# Orbitofrontal network-targeted TMS disrupts neural signaling of identity prediction errors

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## Background

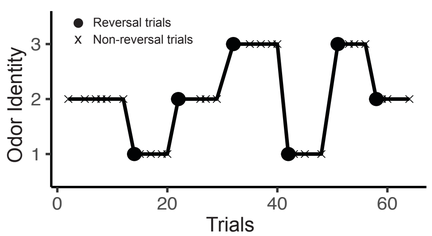
- Learning and representing reward identity supports goal-directed behaviors and is critical for flexible decision making in volatile environments.
- Midbrain dopaminergic system signals violations in value-neutral sensory features of expected rewards (Howard & Kahnt, 2018; Takahashi et al., 2017).
- Lateral orbitofrontal cortex (OFC) represents the identity of predicted outcomes (Howard & Kahnt, 2018; Stalnaker et al., 2014).
- ***Question***: Is the lateral OFC network (encoding identity expectations) critical for computation and representation of identity prediction errors (PEs)?

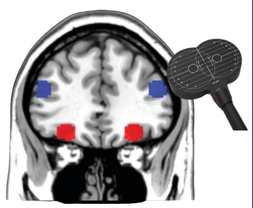
## Experiment Design

Trans-reinforcer reversal learning task

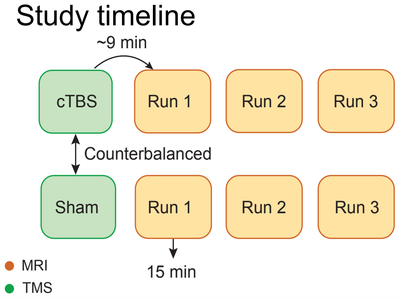
- Subjects (n = 31) predict which of the three pre-selected value-matched odors is associated with the cue.
- Cue-reward associations were switched multiple times.


Reward identity schedule



Study timeline

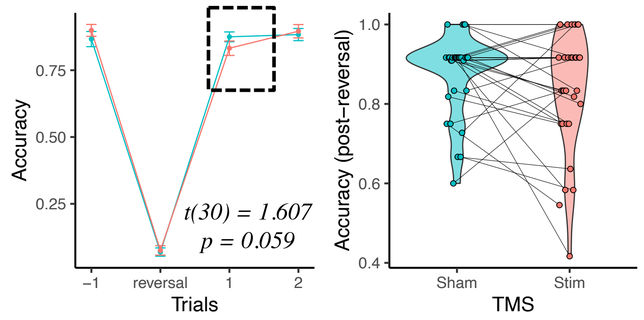



Network-targeted TMS: find the voxel coordinate in LPFC with the highest functional connectivity with OFC

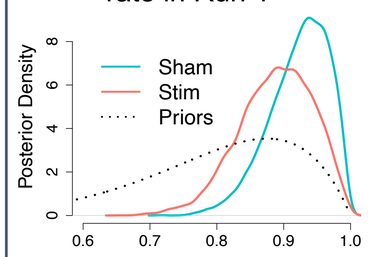
Continuous theta burst stimulation (cTBS): expected to inhibit activity for up to 60 mins

## Behavioral Results

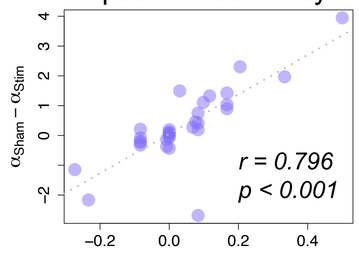
TMS lowers post-reversal accuracy in the first run




TMS lowers learning rate in Run 1



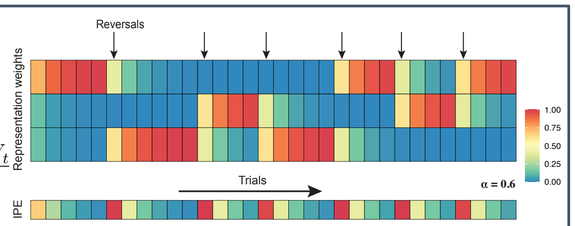

Learning rate correlates with post-rev accuracy



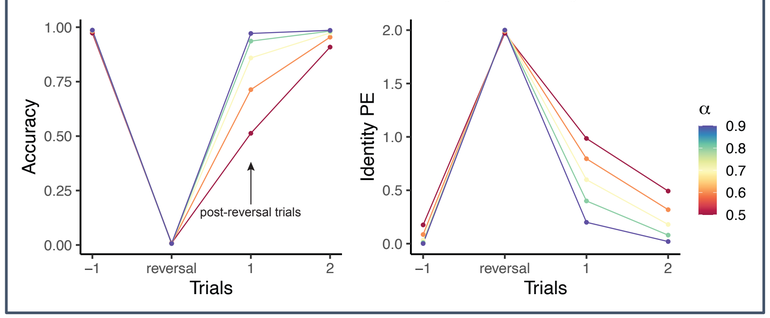

## Model Simulations

Identity-based learning model

$$\delta_t \leftarrow Identity_t - W_t$$
$$W_{t+1} \leftarrow W_t + \alpha\delta_t$$



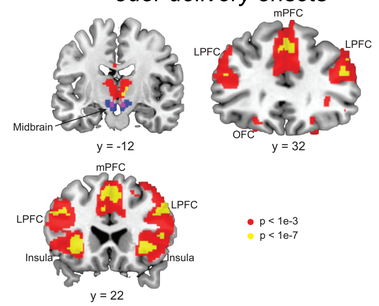

Model simulated choice accuracy & identity PEs



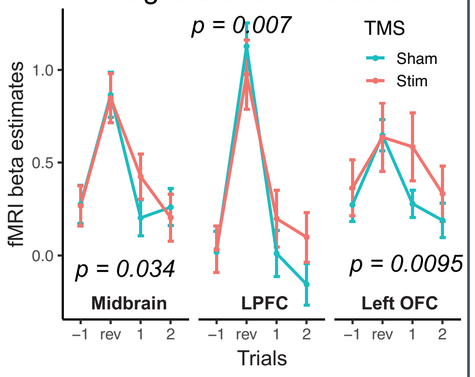

## fMRI Results

Neural correlates of identity prediction errors

*Contrast: reversal > non-reversal trials at odor delivery onsets*

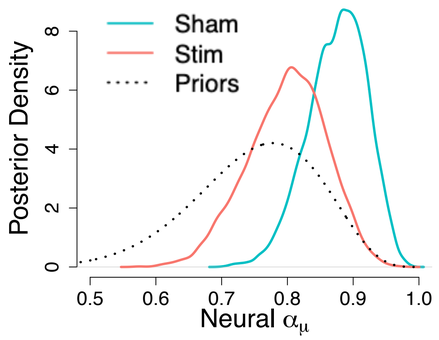



TMS attenuates BOLD signals after reversals

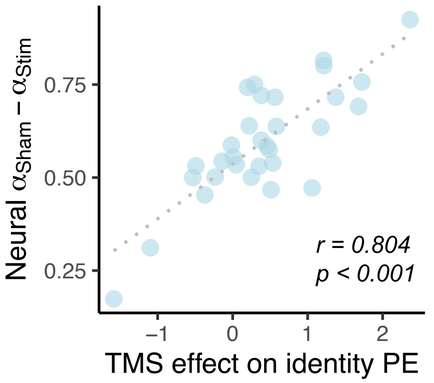



Lower neural learning rate under TMS

(LPFC as an example ROI)




Neural learning rate correlates with identity PE




## Conclusion

- TMS targeting the lateral OFC network ***reduces choice accuracy*** in the post-reversal trial of the first run, ***modulates identity prediction error signals*** in the midbrain, LPFC, and left OFC. Both effects can be quantitatively explained by ***lowered learning rates***.
- These findings support the idea that reward identity expectations in the lateral OFC network are critical for the computation and representation of identity prediction errors.

## Acknowledgement

Fundings: R01 DC015426, ZIA DA000642 (TK)