***Representation of choice bias in the activity of prearcuate gyrus during perceptual decision making***

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Optimal decision making often requires integrating current sensory information with prior history of choices, rewards and stimuli. Such biases may be beneficial when sensory information is weak or ambiguous, especially if the task structure is uncertain or when prior history carries relevant information about upcoming stimuli or rewarding actions. Here, we report the existence of history-dependent biases in the behavior of highly-trained monkeys performing a motion direction discrimination task and demonstrate a neuronal representation of the bias in the activity of prearcuate gyrus (PAG) neurons. In our task, stimulus direction and strength varied randomly on a trial-by-trial basis, making previous history irrelevant for the future choice. Despite this fact, monkeys showed small but significant biases that fluctuated at two distinct time scales: slow (tens to hundreds of trials) and fast (previous trial). Fast bias on each trial reflected previous choice and feedback, while slow bias reflected the monkey's choice preference within the neighboring trials. Knowing these biases significantly improved our ability to predict monkeys' upcoming choice on the individual trials. Importantly, the increased prediction accuracy was strongest for trials with weaker motion, suggesting a stronger role of prior history in shaping the choice when sensory information is limited (improved accuracy $> 2.5$ % for difficult motion coherence with p(correct) $< 0.75$, compared to a model that predicted choices based only on the stimulus strength).

The pre-stimulus population activity of PAG neurons represented the fast and slow biases, indicating a correlate for both types of bias in the prefrontal cortex. Critically, adding the trial-to-trial variability of these neural representations of bias to our choice prediction model trended toward improving the model accuracy, suggesting that these representations reflected the subjective biases that shaped the behavior. The same activity was also directly predictive about the monkey's upcoming choice but further mediation analyses suggest that this predictive power was a consequence of representing bias signals. Since the same PAG neurons also represented past choices and feedback that shaped the subjective bias, they could offer a compact circuit for the computation of prior history signals and leveraging those signals to guide behavior.

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