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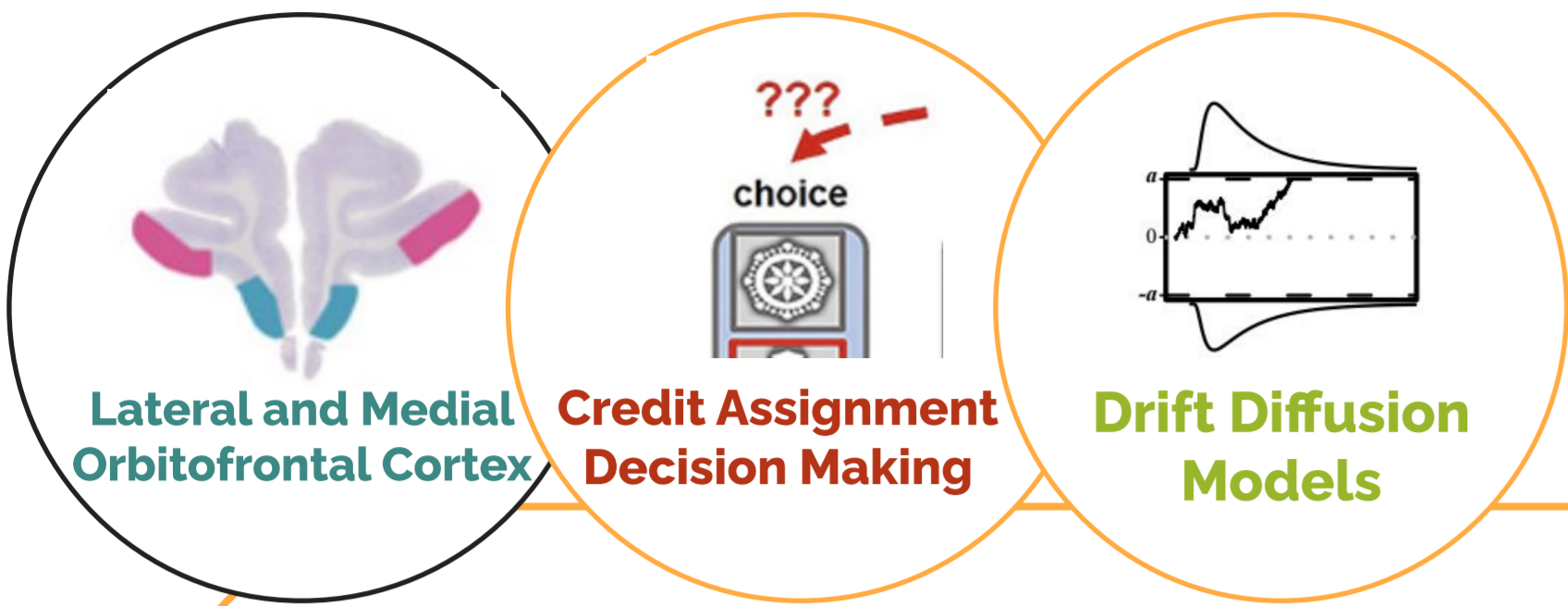
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# A computational model of the lateral and medial Orbitofrontal Cortex in instrumental learning tasks

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## Abstract

**Orbitofrontal cortex (OFC)** : One of the crucial regions in the prefrontal cortex (PFC) involved in decision-making and instrumental learning

- The exact mechanisms through which the OFC encodes, or processes information related to decision-making and learning are unclear.

**Lateral and Medial OFC (ventromedial PFC)**: Several lesion studies have shown that both the sub-regions have differential roles in the process of instrumental learning in the context of multi-alternative choice.

**Multi-alternative decision-making model**: We use a variation of drift diffusion models (DDM) based on an Advantage Race Diffusion (ARD) framework for choices among two or more options, that captures stimulus difficulty, speed-accuracy trade-off, and stimulus-response-mapping reversal effects (RL-ARD)

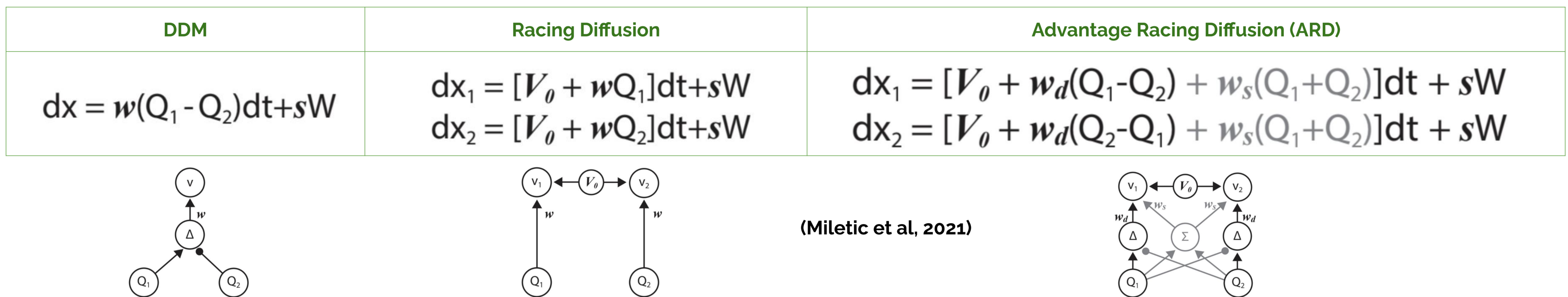
**Complementary roles of lateral and medial OFC**: The ARD based accumulators are driven by both *difference* and *sum* of the mean reward expectancies.

- We simulated lesions of lateral and medial OFC structures on a 3-arm bandit task with varying reward probabilities

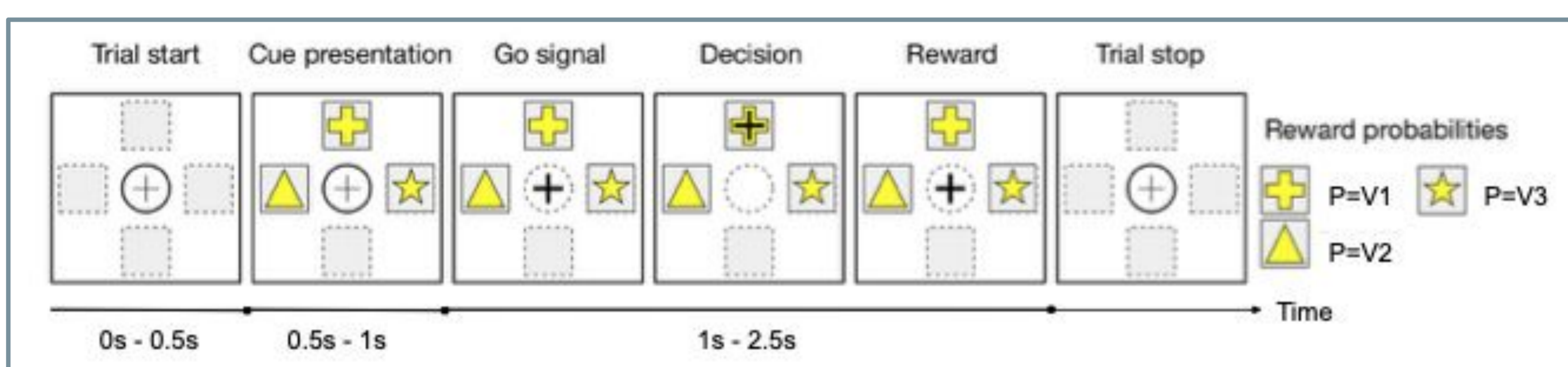
The model showed differential effects in performance depending on the value difference of the presented options, thus accounting for recent experimental findings about the dissociate functional roles of both the sub-regions.

## Model and Experimentation

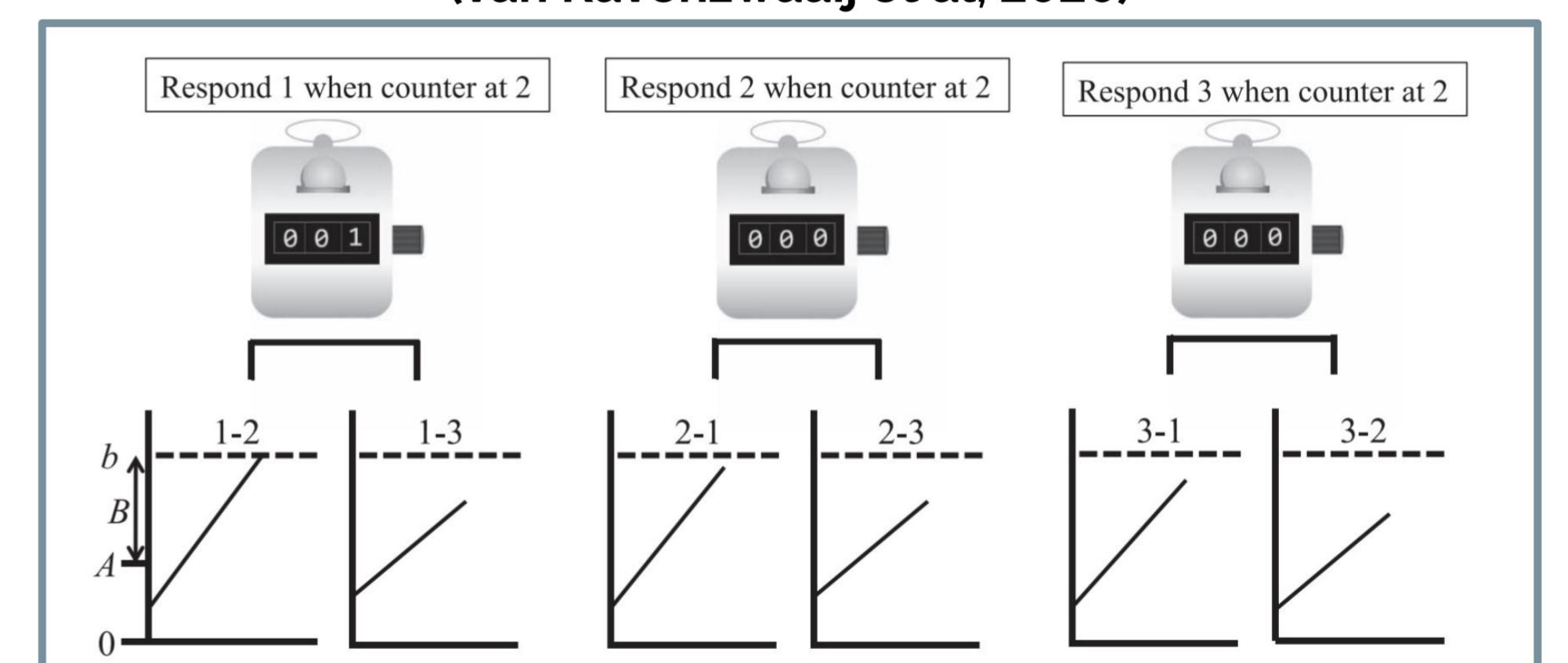
### Binary choice - Advantage Race Diffusion (ARD)



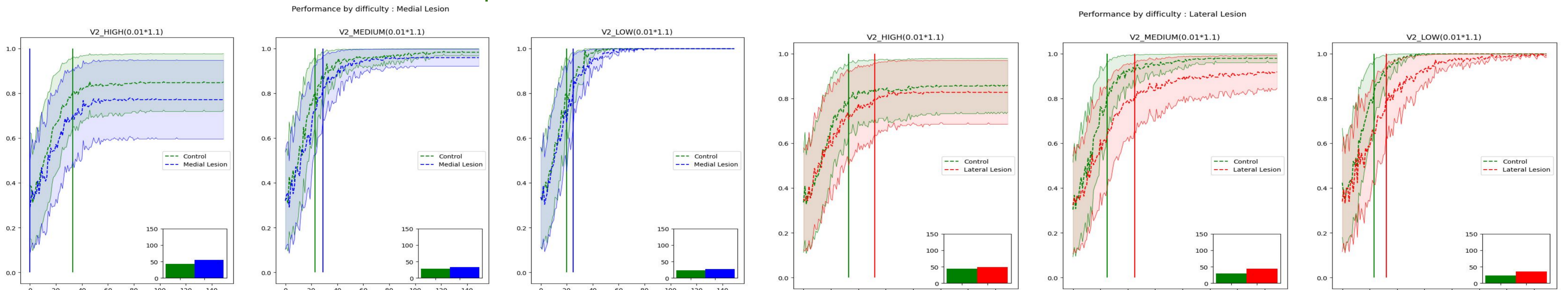
### Multi-alternative choice - 3-Arm bandit Task



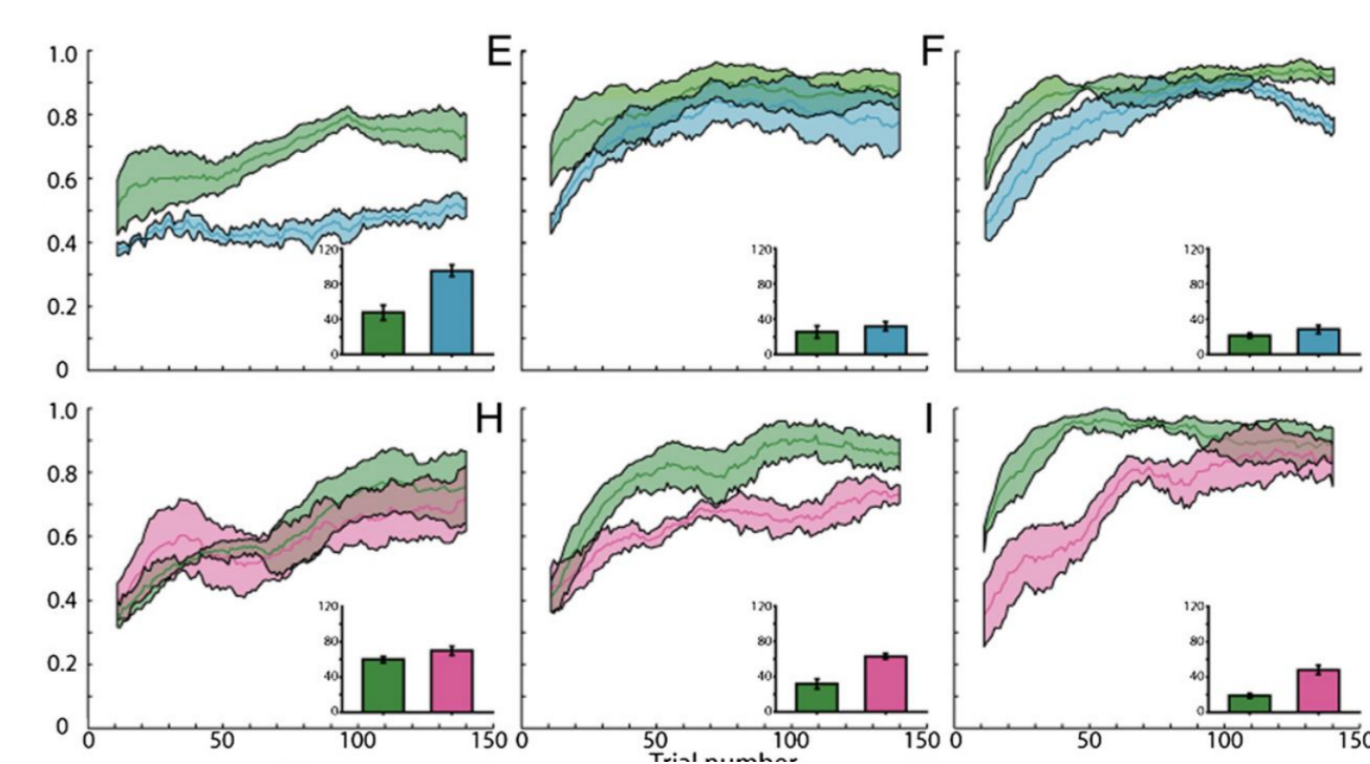
### Advantage Linear Ballistic Accumulators (ALBAs) (van Ravenzwaaij et al, 2020)



### Separate mechanisms in medial and lateral OFC - Lesion simulations, Results



Medial OFC Lesion	Lateral OFC Lesion
Value Comparison	Learning Credit Assignment
$dx_1 = [V_0 + w_d(Q_1 - Q_2) + w_s(Q_1 + Q_2)]dt + sW$ $dx_2 = [V_0 + w_d(Q_2 - Q_1) + w_s(Q_1 + Q_2)]dt + sW$	$dx_1 = [V_0 + w_d(Q_1 - Q_2) + w_s(Q_1 + Q_2)]dt + sW$ $dx_2 = [V_0 + w_d(Q_2 - Q_1) + w_s(Q_1 + Q_2)]dt + sW$ $Q_{i,t+1} = Q_{i,t} + \alpha(r_t - Q_{i,t})$



(Noonan et al, 2010)

## References

[Miletic et al., 2021] Miletic, S., Boag, R. J., Trutti, A. C., Stevenson, N., Forstmann, B. U., & Heathcote, A. (2021). A new model of decision processing in instrumental learning tasks. *eLife*, 10, e63055. <https://doi.org/10.7554/eLife.63055>  
[van Ravenzwaaij et al, 2020] van Ravenzwaaij, D., Brown, S. D., Marley, A. a. J., & Heathcote, A. (2020). Accumulating advantages: A new conceptualization of rapid multiple choice. *Psychological Review*, 127(2), 186–215. <https://doi.org/10.1037/rev000166>  
[Noonan et al., 2010] Noonan, M. P., et al. "Separate value comparison and learning mechanisms in macaque medial and lateral orbitofrontal cortex." *Proceedings of the National Academy of Sciences* 107.47 (2010): 20547-20552.