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### Active Mechanisms of Learning and Decision-Making

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ITI 2850 -3150 ms

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Stim on = RT



Direction of intervening motion stimulus

#### Akaishi et al., Neuron, 2014

prev

-Low

### $V_{n+1} = V_n + \alpha(R_n - V_n)$

### $P_{C} = f(V_{n})$

# $CE_{m+1} = CE_{n} + c((C_{n} + E_{0})E_{n})$ $P_{C} = f(CE)$

CE: Entinetestimate C: Choice



### $CE_{n+1} = CE_n + \alpha(C_n - CE_n)$

## Cn - CEn









## **Predictor Selection**



# Credit Assignment







# L:60% L:20% R:40% R:40%



60% Reward



### 80% Reward

# Rain:60%Rain:20%Sun:40%Sun:80%



Rain Option Sun Option Association 1.0% Strength Cues Choice

> Non-Selected Predictor

Selected Predictor

### Prediction Weight model



















### **Selected Predictor**





**Non-selected Predictor** 



### Summary

- Subjects solve credit assignment by selecting one cue as a predictor of outcome.
- If the prediction is confirmed, credit for the outcome is assigned to the selected predictor.
- If it is disconfirmed, credit is switched to the non-selected predictor.
- MFC and IOFC underlie the confirmation and switch processes, respectively.

### **General Discussion**

- Predictor Selection = Information Seeking
  - Advance information (Bromberg-Martin & Hikosaka, 2009)
  - Attention-based information accumulation (Krajbich, Armel, & Rangel, 2010)
  - Information seeking in learning and decision making (Gottlieb, 2012)
- When making decisions, an animal is also actively choosing information.
- "Hypothesis (Testing)":
  - ...responses to ... cues from experimenter's ... represent attempted solutions. (Lashley, 1929)
  - ... "attempted solutions" or "hypotheses"... rats adopt a series of hypotheses before finally hitting on the correct hypothesis (Sutherland & Mackintosh, 1971)
- When experiencing the outcome of action, it is used to reevaluate the information context that led to the action by confirming/disconfirming it.

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