# Neural Substrates of Working Memory Updating

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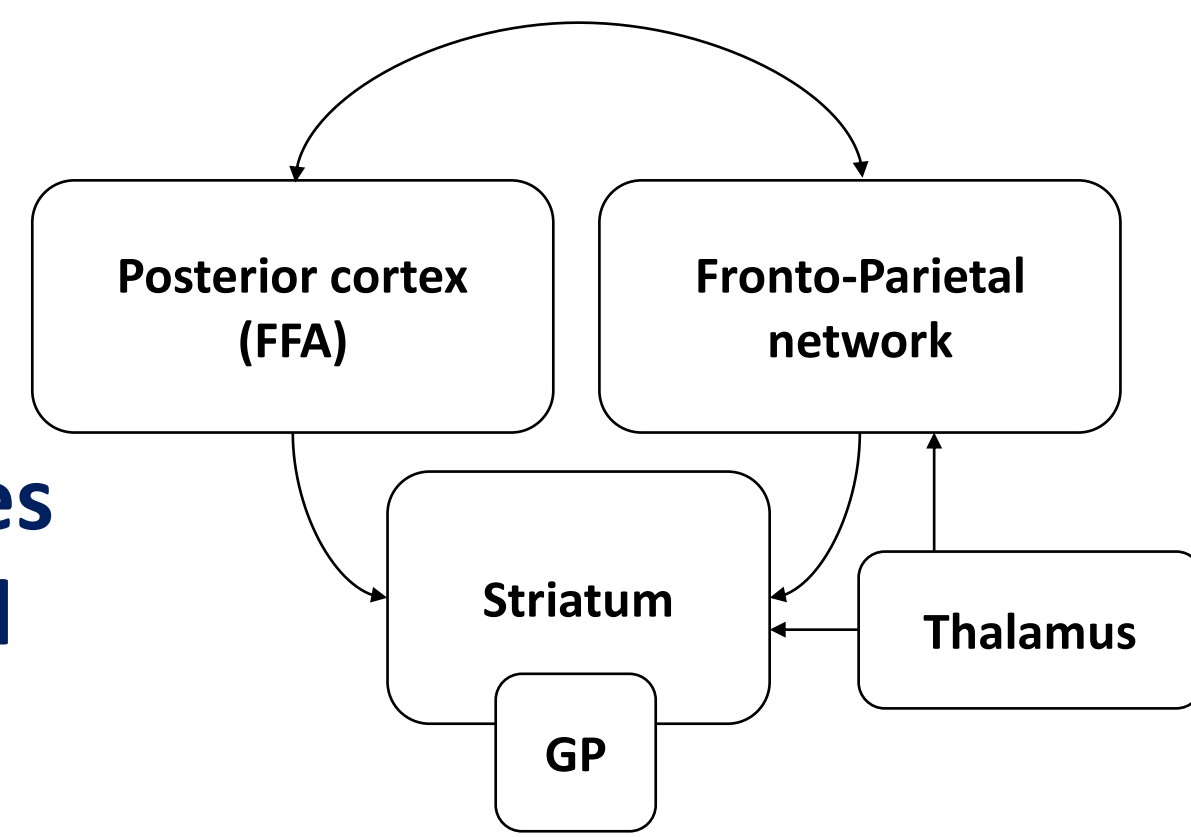
I. Introduction

➢ Working memory (WM) is the cognitive mechanism that enables retention of information over the short term and its manipulation as part of higher-level cognitive tasks[1].

➢ Due to its limited capacity, control over the contents of WM needs to take place.
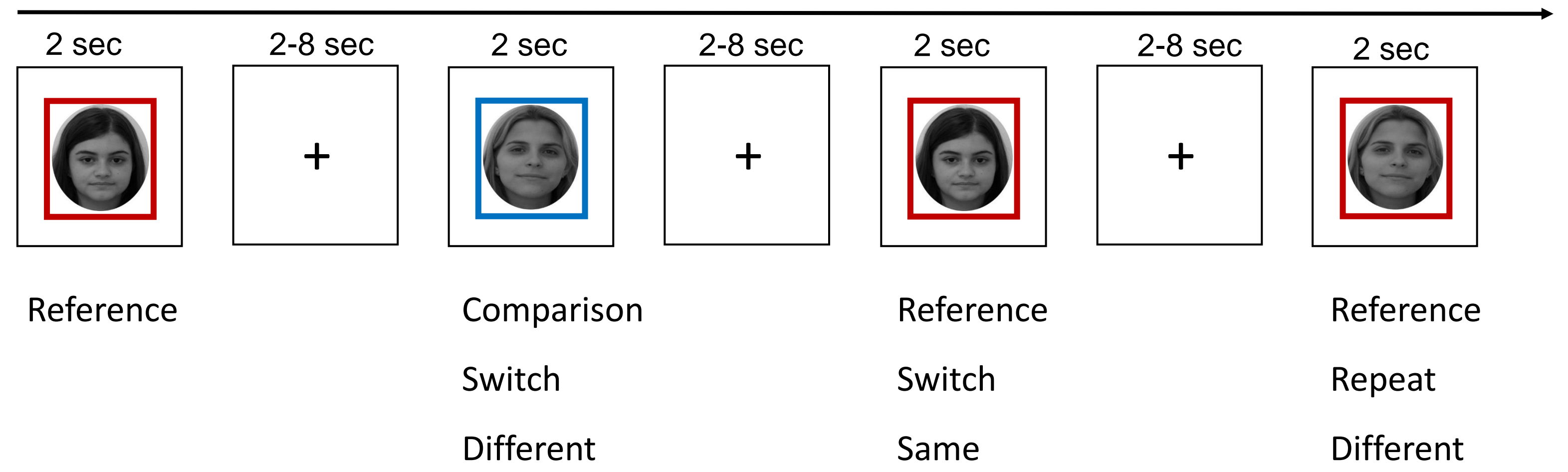
➢ The PBWM model[2,3] :

a) Update   b) Maintain

Working Memory   Gating — open / closed   Sensory Input
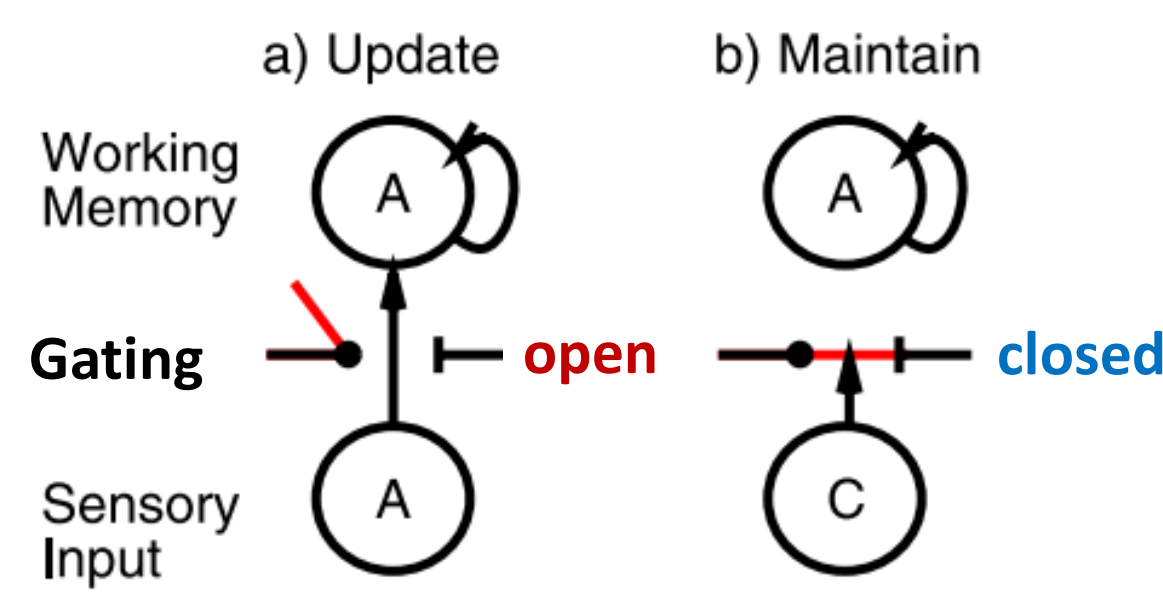
Goal:

To explore and identify the neural correlates of updating and gating in WM


II. Method

The "reference-back" paradigm[4,5]

	2 sec	2-8 sec	2 sec	2-8 sec	2 sec	2-8 sec	2 sec
Trial Type	Reference		Comparison		Reference		Reference
Switching			Switch		Switch		Repeat
Response			Different		Same		Different

Contrasts:

Trial Type	Reference				Comparison			
Gate Switch	Repeat		Switch		Repeat		Switch	
Response	Same	Different	Same	Different	Same	Different	Same	Different
Gate-opening	-	-	+	+				
Gate-closing					-	-	+	+
Substitution	-	+			+	-		
Updating mode	+	+			-	-		

III. Results

Behavioral Analysis
N = 48
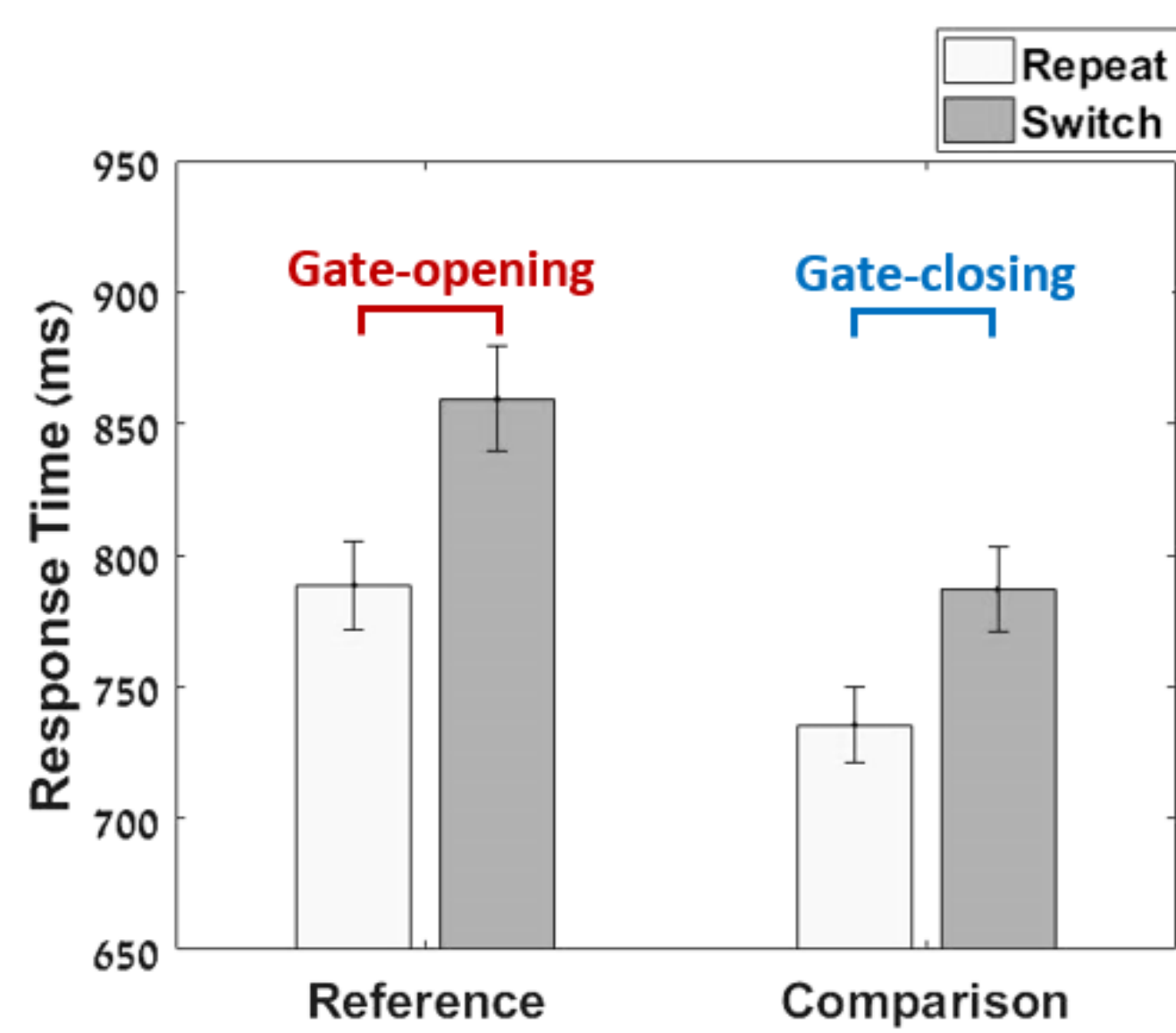
Gate-opening
$F(1,47) = 71.12$, $p < .001$, $\eta_p^2 = .60$

Gate closing
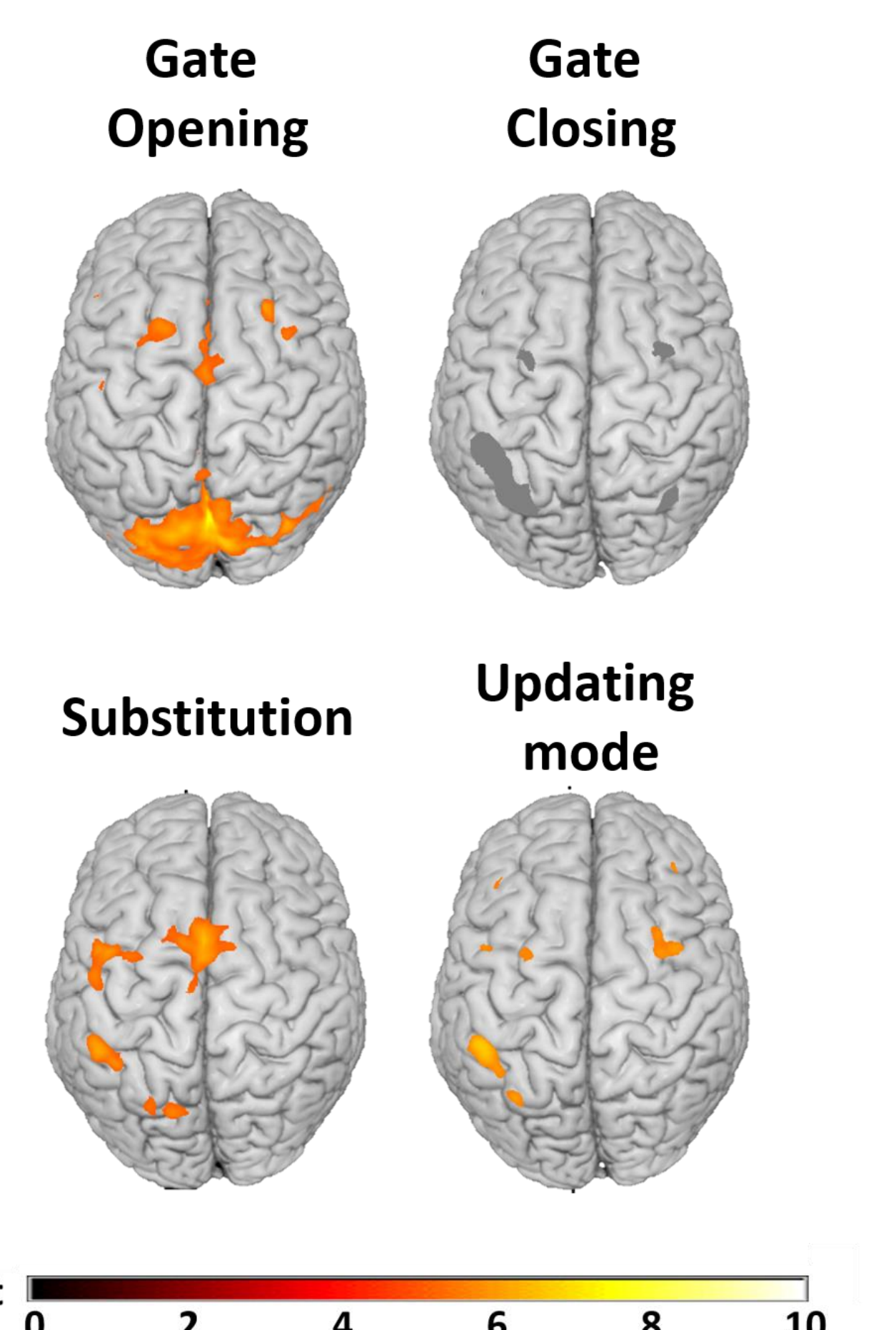$F(1,47) = 78.33$, $p < .001$, $\eta_p^2 = .62$
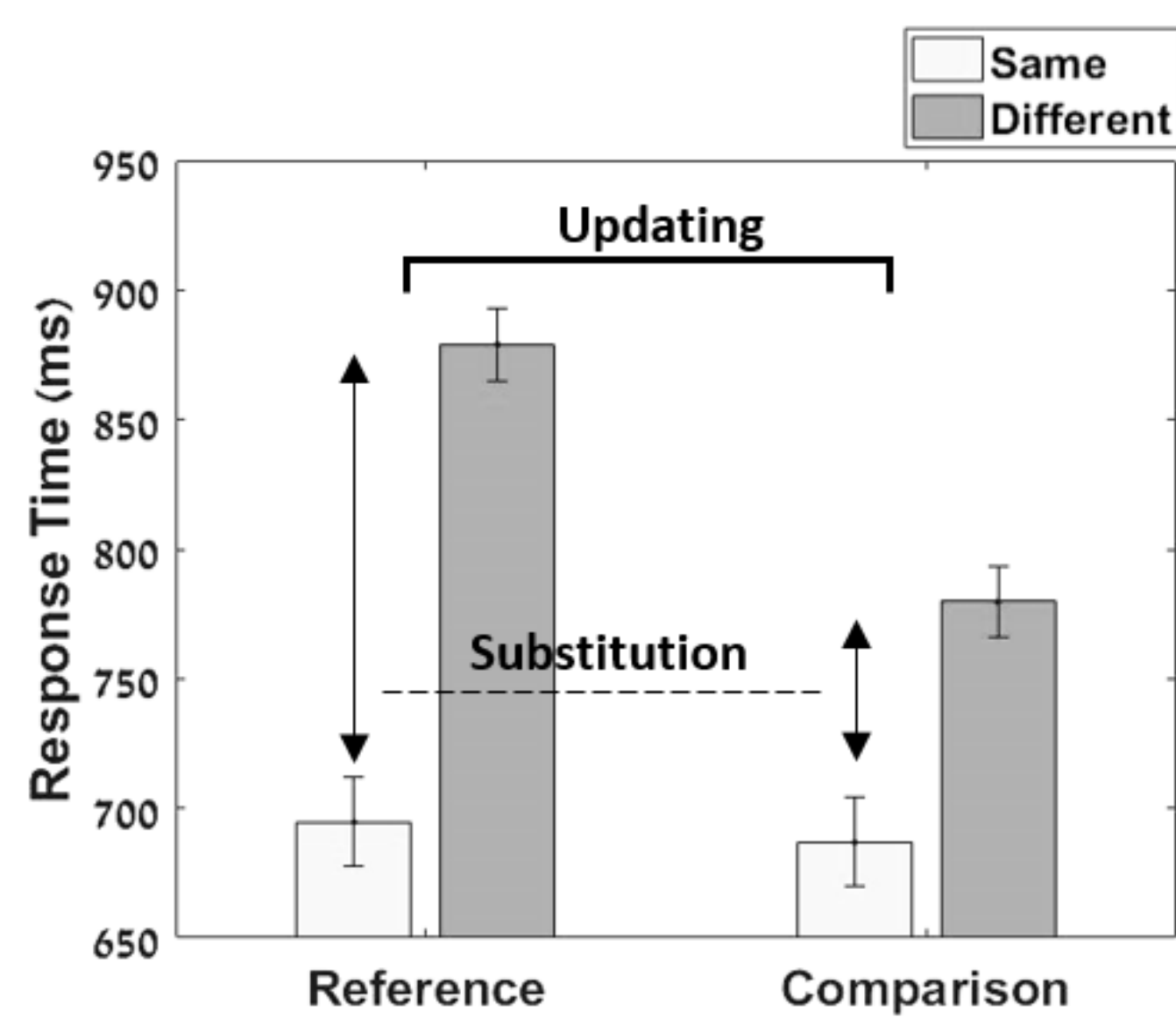
Substitution
$F(1,47) = 162.45$, $p < .001$, $\eta_p^2 = .77$

Updating
$F(1,47) = 57.88$, $p < .001$, $\eta_p^2 = .47$

ROI Analysis (FDR, *p* < .05)

Gate-opening   **Substitution**   **Updating mode**   **Gate-closing**

Fronto-parietal Network

Basal ganglia & Thalamus

FFA
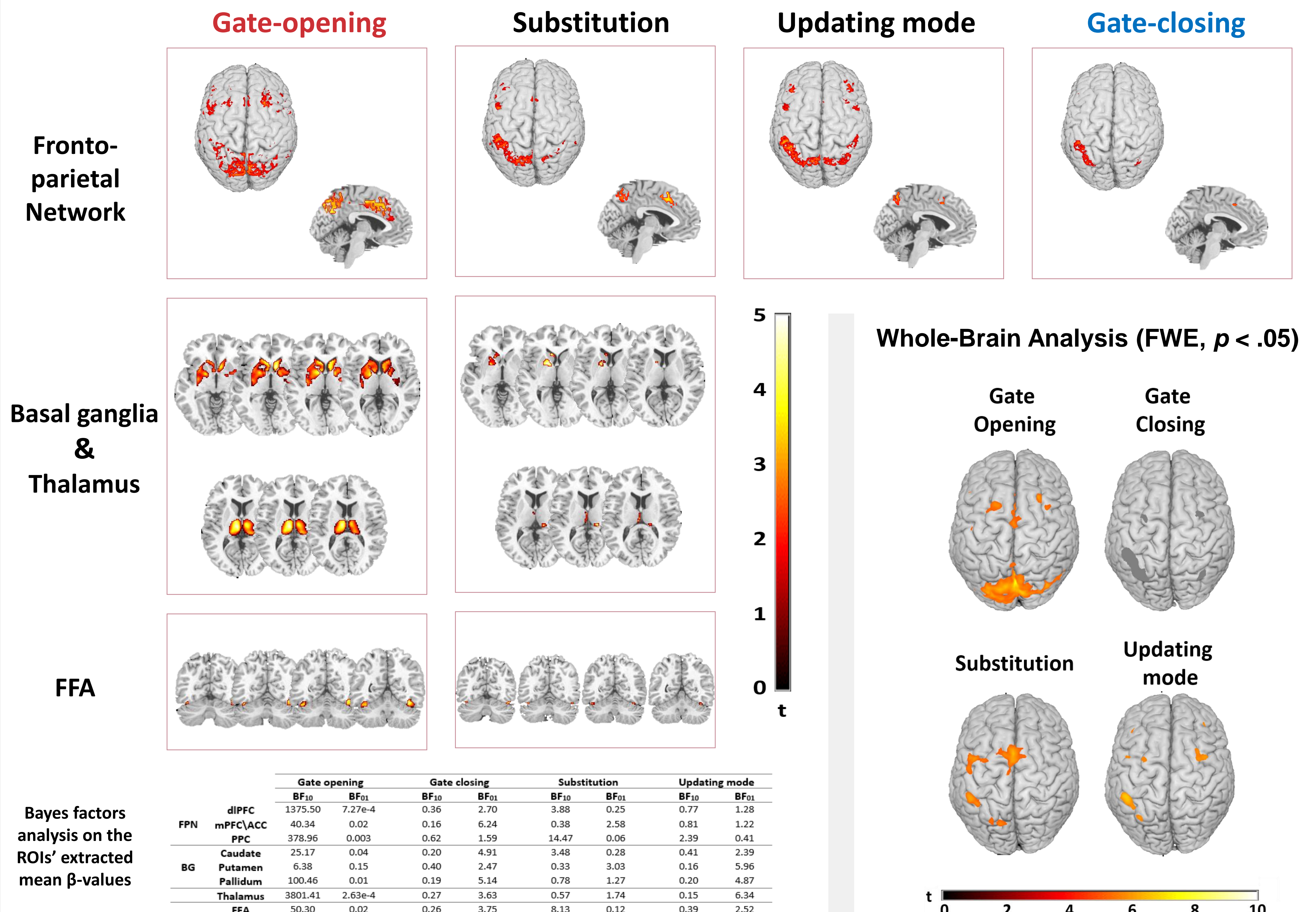
Whole-Brain Analysis (FWE, *p* < .05)

Gate Opening   Gate Closing   Substitution   Updating mode

Bayes factors analysis on the ROIs' extracted mean β-values

		Gate opening		Gate closing		Substitution		Updating mode	
		BF_{10}	BF_{01}	BF_{10}	BF_{01}	BF_{10}	BF_{01}	BF_{10}	BF_{01}
FPN	dlPFC	1375.50	7.27e-4	0.36	2.70	3.88	0.25	0.77	1.28
	mPFC\ACC	40.34	0.02	0.16	6.24	0.38	2.58	0.81	1.22
	PPC	378.96	0.003	0.62	1.59	14.47	0.06	2.39	0.41
BG	Caudate	25.17	0.04	0.20	4.91	3.48	0.28	0.41	2.39
	Putamen	6.38	0.15	0.40	2.47	0.33	3.03	0.16	5.96
	Pallidum	100.46	0.01	0.19	5.14	0.78	1.27	0.20	4.87
	Thalamus	3801.41	2.63e-4	0.27	3.63	0.57	1.74	0.15	6.34
FFA		50.30	0.02	0.26	3.75	8.13	0.12	0.39	2.52

IV. Discussion and Conclusions

➢ Supporting the PBWM model, opening the gate to WM relies on activating the fronto-thalamic-striatal loop.

➢ Supported by Bayesian analysis, BG and the thalamus showed a clear **single dissociation** – with strong evidence for gate-opening related activity, and strong evidence against gate closing related activity.

➢ Updating mode (i.e., keeping the gate open) relies exclusively on the FPN and not on any thalamic-striatal loop.

➢ Regions supporting perceptual processing of the task stimuli (i.e., the FFA) seem to be directly involved in WM input gating and substitution processes

References

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