Active Mechanisms of Learning and Decision-Making

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\[ V_{n+1} = V_n + \alpha(R_n - V_n) \]

\[ P_C = f(V_n) \]

\[ CE_{m+1} = CE_n + \alpha(C_n, E_n, E_n) \]

\[ P_C = f(CE) \]

CE: Choice Estimate
C: Choice
E: Estimate

Akaishi et al., Neuron, 2014
$$CE_{n+1} = CE_n + \alpha (C_n - CE_n)$$
Trial 1

No feedback

Trial 2
Predictor Selection & Credit Assignment
Association Strength

Cues

Choice

Non-Selected Predictor

Selected Predictor
Prediction Weight model

Basic model

C1 \rightarrow D \quad p_w

C2 \rightarrow D \quad (1-p_w)

BIC

Basic model

Prediction Weight model

C1 \rightarrow D \quad 0.86

C2 \rightarrow D \quad 0.14
Learning Weight & Feedback model

Correct Feedback

Incorrect Feedback

Learning Weight model

Correct/Incorrect Feedback

R-W model

Correct/Incorrect Feedback
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 \( \equiv \) 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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