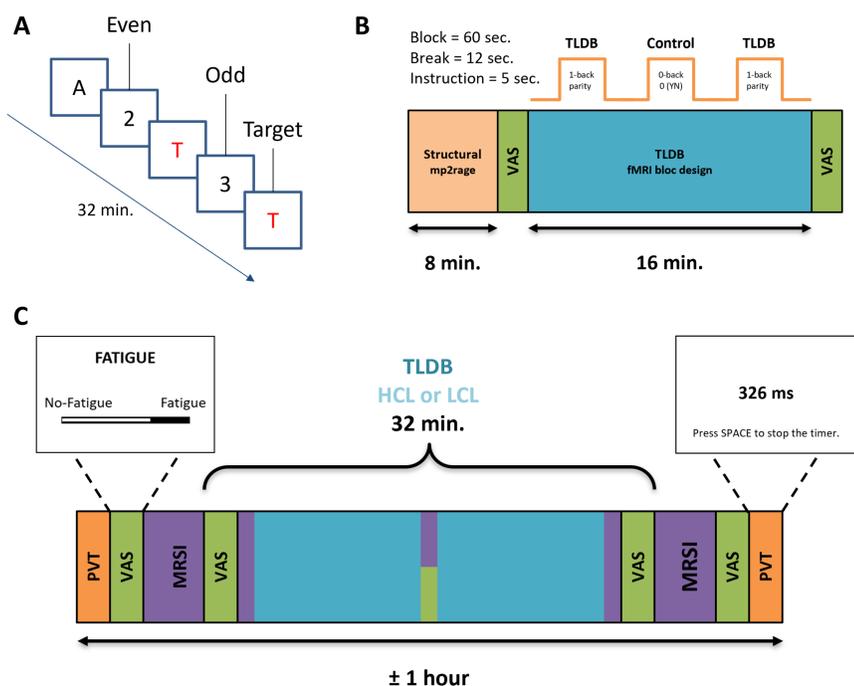


Figure 1 | Two days experimental set-up.

(A) Time Load Dual Back task (TLDB) used to induce mental fatigue⁴. The HCL condition is fast and difficult while the LCL is slow and easy.

(B) First session consists of an fMRI bloc design (2.5 mm iso; TR = 2340 ms; TE = 24 ms) to identify task-specific regions involved during the TLDB.

(C) Second session consists of concentric rings trajectory-based free induction decay MRSI acquisitions at 7T (FoV = 22×22×9 cm; Matrix = 44×44×29 at 5 mm iso; TA = 8:22; TR = 600 ms; TE = 1.3 ms)⁵ to assess changes in Glutamate + Glutamine (Glx) changes during and after the TLDB.

Data processing

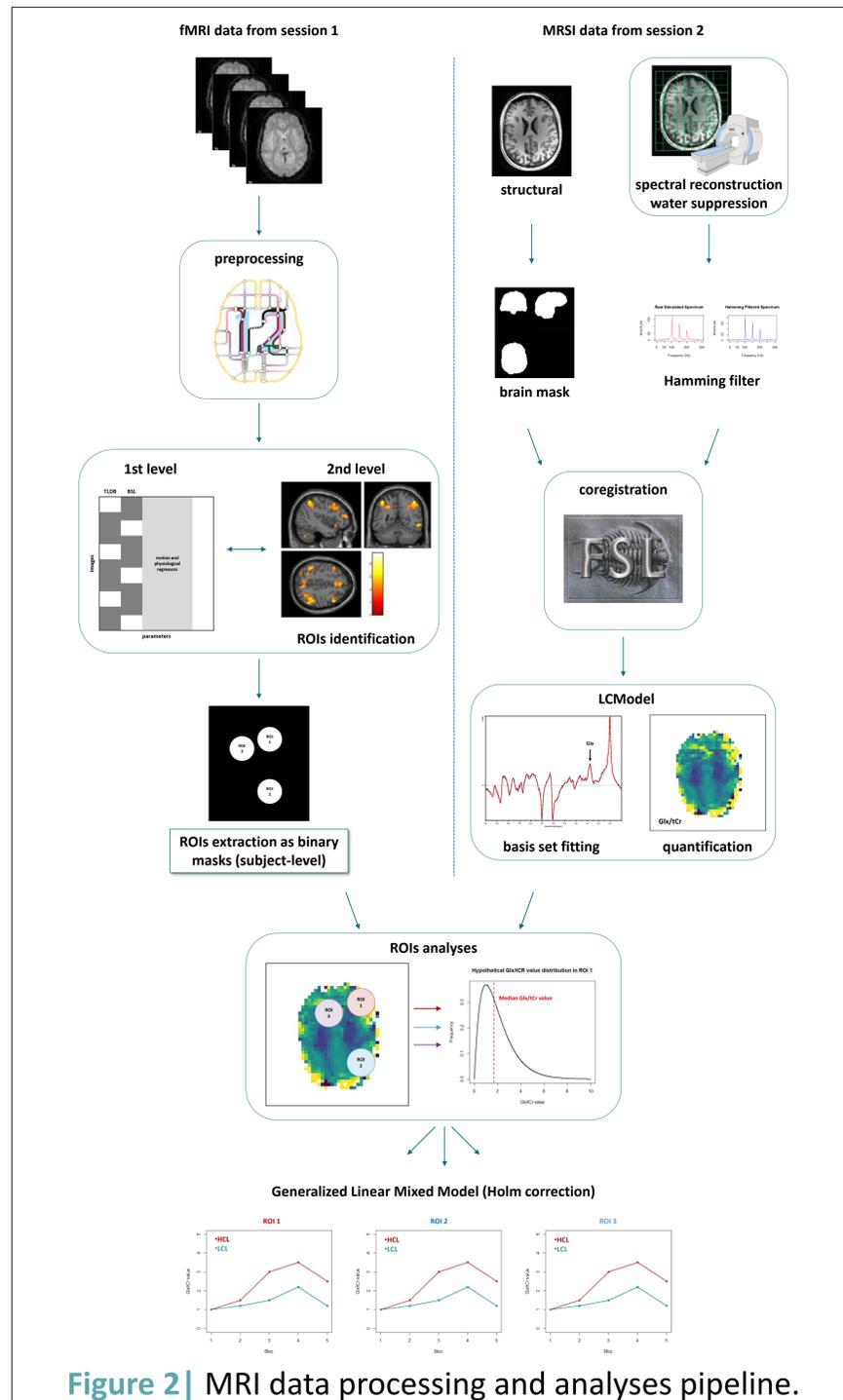


Figure 2 | MRI data processing and analyses pipeline.

Hypotheses

Quadratic Condition*Time interactions with:

1. higher fatigue scores after HCL compared to LCL;
2. steeper Glx/tCr concentrations increase in HCL;
3. both followed by partial decrease with rest.

→ Association between Glx/tCr and Δ fatigue (rest – baseline) to explain unrecoverable fatigue.

References

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