

BACKGROUND

The **hippocampus** is thought to serve as a **comparator**, detecting mismatches between expected and actual events. Expectations about upcoming events can depend on different types of contextual representations.

GENERALISED KNOWLEDGE
What usually happens in similar situations

EPISODIC MEMORY
What happened in a specific past event

Currently, it is unclear what prior contextual representations the hippocampus uses to evaluate incoming input.

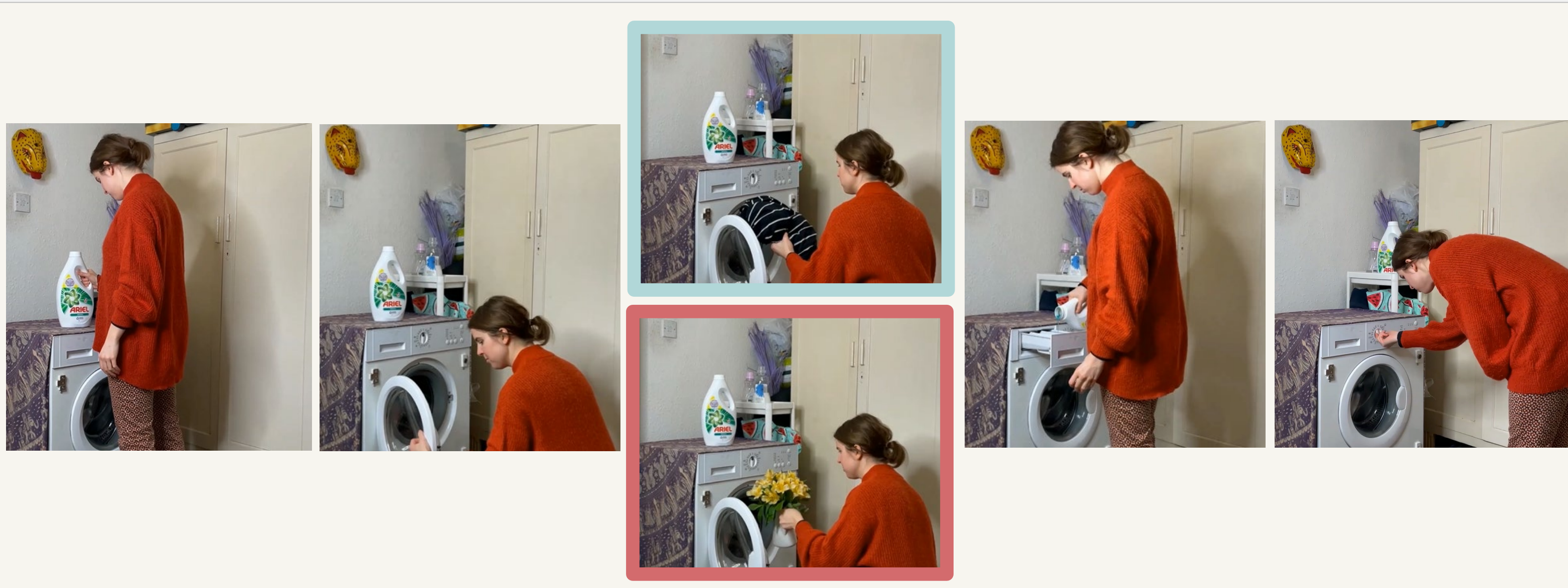
To test the hippocampus' (and other exploratory networks') role in detecting mismatches with different types of expectations, we ran **3 fMRI experiments** manipulating:

- the context-congruence (typicality) of actions depicted in video clips of everyday situations (Typical / Atypical)
- participant's familiarity with the video clips before scanning, and thus, which actions were unexpected given prior contextual representations.

In a separate **functional Magnetic Resonance Spectroscopy experiment**, we tested if hippocampal mismatch detection is accompanied by changes in choline and glutamate concentrations, as predicted by theoretical and animal models of the hippocampal comparator mechanism^{1,2}.

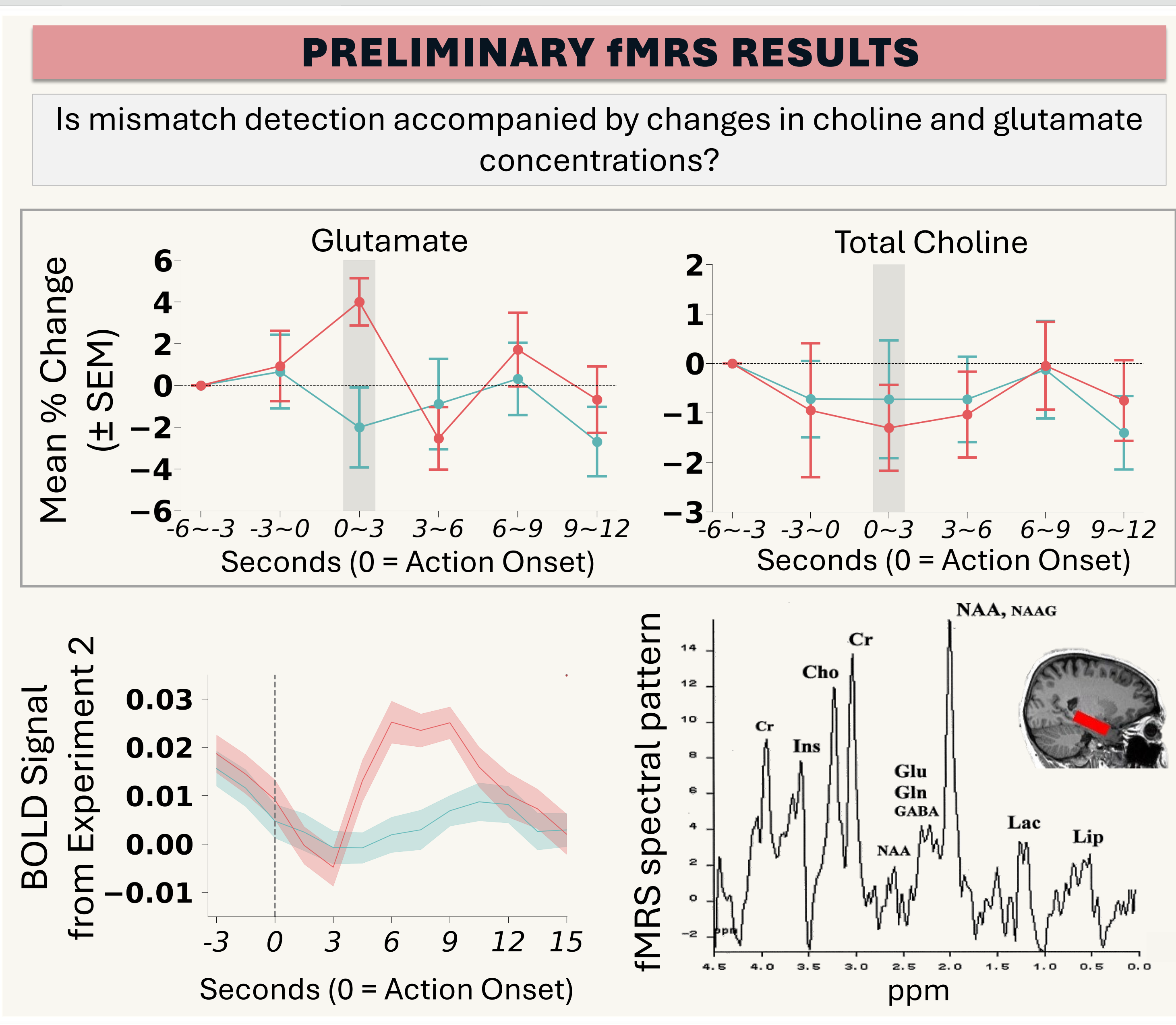
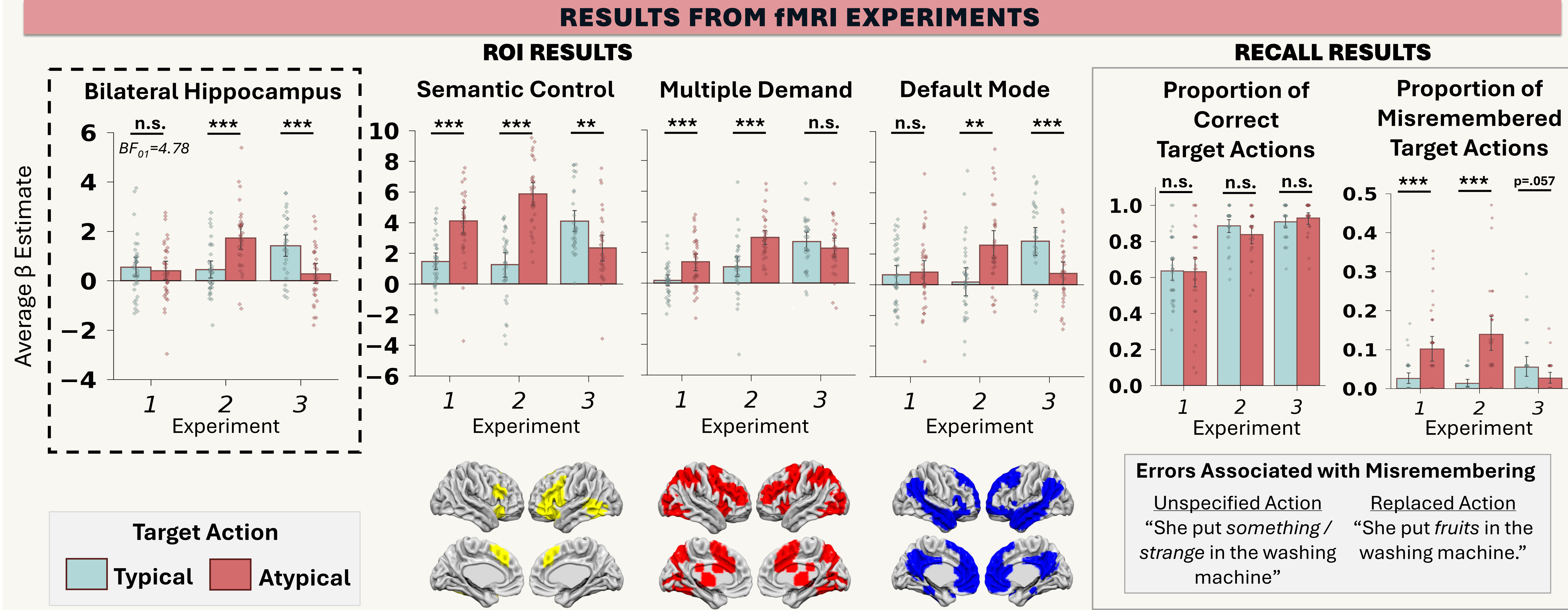
DESIGN

34 stop motion clips with 2 versions showing context **Typical** or **Atypical** actions.



In the scanner, all participants watched 17 typical and 17 atypical clips, participants in experiment 2 and 3 pre-watched one version of the clips before scanning. Experiment 2 was also scanned in a separate fMRS study.

Experiment	Mismatched Representation	Pre-scan Familiarisation	fMRI Scanning	After Scan Recall
1 N = 36	Schema Knowledge		 34 clips in total 17 Typical 17 Atypical	 Recall all clips watched inside the scanner
2 N = 33	Episodic Memory and Schema Knowledge			
3 N = 30	Episodic Memory			



- CONCLUSION
- Across three fMRI experiments, we found that the hippocampus detects mismatches based on episodic memories, not generalised knowledge, constraining theories of hippocampal function. The findings support a specific, memory-based comparator role^{3,4}, challenging broader accounts in evaluating input based on general contextual representations^{5,6}.
 - Unexpected events engaged a network of regions associated with conflict resolution and internal model updating. The SCN was sensitive to violations of both schematic and episodic expectations, suggesting it supports context-sensitive inference across memory systems. The DMN was selectively engaged by episodic mismatches, possibly reflecting increased internally directed processing (e.g., reinstatement of prior predictions)⁷.
 - While participants were equally likely to correctly recall unexpected and expected actions, they were more likely to make errors when recalling unexpected actions. This finding challenges models suggesting that surprise improves memory for incidental information⁶.
 - Finally, preliminary fMRS data showed increased glutamate prior to hippocampal increase in BOLD response to mismatches, suggesting a link to excitatory neuronal activity. However, the lack of changes in choline levels require cautious interpretation due to measurement challenges.

¹ Hasselmo, 2006 ; ² Giacomo & Hasselmo, 2007 ; ³ Hasselmo, M. E., Wyble, B. P., & Wallenstein, G. V. (1996).; ⁴ Zheng, Y., Liu, X. L., Nishiyama, S., Ranganath, C. & O'Reilly, R. C. (2022); ⁵ Ranganath, C. & Rainer, G. (2003); ⁶ Van Kesteren, M. T., Ruiter, D. J., Fernández, G., & Henson, R. N. (2012); ⁷ Lu, Q., Hasson, U. & Norman, K. A. (2022)