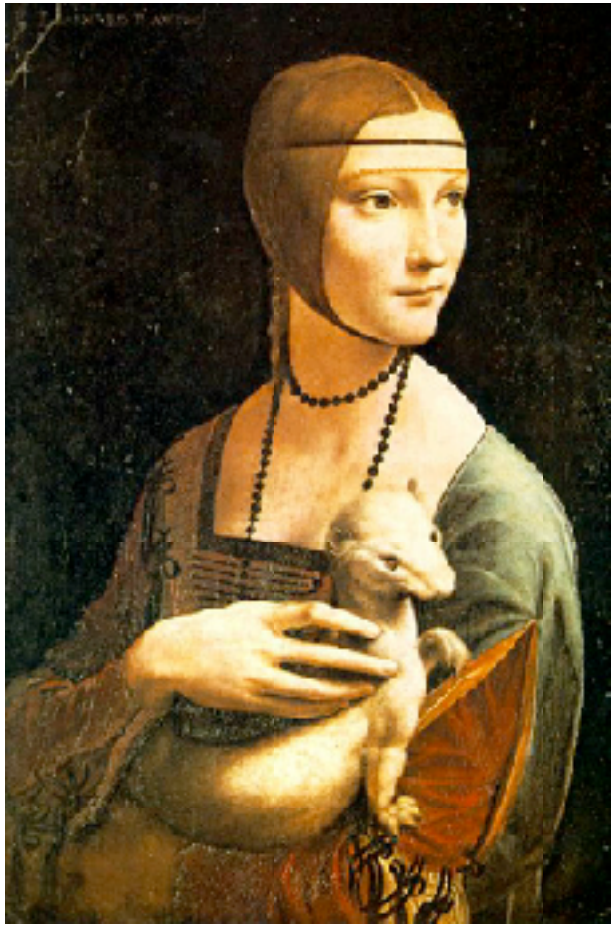
Attention and Rapid Plasticity in Auditory Cortex



Shihab Shamma, Jonathan Fritz
Stephen David, Mounya Elhilali
Serin Atiani

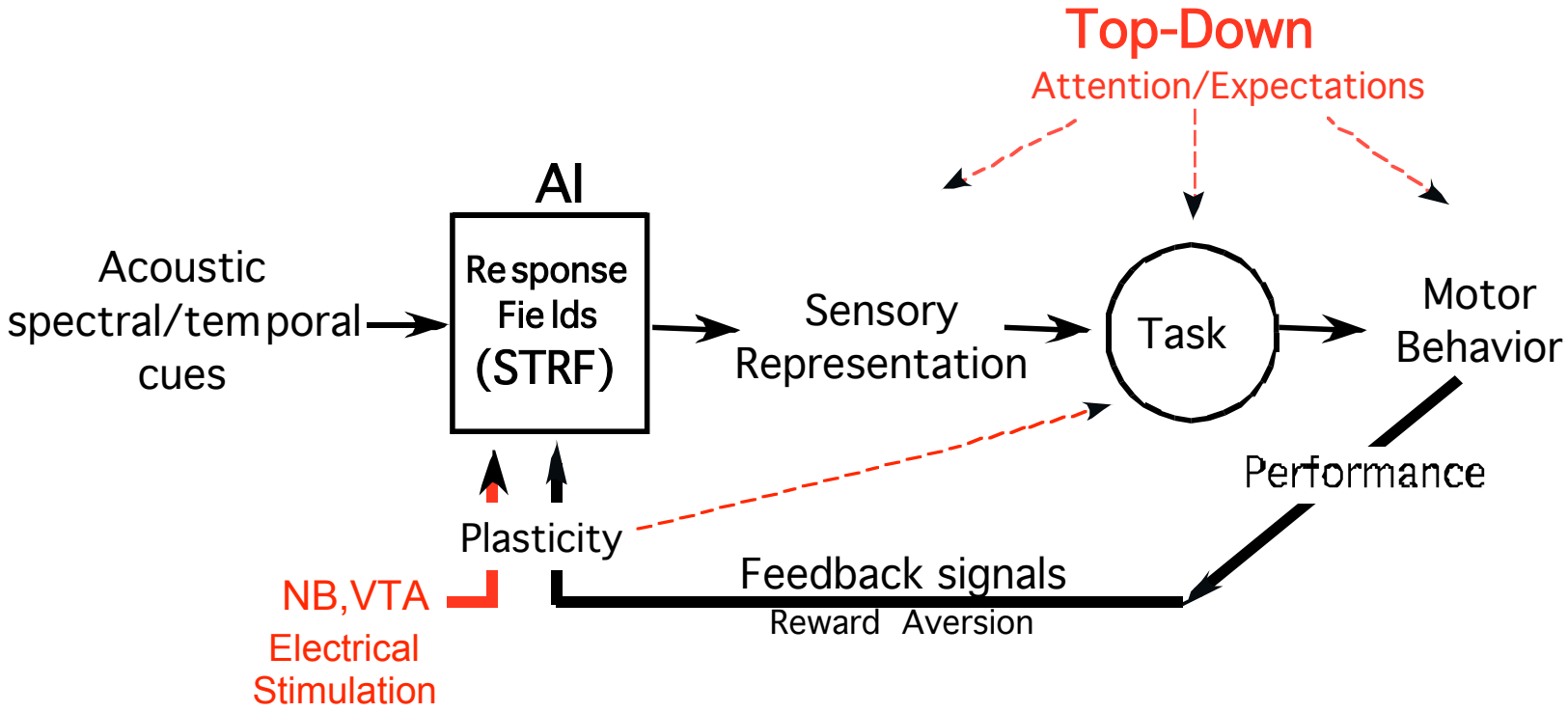
Institute for Systems Research
Department of Electrical & Computer Engineering
University of Maryland

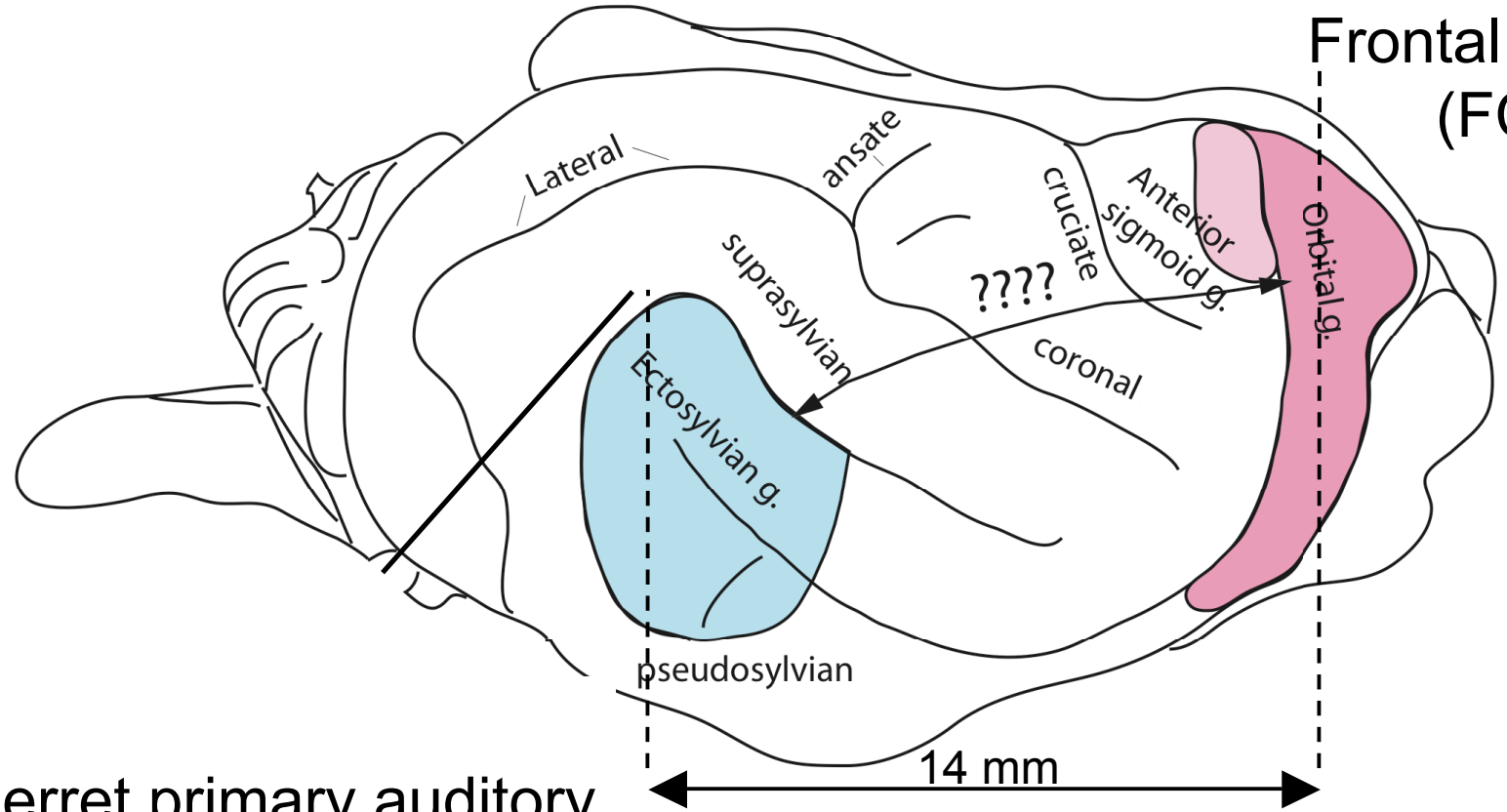
Supported by:
NIH, NSF, and AFOSR

Auditory Streams

Attention & Cortical Plasticity

These processes imply the existence of rapidly adapting receptive fields during behavior to change spectral tuning or dynamics. These changes are in accord with ongoing task expectations (top-down) and salient sensory cues (bottom-up).

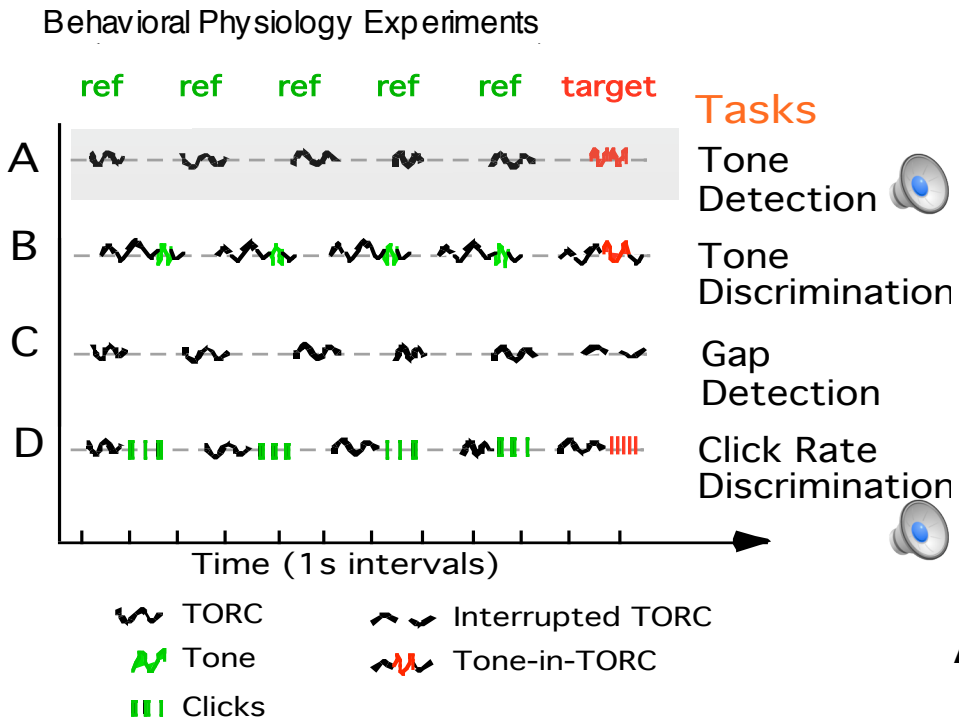


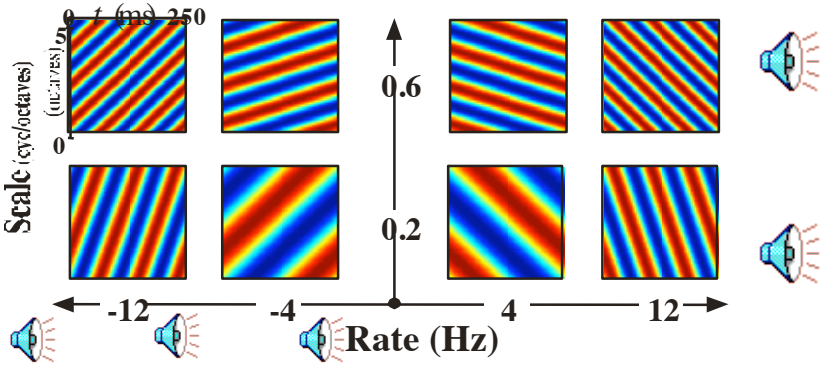


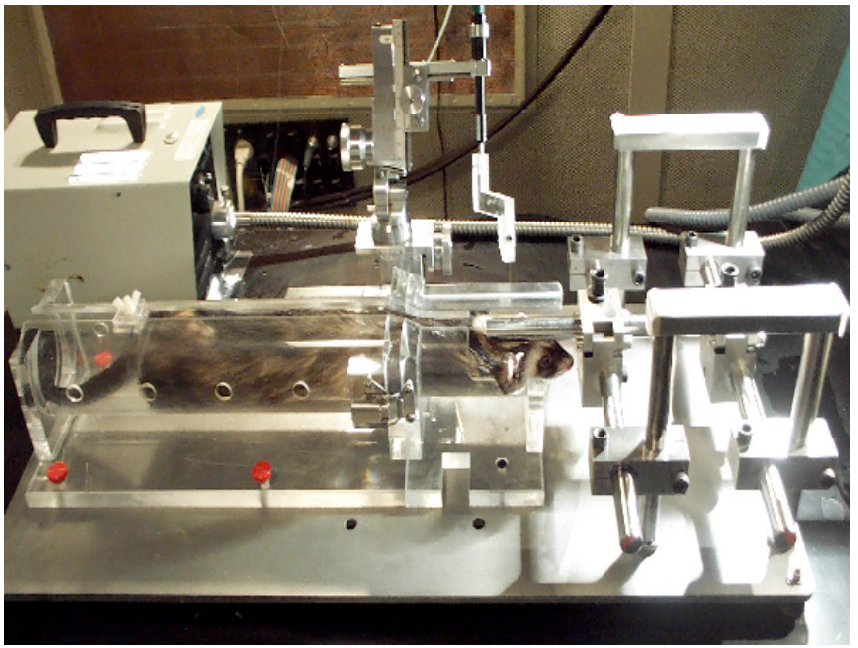
Ferret primary auditory cortex (A1)

(Duque and Goldman-Rakic; Bizley and King)

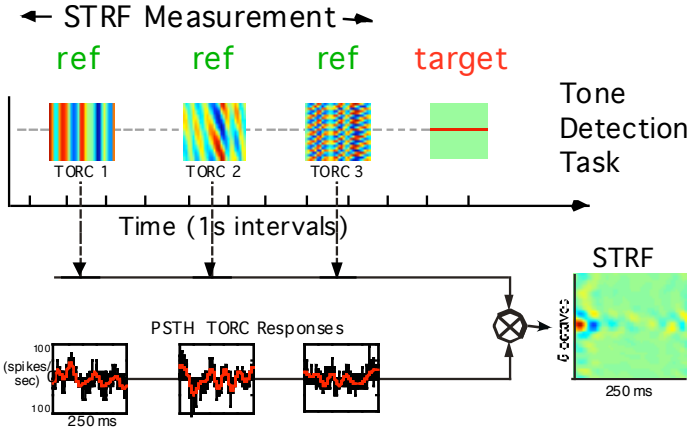
Attention and Behavior Influence Cortical STRFs and Responses





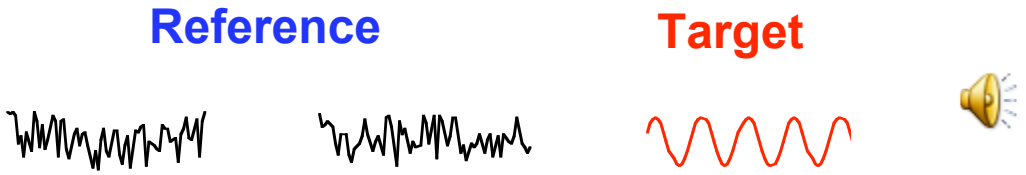


Aversive Paradigm - Positive Reinforcement

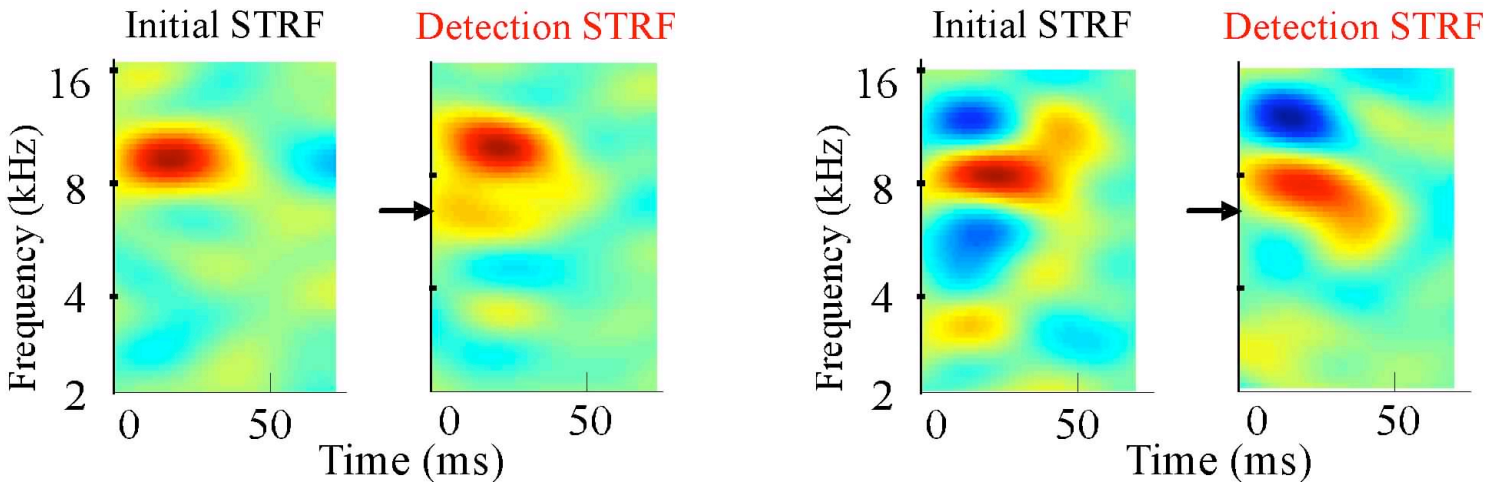


Tone Detection Task

Paradigm

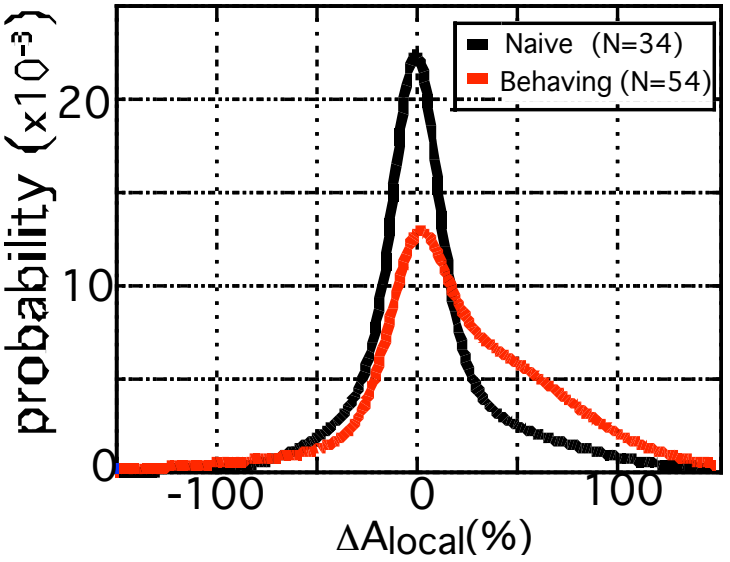


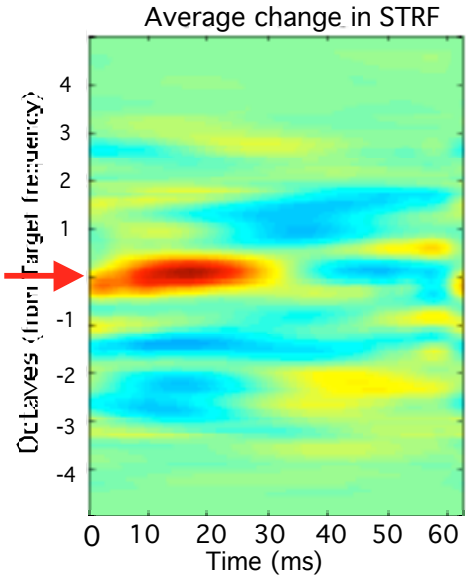
Neural Data



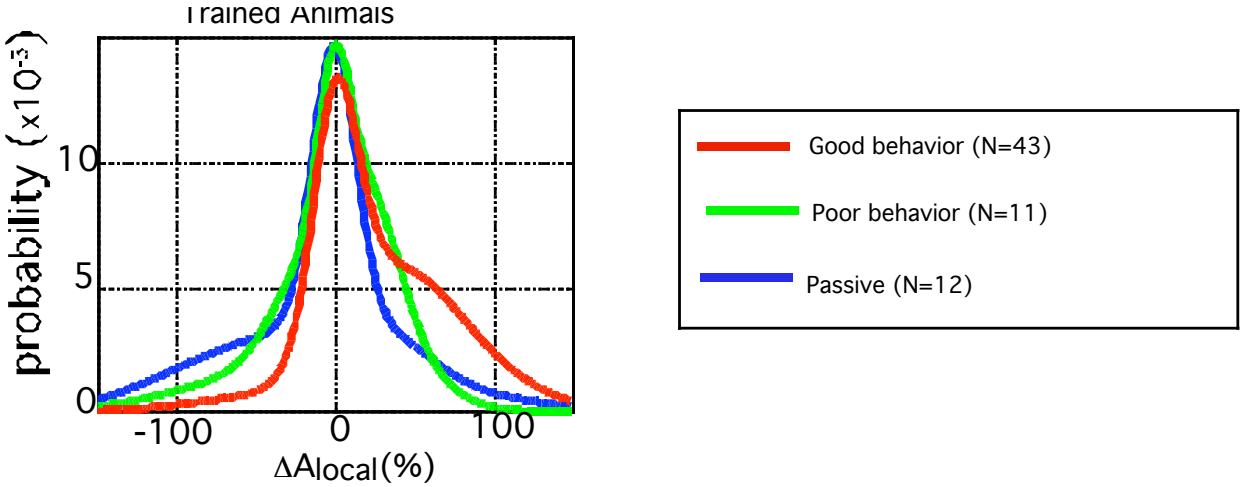
Behavior is essential for plasticity

Naïve *vs.* behaving animal





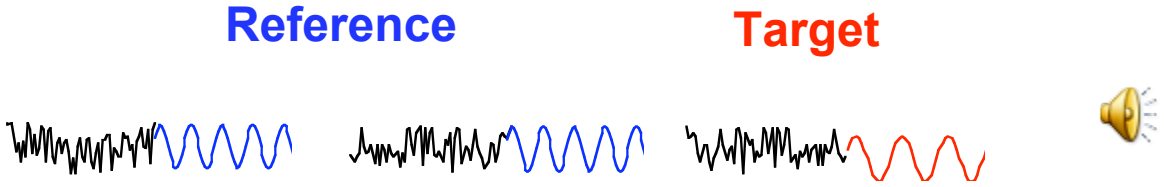
Plasticity as a function of behavior



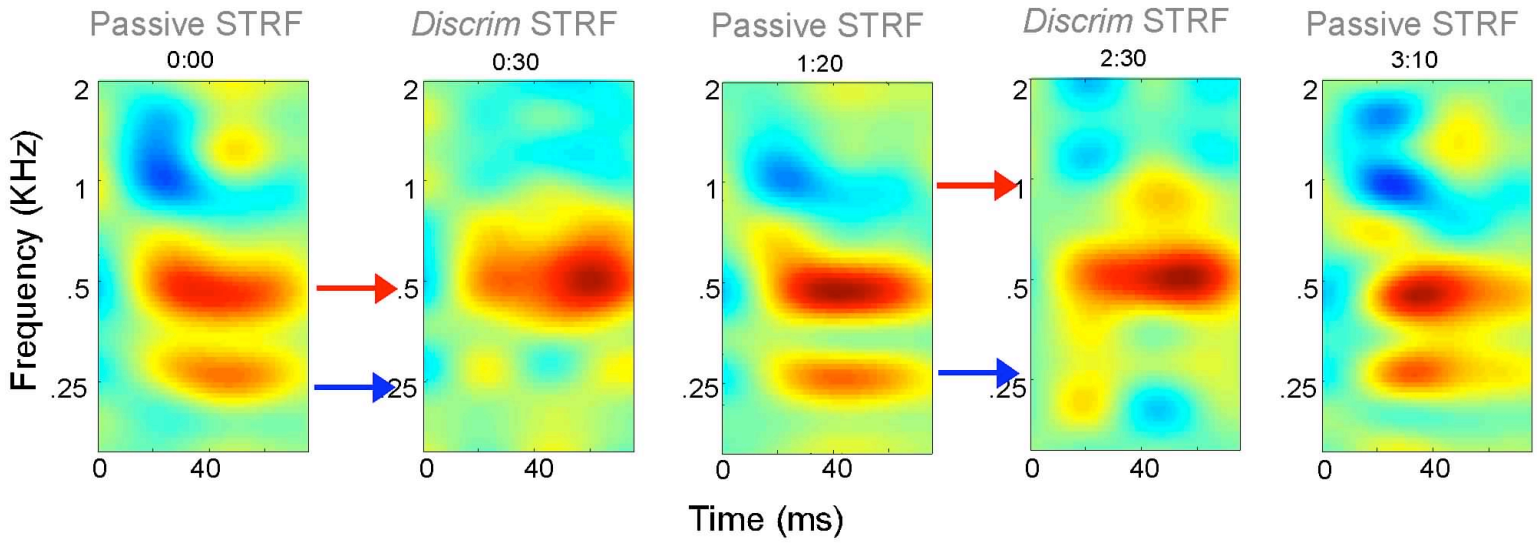
Persistence, “Selective” attention

Tone Discrimination Task

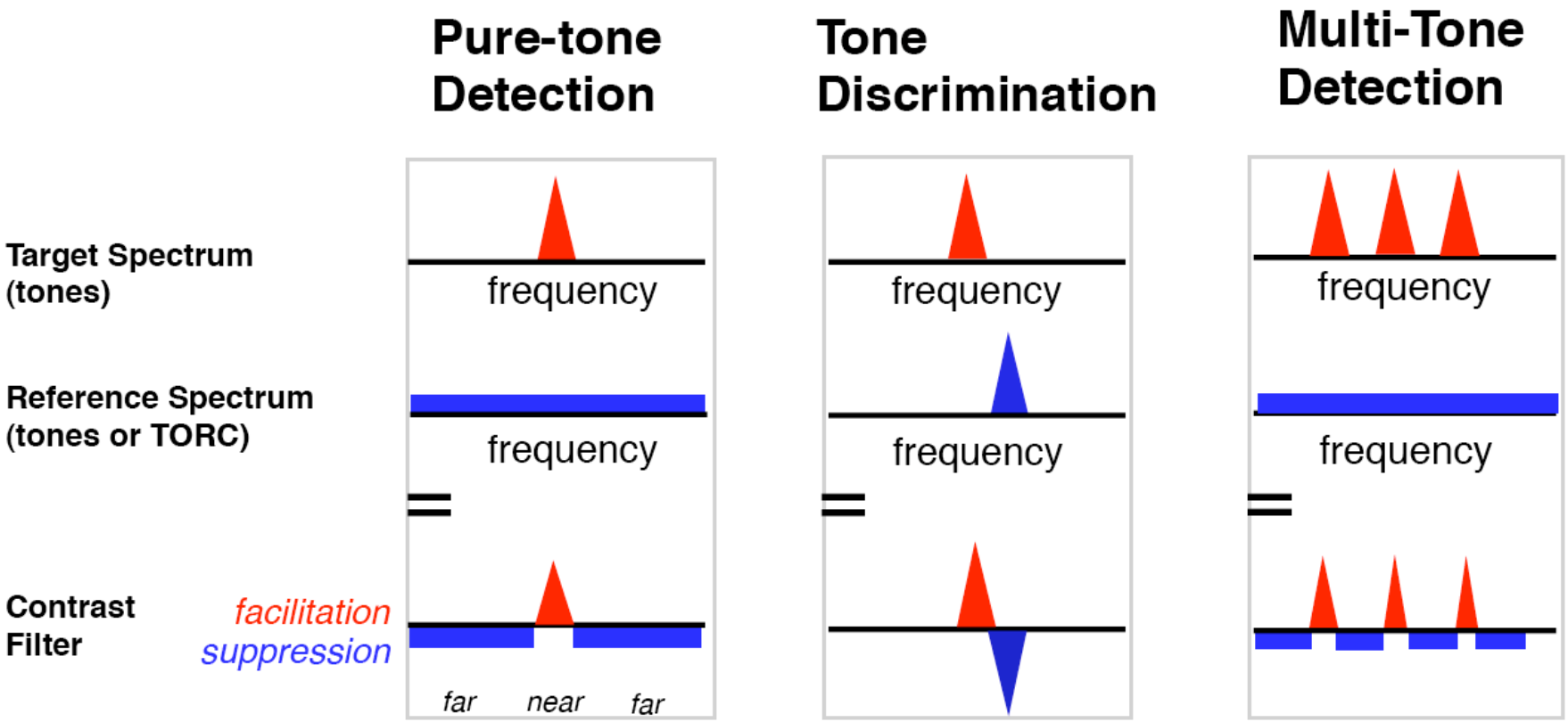
Paradigm



Neural Data



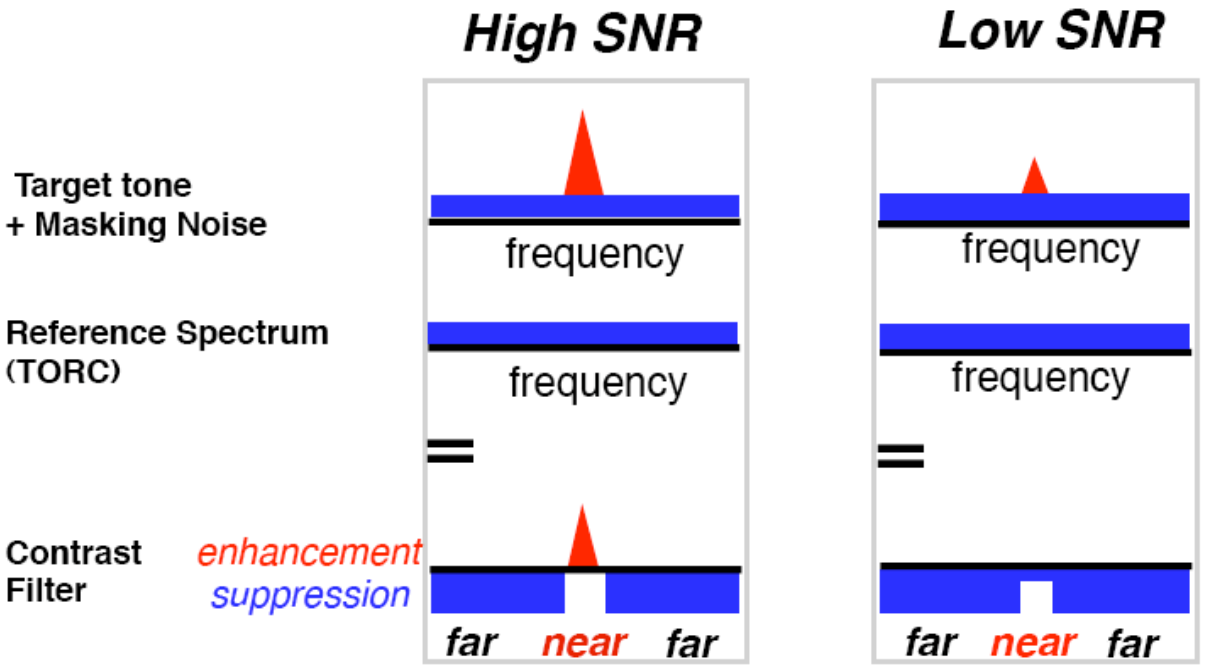
Patterns of STRF Plasticity

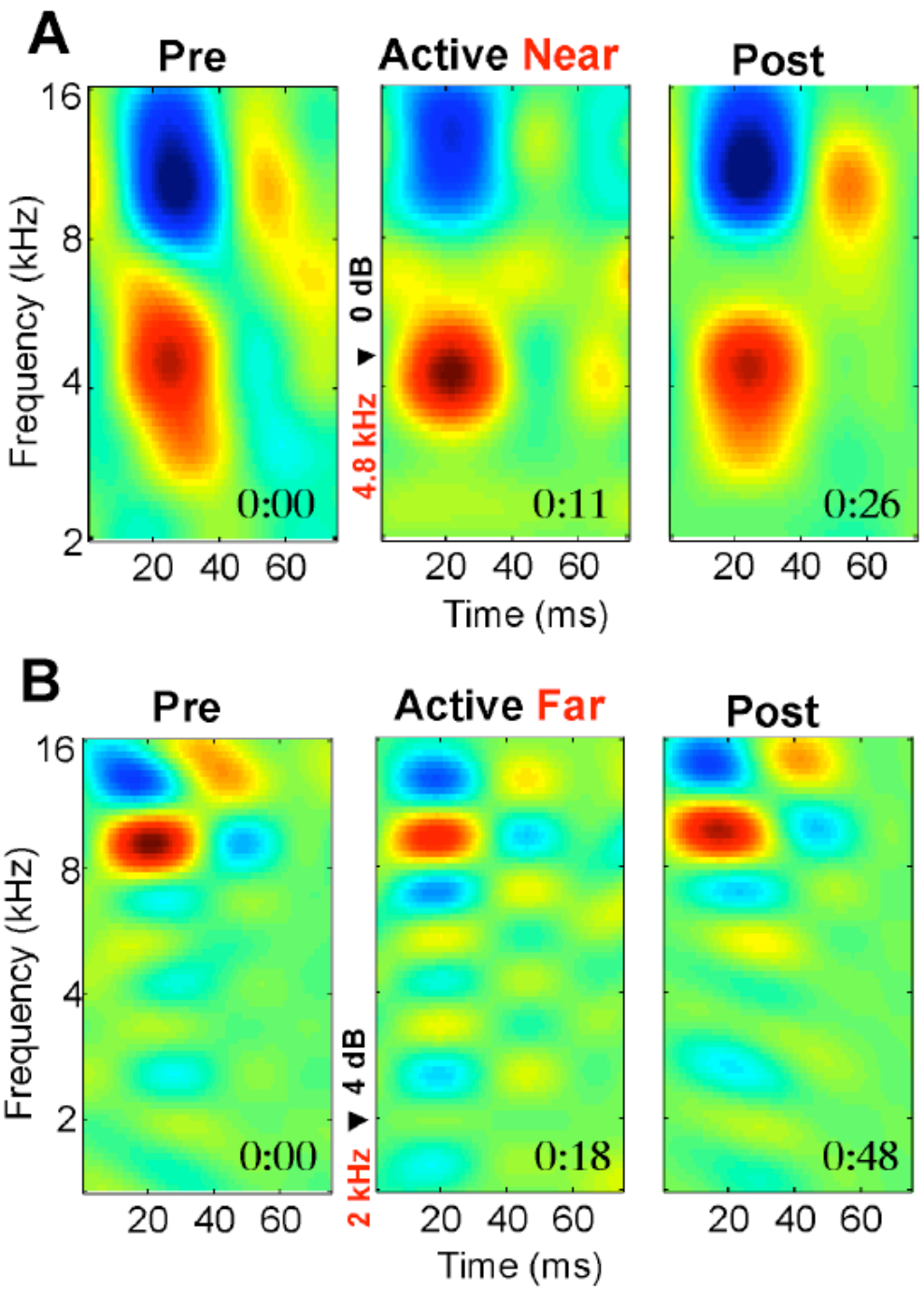


Modulating Task Difficulty

Detection of Tone-in-Noise

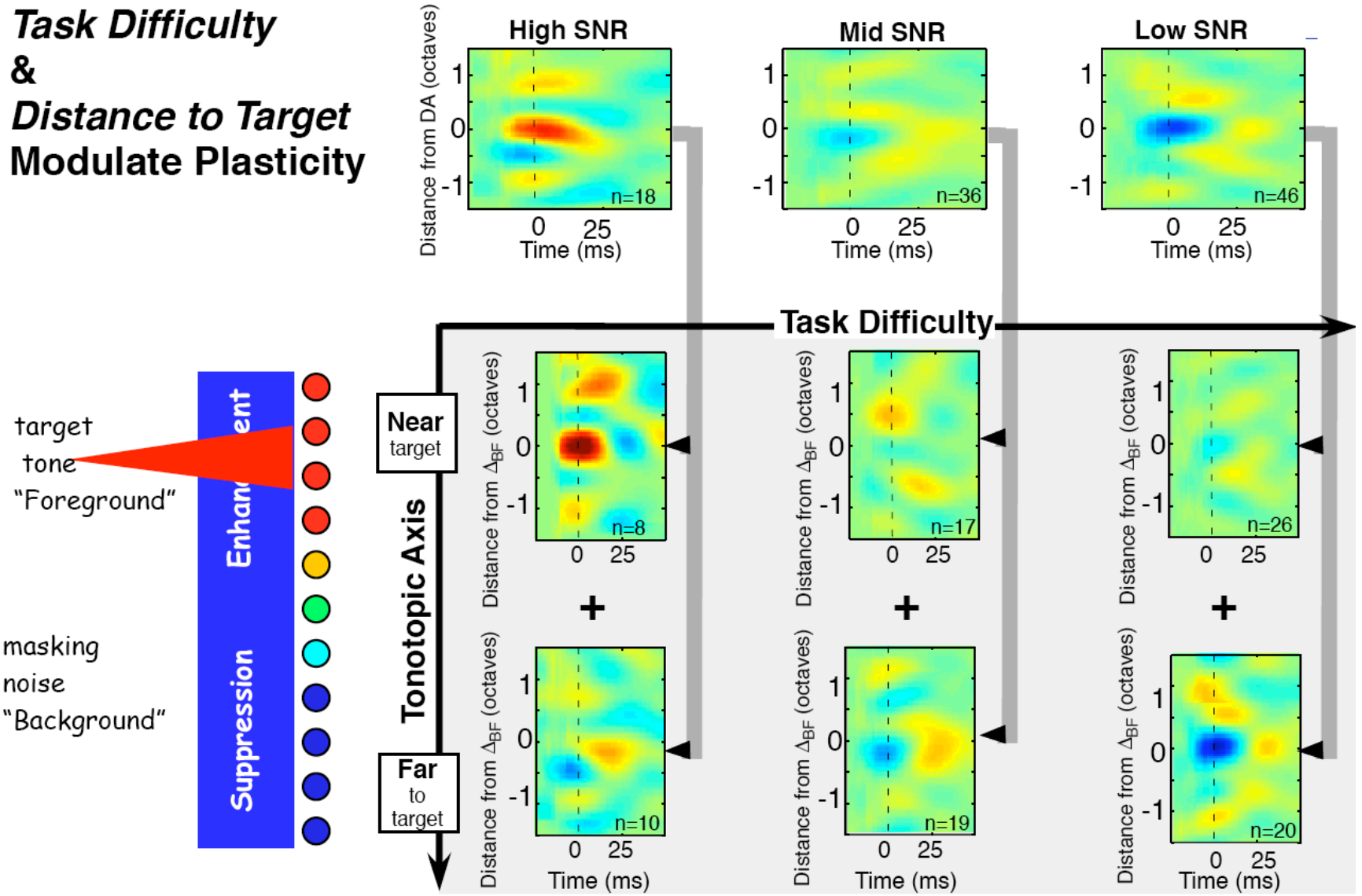
Predictions





STRF changes in *high SNR*

Task Difficulty
&
Distance to Target
Modulate Plasticity



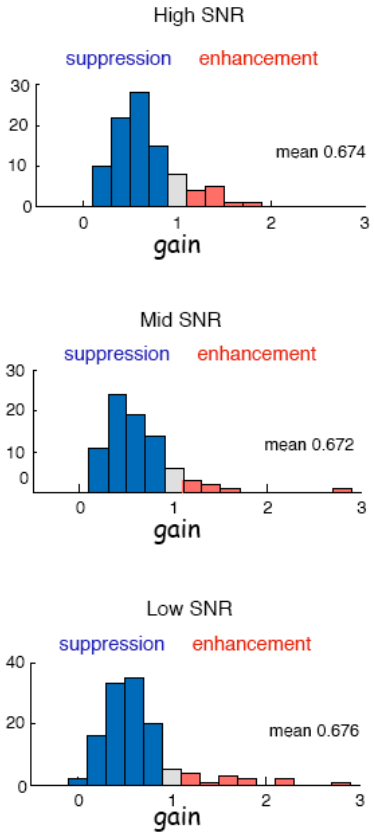
STRF Gain or Shape ?

$$S_d = g.S_b + \delta$$

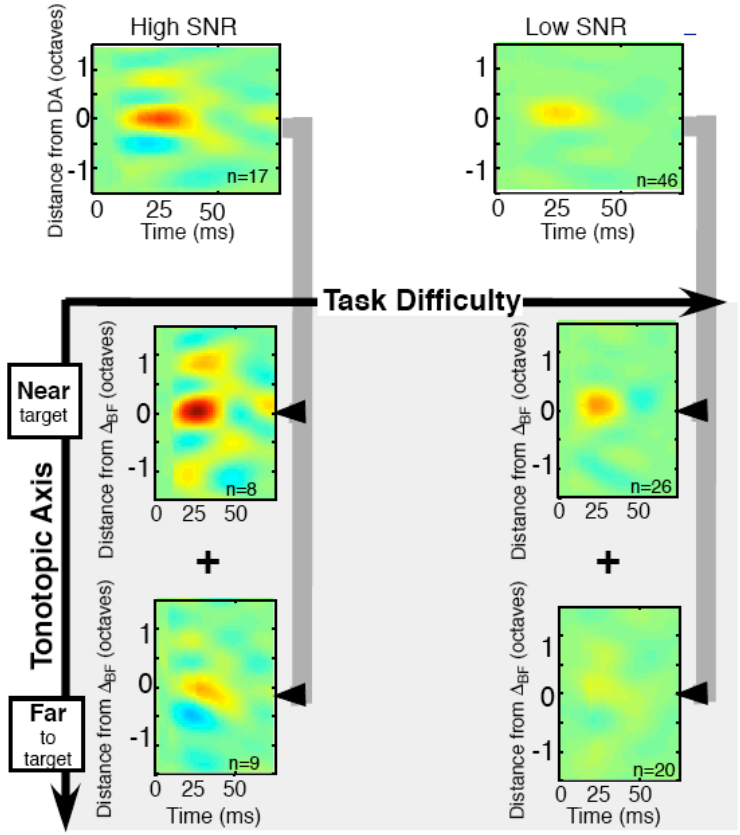
STRF (during) = gain × STRF (before) + Shape

$$gain = g = \langle S_d, S_b \rangle / \sigma_b^2$$

$$Shape = \delta = S_d - g.S_b$$

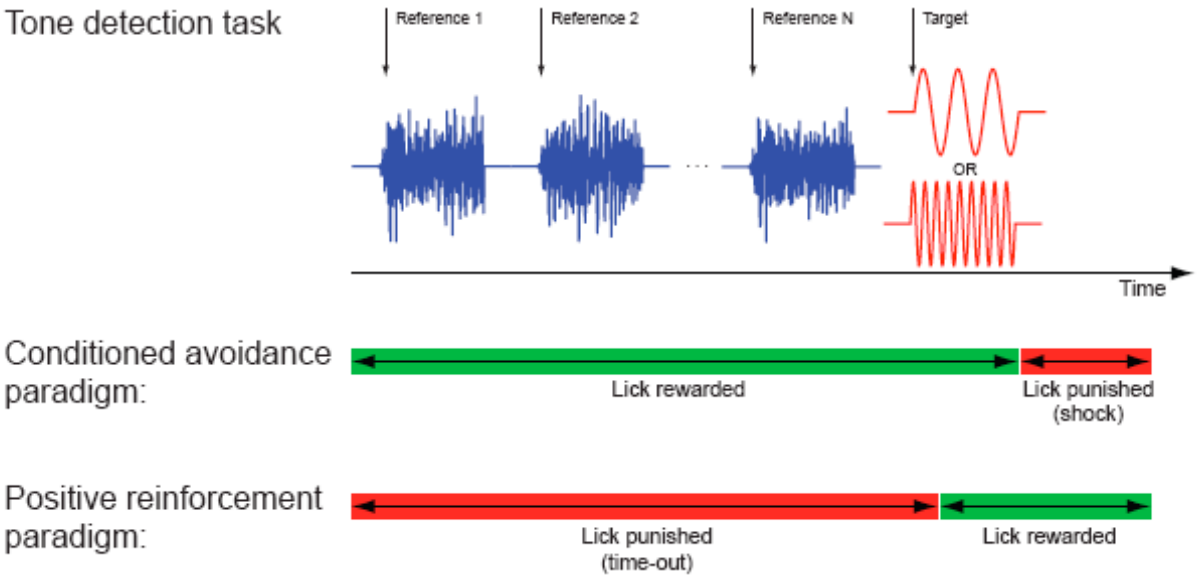


Mostly Suppressed

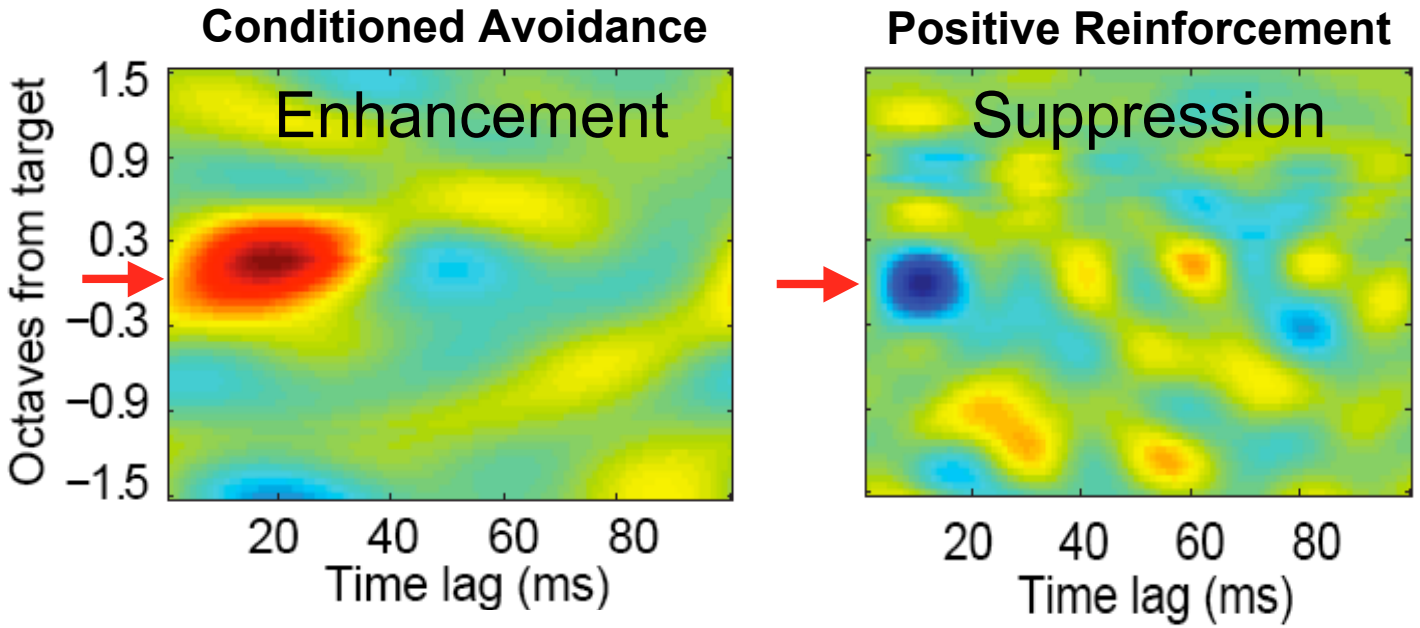


Mostly Enhanced

Details of Behavioral Paradigms are Critical



Similar stimuli,
but
opposite actions,
induce
opposite plasticity



Stephen David

Conclusions

- Behavior induces rapid STRF plasticity that reflects tasks stimuli and rules.
- Persistence of changes following task is common.
- Defining target and reference is the critical aspect of the task. The rest follows “automatically”.
- “Center enhancement - surround suppression” rule applies to “target-reference”, or “foreground-background”, or “target-distracter”
- Behavioral paradigm can influence the valence of the change.
- The role of the PFC?