Presentation Abstract

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Presentation Title:	Neural mechanisms of context representation and reinforcement expectation in the amygdala and prefrontal cortex
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Abstract:	The motivational significance of a sensory stimulus can depend upon the context in which it appears. Often the context is not explicitly signaled but instead is internally represented (a "cognitive" representation). To investigate how the brain combines sensory and cognitive information to predict reinforcement, we trained monkeys to perform a task in which the reward associated with visual stimulus presentation depended upon context. In Context 1, liquid reward followed one image but not another; in Context 2, reinforcement contingencies reversed. Within sessions, Contexts 1 and 2 switched many times unpredictably. Behavioral data indicate that monkeys did not gradually re-learn stimulus-outcome associations after a context switch. Instead, they switched between 3 different "mental states": a default state immediately after a context switch, and states corresponding to each context. These data suggest that monkeys retain an abstract representation of each context to guide reward prediction.

We recorded single unit activity in the amygdala and 2 parts of prefrontal cortex (PFC), orbitofrontal and anterior cingulate cortices, while monkeys performed the context-switching task. To analyze the data, we trained a linear readout to decode from the firing rate of the populations of recorded neurons the task relevant parameters: context, visual stimulus identity, and reward expectation. The cross-validated decoding accuracy was significantly above chance for all task relevant parameters and all recorded areas on trials when monkeys correctly expected reward or no reward. On trials in the default state, decoding accuracy dropped to chance level for context and reward expectation. On error trials, decoding accuracy remained the same for image identity and context but decreased for reinforcement expectation. To explain the errors, we hypothesized that neural representations require that information about image identity and context be mixed non-linearly in the neural responses to underlie performance. Neural responses reflect non-linear mixing when they cannot be explained by a linear combination of selective response properties. Non-linear mixed selectivity allows a linear readout to generate correct reward expectation. We found that the strength of the non-linear mixed selectivity component of the recorded neurons significantly decreases on error trials in the amygdala, but not PFC. This result suggests that the amygdala represents a nexus for cognitive-emotional interactions, playing a central role in processing sensory stimuli and internally represented contextual information to generate reinforcement expectations.

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MENTAL STATE

CONTEXT

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