



# Human medial temporal lobe (MTL) and medial frontal cortex (MFC) neurons represent metacognitive confidence judgments in a domain-specific manner across recognition memory and visual discrimination tests

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PSTR108.15

## Are the neural substrates of metacognitive confidence judgments in memory and perceptual tests domain-specific or domain-general?

We developed a new task that consists of recognition memory and visual discrimination tests, that tightly controlled for task structure and difficulty. 155 students conducted the computer task, which showed strong correlations in metacognitive bias between domains ( $r_{(153)} = .75$ ), but not metacognitive efficiency ( $r_{(153)} = .05$ ).

This task was tested in 6 epilepsy patients with depth-electrode implants that provided single-unit recordings in the amygdala, hippocampus, posterior temporal cortex, anterior cingulate cortex (ACC), supplementary motor area (SMA), and ventromedial prefrontal cortex (vmPFC).

To identify confidence-selective neurons, we assessed differences in firing rates between test trials rated with high versus low confidence during the stimulus presentation period. We report data from 5 sessions where patients reported each confidence rating at least 8 times per domain.

### Task: 4 study/test cycles (256 total test trials)

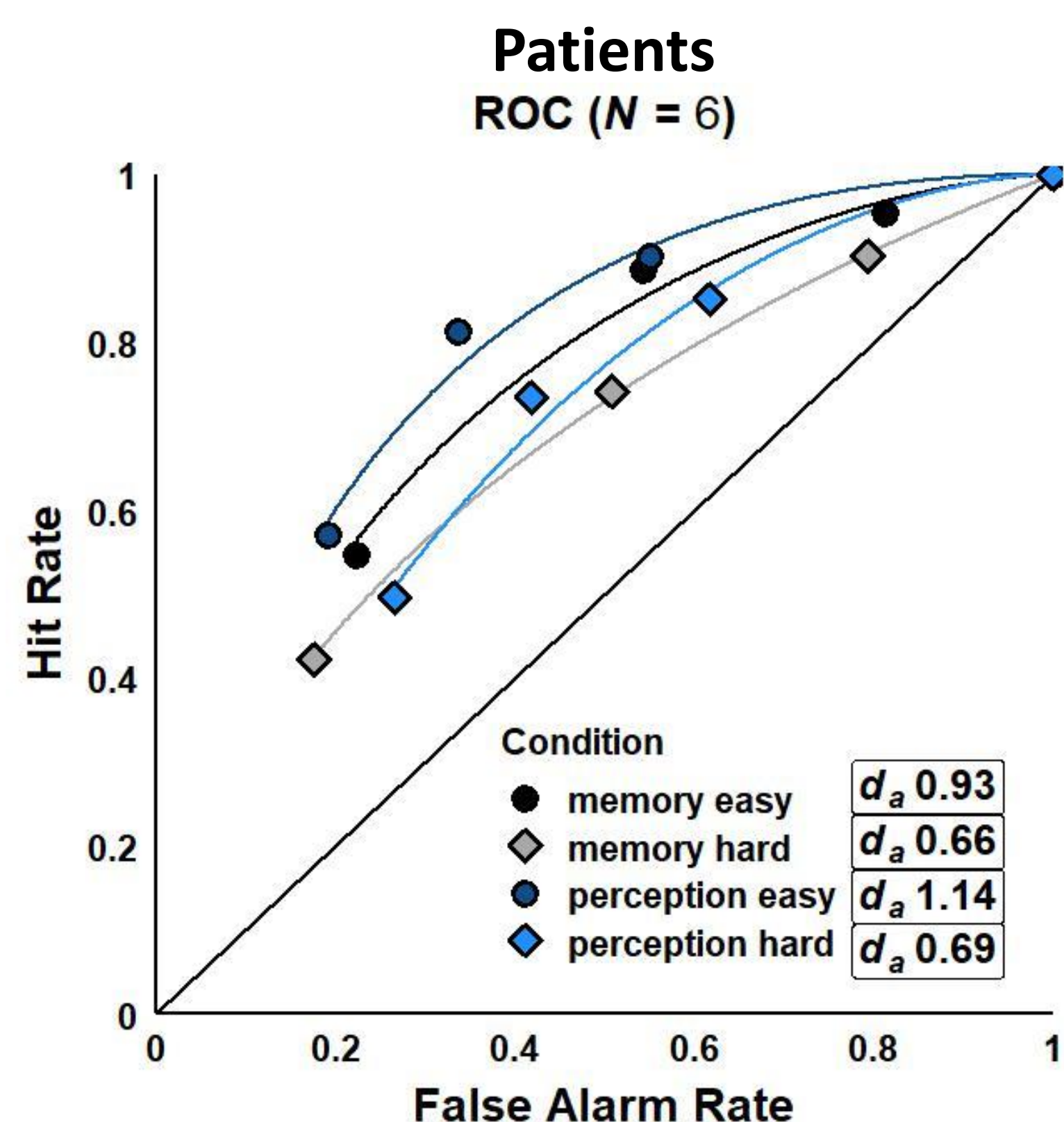
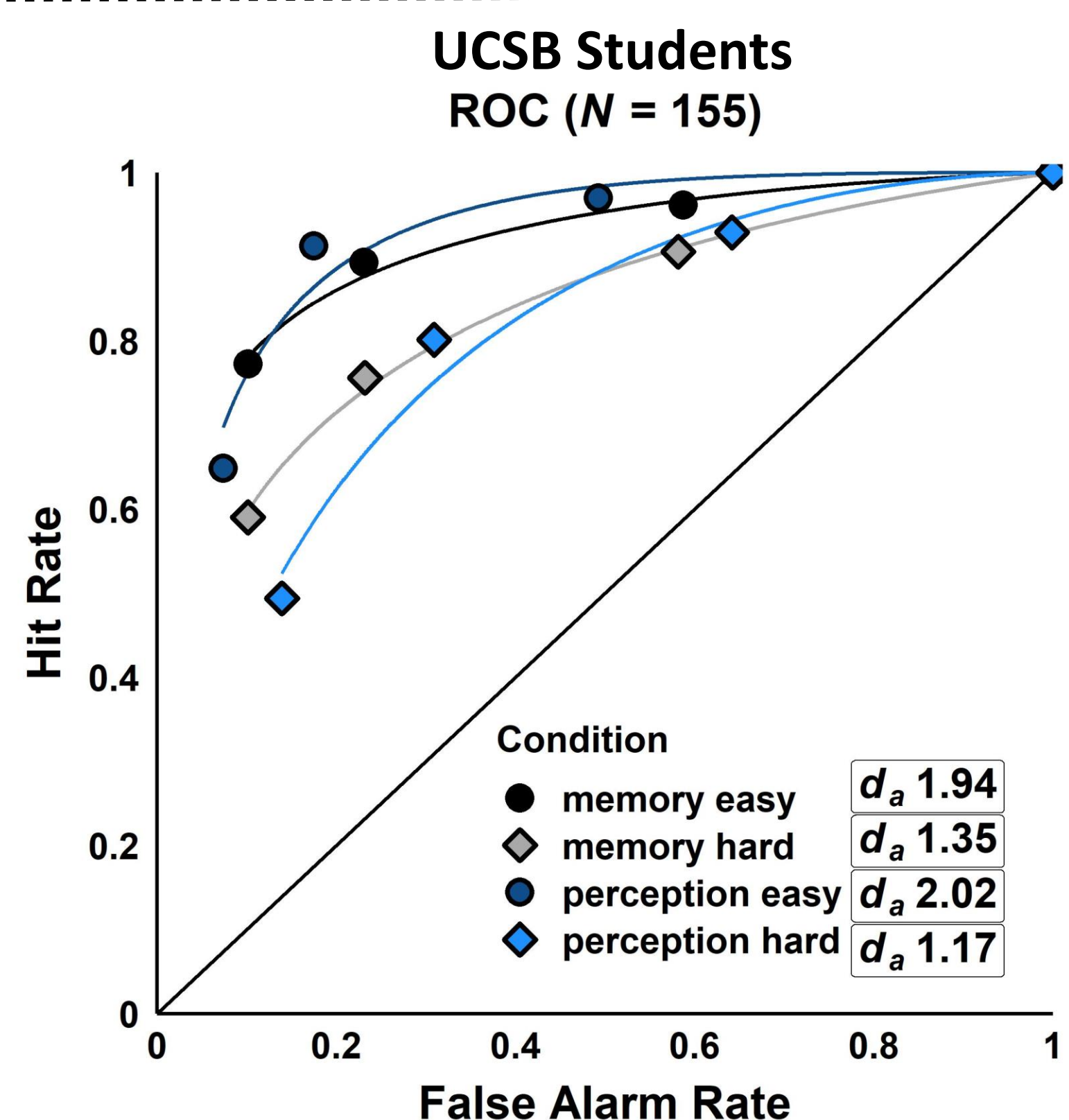
#### STUDY PHASE

16 shown 1x (hard), 16 shown 2x (easy)



#### TEST PHASE

(4 blocks of 16 trials)

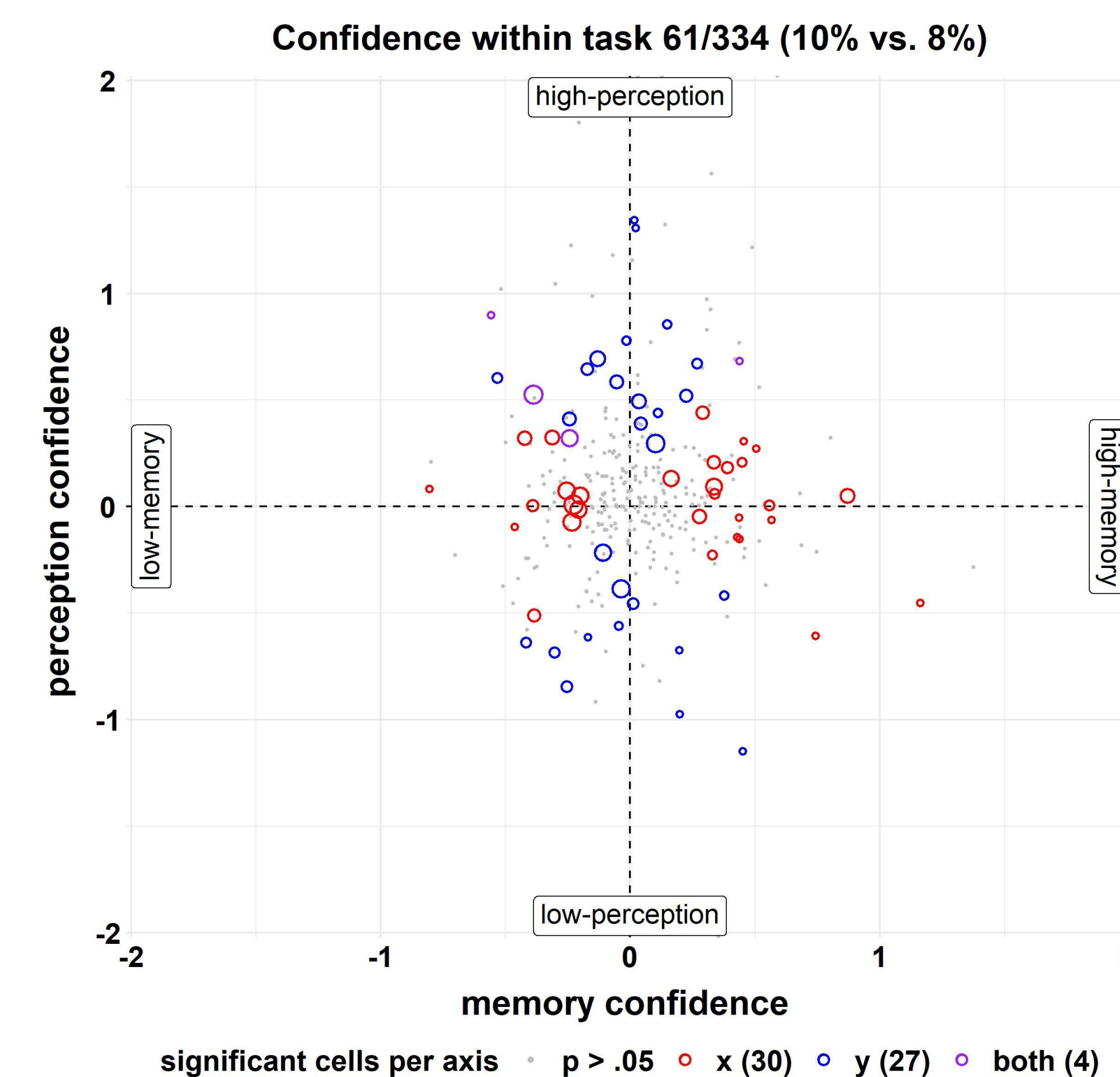


## Neural Results

### Neuron counts (5 patients)

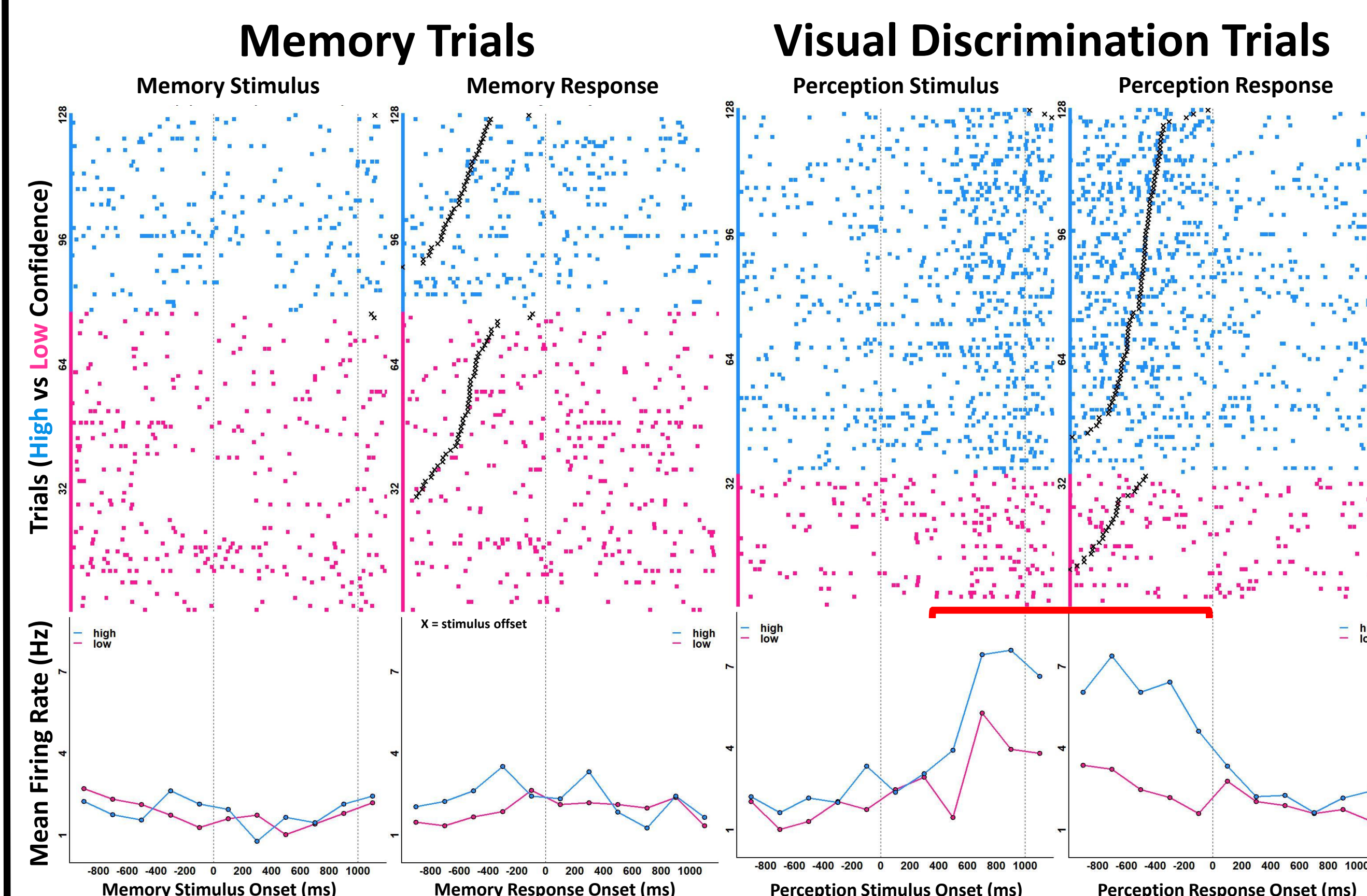
Brain Area	Total Neurons	Confidence-Selective Neurons	Decoding Accuracy (Confidence)
Amygdala	80	13 (16%)	62%
Hippocampus	58	6 (10%)	52%
Posterior Temporal	47	9 (19%)	54%
ACC	62	14 (23%)	61%
SMA	44	7 (16%)	55%
vmPFC	43	12 (28%)	57%
<b>TOTAL</b>	<b>334</b>	<b>61 (18%)</b>	<b>77%</b>

Neurons are confidence-selective if the firing rate differs for high vs. low confident responses during the 200 – 1200 ms period after stimulus onset in *either* the memory or visual discrimination test ( $p < .05$ ). Decoding accuracy for high vs. low confidence was performed via a linear SVM decoder ( $p < .05$ ; chance = 50%).



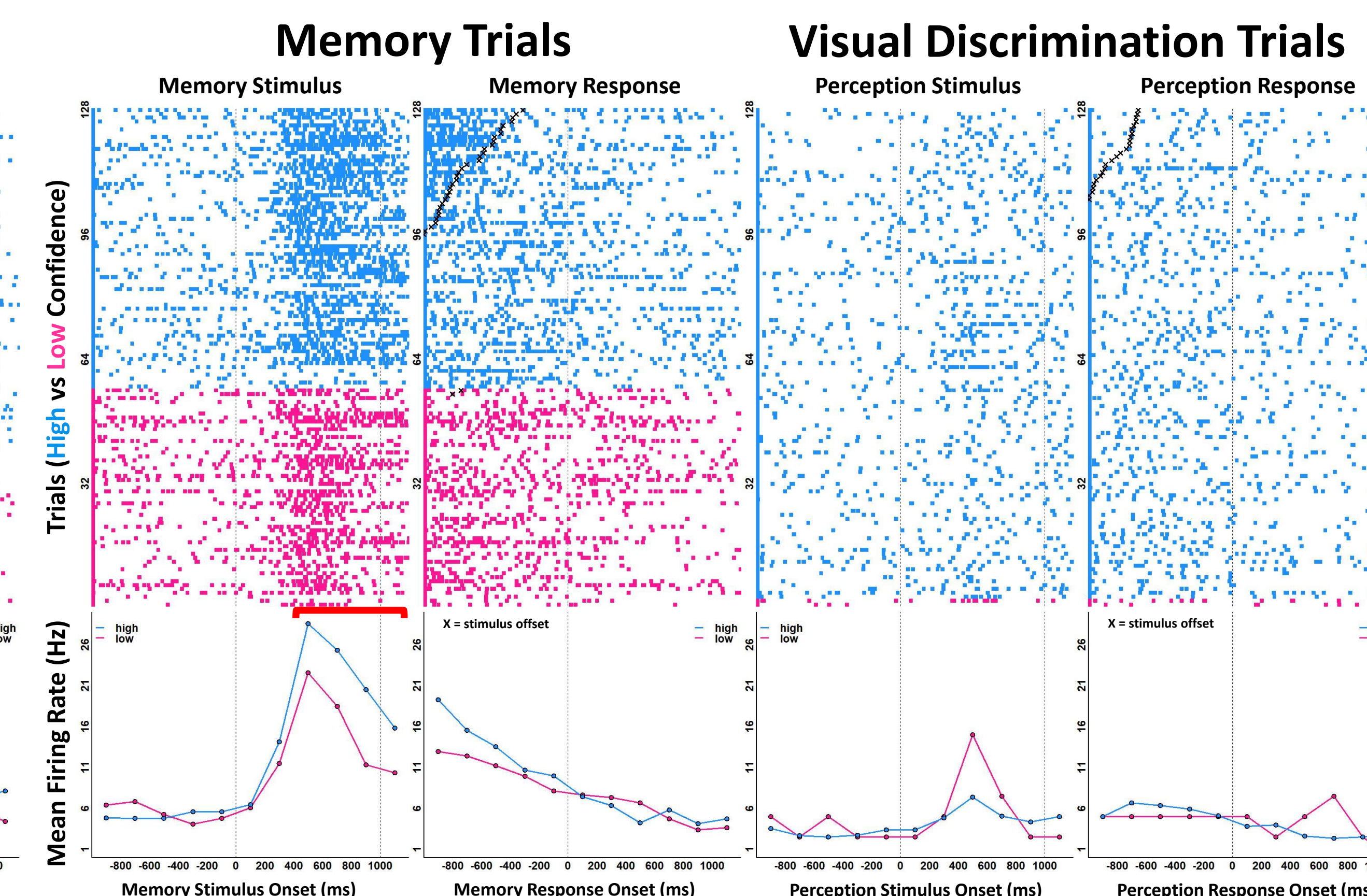
Natural log of mean firing rates for high vs. low confidence for memory (x) and visual discrimination (perception) tests (y).

### Raster plot: vmPFC neuron



This vmPFC neuron shows a greater firing rate for high vs. low confidence responses, but only during the visual discrimination test.

### Raster plot: Amygdala neuron\*



This amygdala neuron shows a greater firing rate for high vs. low confidence responses, but only during the memory test.

\*This session was excluded from analyses due to insufficient low confidence perception responses

## Conclusion

Data collection is ongoing, but preliminary results suggest that almost all of the confidence-selective neurons in these MTL and MFC regions are only selective in one of the two test domains (57/61 neurons). Many of these confidence-selective neurons are also task-selective (such as the neurons depicted in the raster plots), which means the firing rate is greater in one task versus the other *regardless* of the confidence rating. This suggests that confidence information is incorporated with task-specific processing in many of these confidence-selective neurons. Overall these results indicate that the neural substrates supporting metacognitive confidence judgments are largely represented in a domain-specific manner between recognition memory and visual discrimination tests at the single-unit level in these regions.

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Society for Neuroscience: 11/12/2023 (Washington, D.C.)