Predictable Learning Demands Enable Direct Down-Regulation of Long-term Memory Encoding

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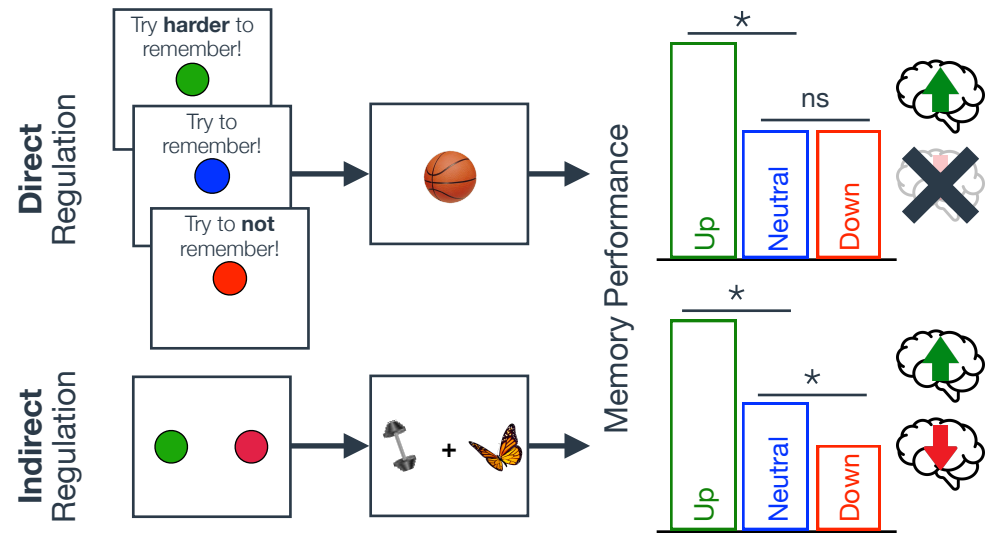
A. Background

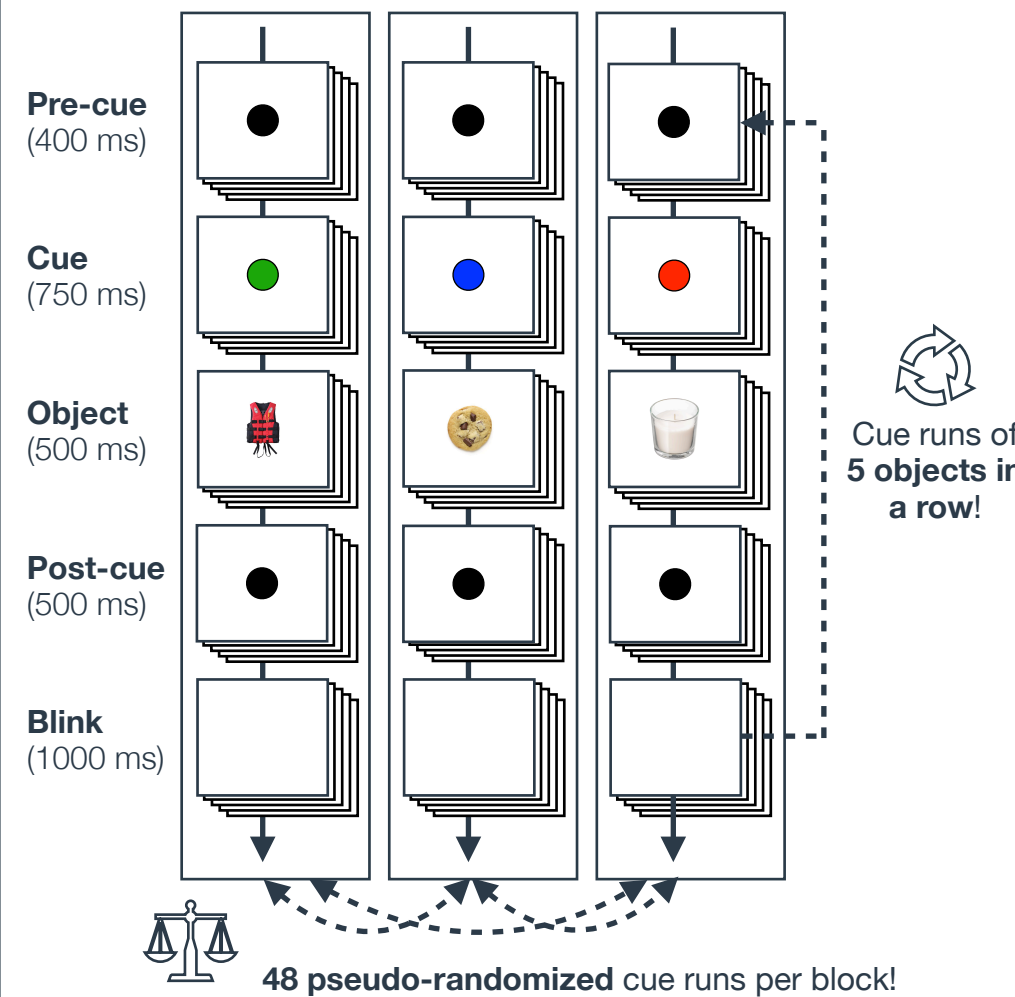Individuals can voluntarily regulate their memory encoding, but regulation is *asymmetrical* across learning goals

Direct Regulation
- Try **harder** to remember!
- Try to remember!
- Try to **not** remember!

Memory Performance: Up / Neutral / Down — * / ns

Indirect Regulation

Can observers directly down-regulate memory encoding when learning goals are *predictable*?

B. Method

Encoding Task

● Up ● Neutral ● Down
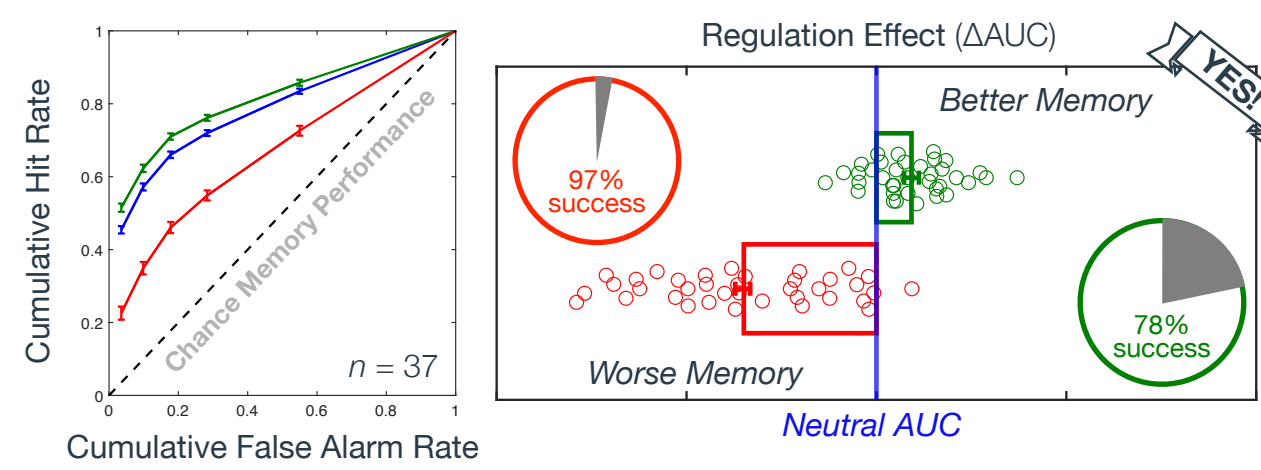
- Pre-cue (400 ms)
- Cue (750 ms)
- Object (500 ms)
- Post-cue (500 ms)
- Blink (1000 ms)

Cue runs of **5 objects in a row!**

48 pseudo-randomized cue runs per block!

Recognition Task

240 studied | 120 novel

Do you remember this picture?

400 ms — Untimed

Yes: 100% 60% 80% / No: 100% 80%
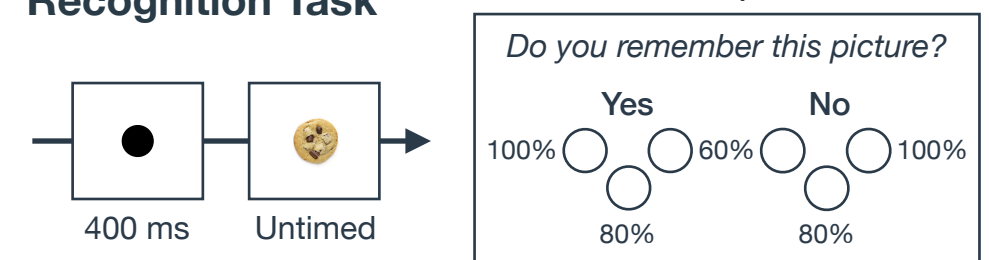
C. Did predictable demands enable direct down-regulation?

Cumulative Hit Rate vs Cumulative False Alarm Rate — Chance Memory Performance — $n = 37$

Regulation Effect (ΔAUC)

Better Memory — *Worse Memory* — Neutral AUC

97% success — 78% success

Down-regulation was successful for *nearly every observer*!

D. Was down-regulation restricted by time or resources?

After Neutral Run — NO! — Regulation Effect (ΔAUC) — Trial Index (within cue run): 1st 2nd 3rd 4th 5th

After Experimental Run — NO! — 1st 2nd 3rd 4th 5th
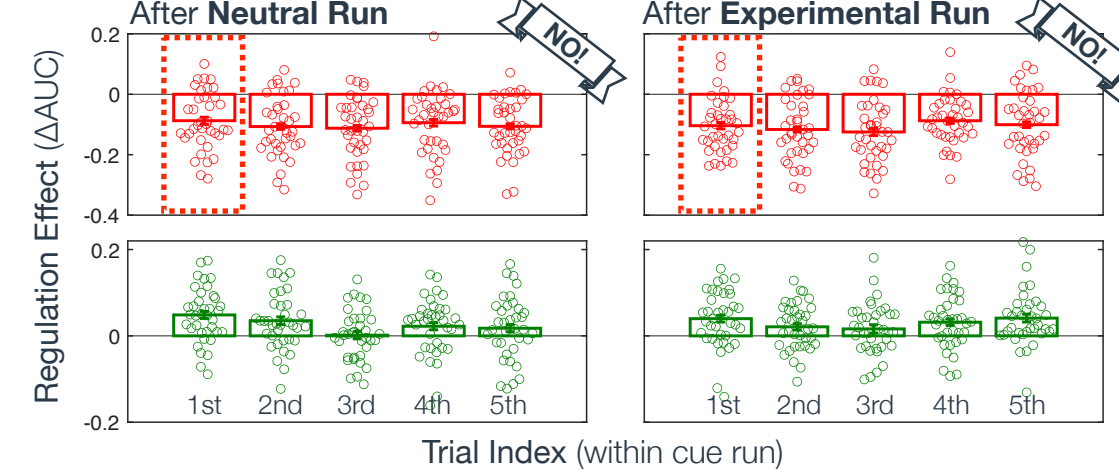
Down-regulation was *rapid* and *resource-efficient*!

E. Did down-regulation evolve in the course of the task?

Block 1 (Run 1-16) — NO! — 1st 2nd 3rd 4th 5th

Block 2 (Run 17-32) — NO! — 1st 2nd 3rd 4th 5th
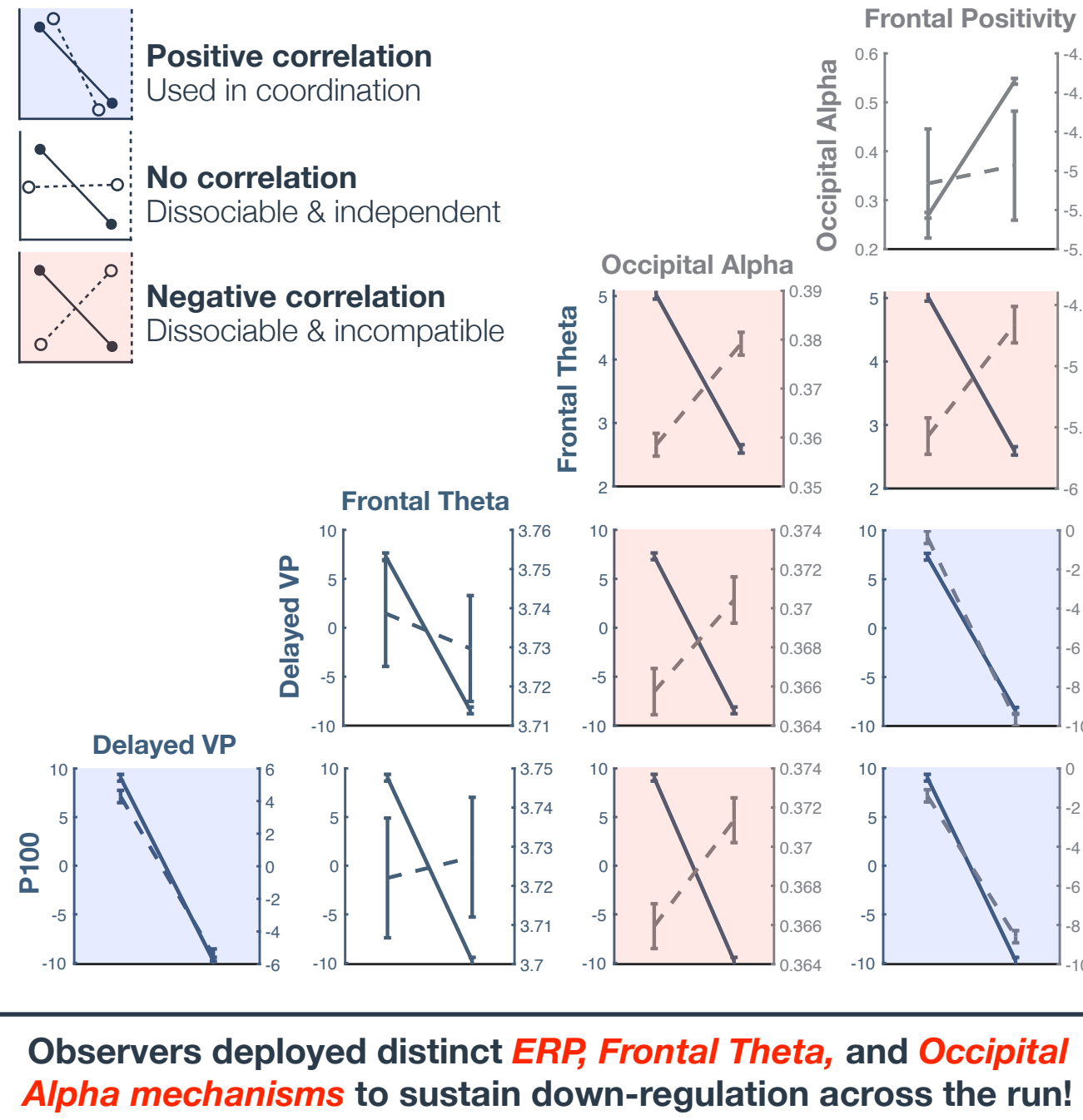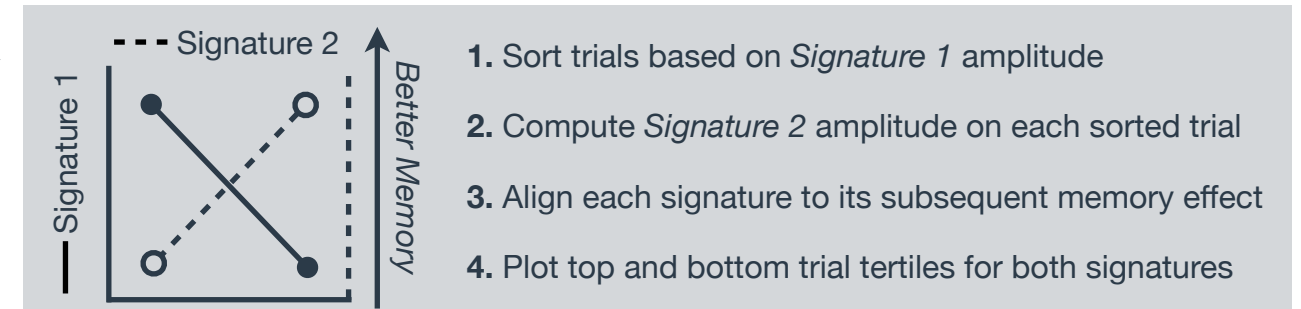
Block 3 (Run 33-48) — NO! — 1st 2nd 3rd 4th 5th

Down-regulation was *implemented early* and *uniformly* over time!

F. Was the cascade of stimulus processing in the brain uniform across time like behavior?

	Before Stimulus		During Stimulus		After Stimulus	
	Frontal Theta	*Occipital Alpha*	*Frontal Theta*	*P100/Delayed VP*	*Occipital Alpha*	*Frontal Positivity*
Early in Run	↑ Increase ↑	–	–	–	↓ Decrease ↓	–
Late in Run	–	↑ Increase ↑	↑ Increase ↑	–	–	↑ Increase ↑
Early in Run	↑ Increase ↑	–	–	–	–	↓ Decrease ↓
Late in Run	–	↑ Increase ↑	↓ Decrease ↓	↓ Decrease ↓	↑ Increase ↑	–

NO!

Frontal Theta — Amplitude (μV) vs Time (ms) — *Cognitive control during switch…*

Occipital Alpha — *…shifted to temporal expectancy later!*

Frontal Theta — *Divergent modulation!*

P100 + Delayed Visual Potentials — P100, DVP — *Sustained perceptual gating!*

Occipital Alpha — *Late modulation!*

Frontal Positivity — *Early modulation!*
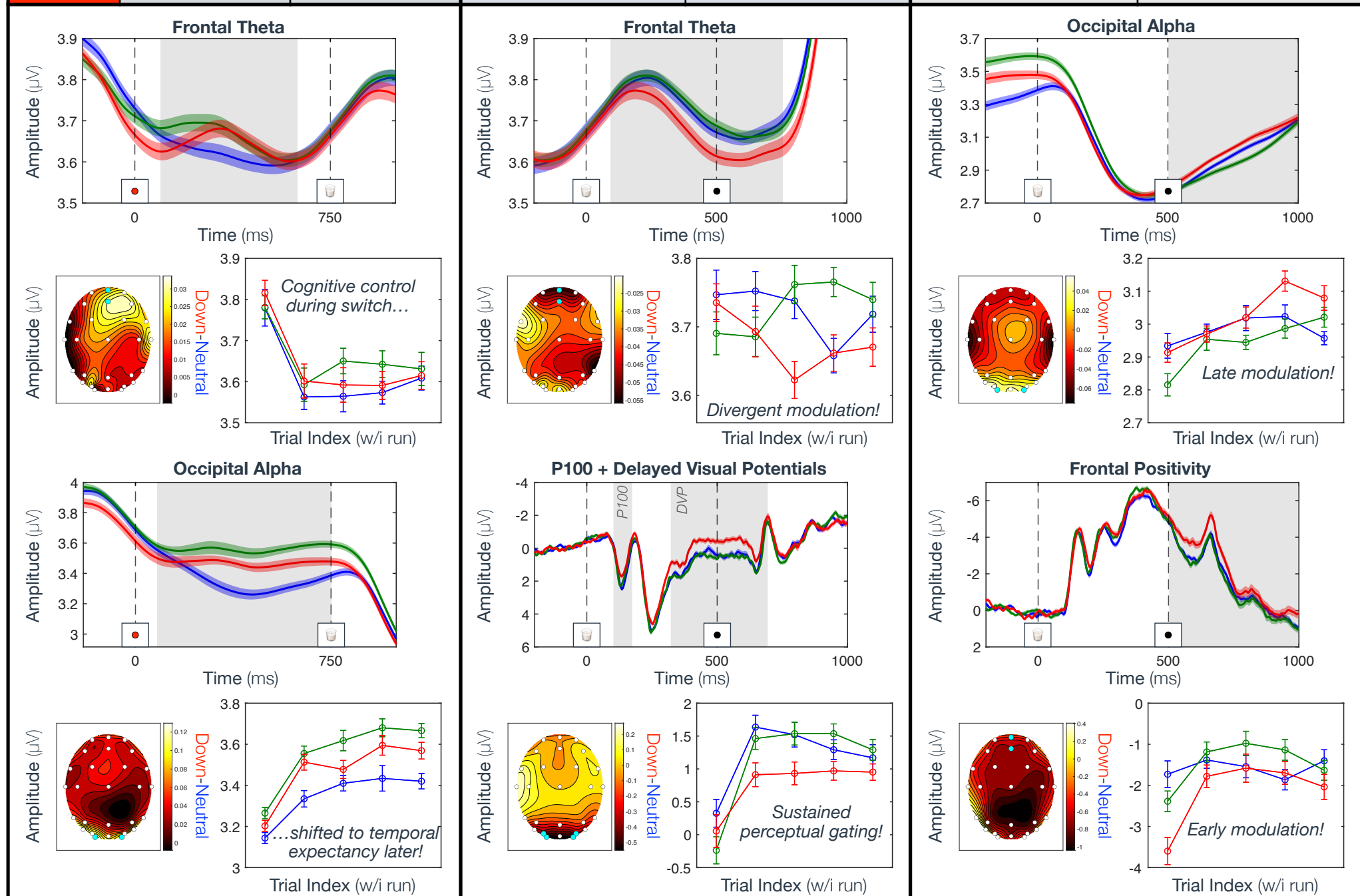
G. Were signatures of regulation coordinated or dissociable?

— Signature 1 / Signature 2 — *Better Memory*

1. Sort trials based on *Signature 1* amplitude
2. Compute *Signature 2* amplitude on each sorted trial
3. Align each signature to its subsequent memory effect
4. Plot top and bottom trial tertiles for both signatures

Positive correlation — Used in coordination
No correlation — Dissociable & independent
Negative correlation — Dissociable & incompatible

Frontal Positivity / Occipital Alpha / Frontal Theta / Delayed VP / P100

Observers deployed distinct *ERP*, *Frontal Theta*, and *Occipital Alpha mechanisms* to sustain down-regulation across the run!

H. Discussion

Predictable learning demands reveal an ability for individuals to directly down-regulate their long-term memory encoding.

Down-regulation success was *strikingly uniform*—it was deployed *quickly*, *sustained* for a brief period, & *was not strongly dependent* on available cognitive resources.

However, uniform behavioral success was *underpinned by variability* in dissociable & coordinated neural mechanisms that *changed across the run*.

Currently…

Was the predictability benefit observed here afforded by the *temporal consecutiveness* of learning demands or their *temporal predictability* per se?

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