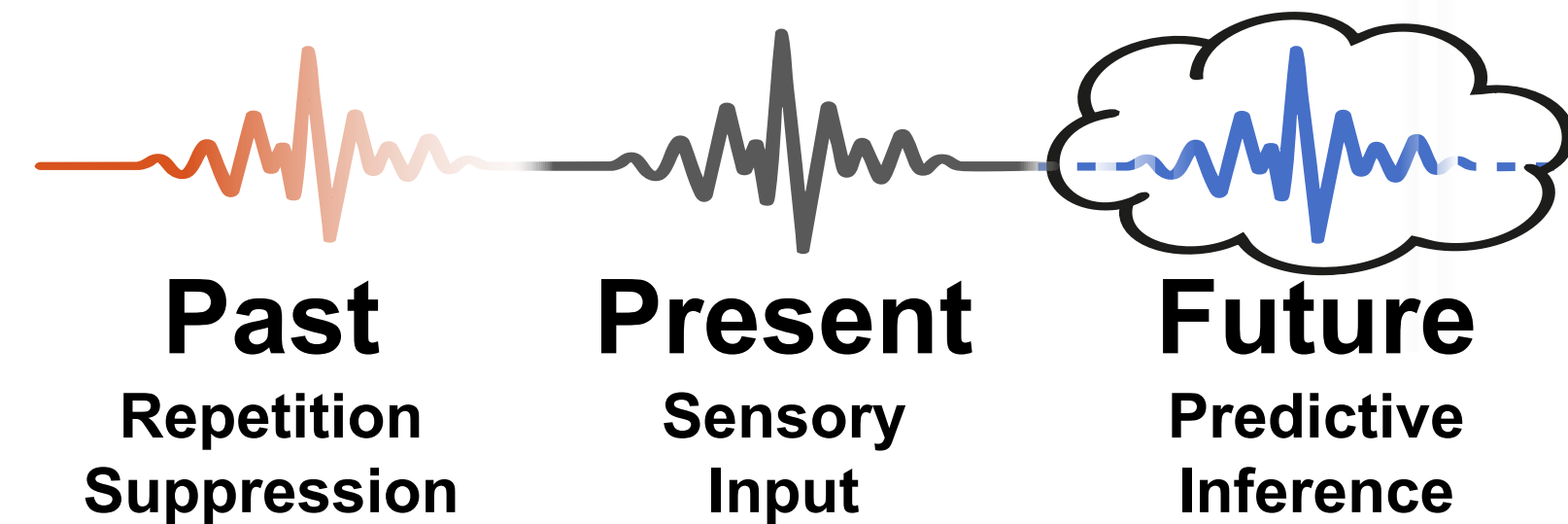


Dissociating Contributions of Expectation and Repetition Suppression Using High-Field fMRI and MEG

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INTRODUCTION

Auditory perception is shaped by integrating **past** repetition and **future**-oriented expectations with incoming sensory information, each influencing neural responses in distinct ways^{1,2}.



However, these processes are often difficult to disentangle, as prediction violations (i.e. surprisal) often coincide with breaks in stimulus repetition (i.e. release from adaptation)³.

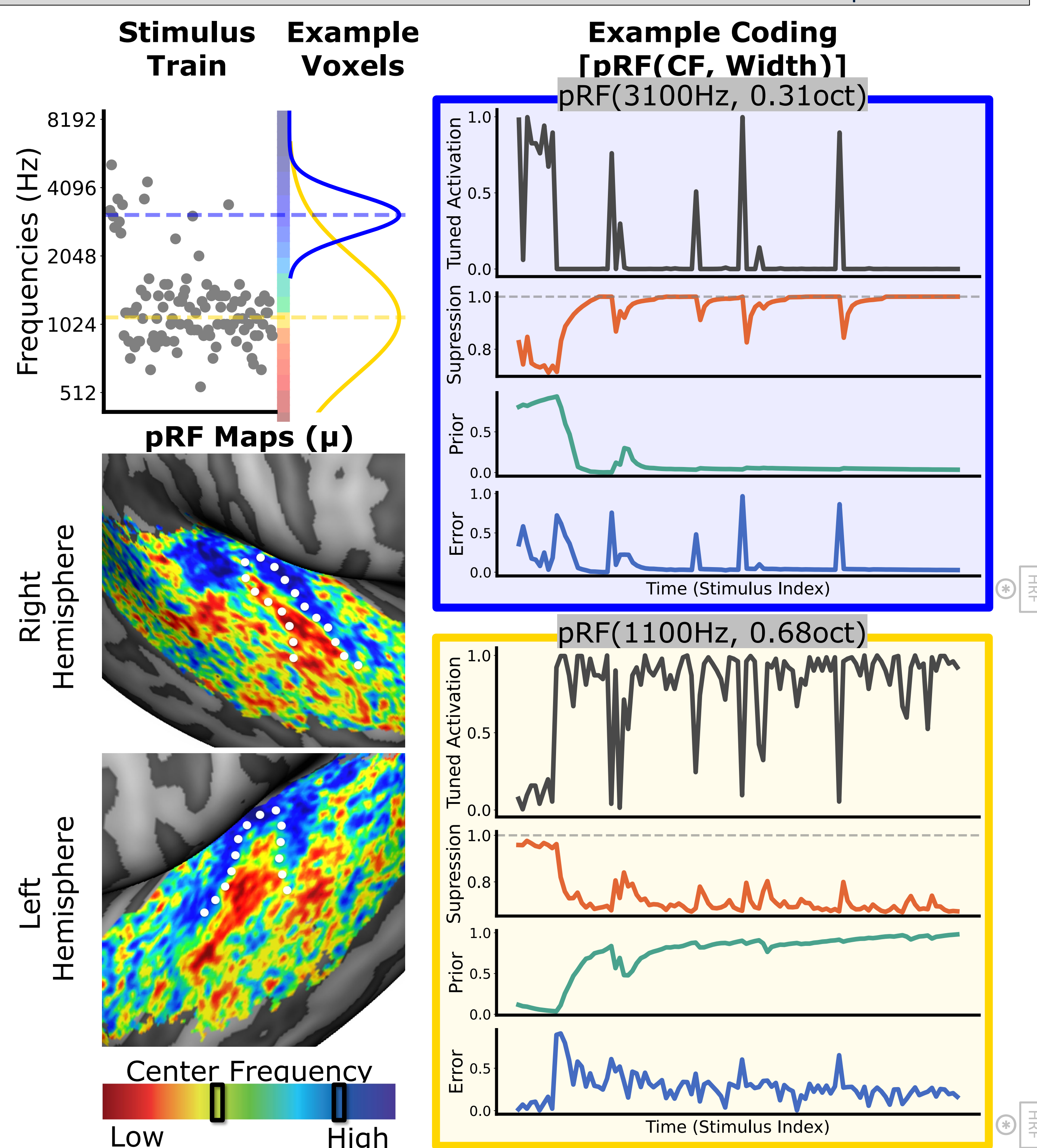
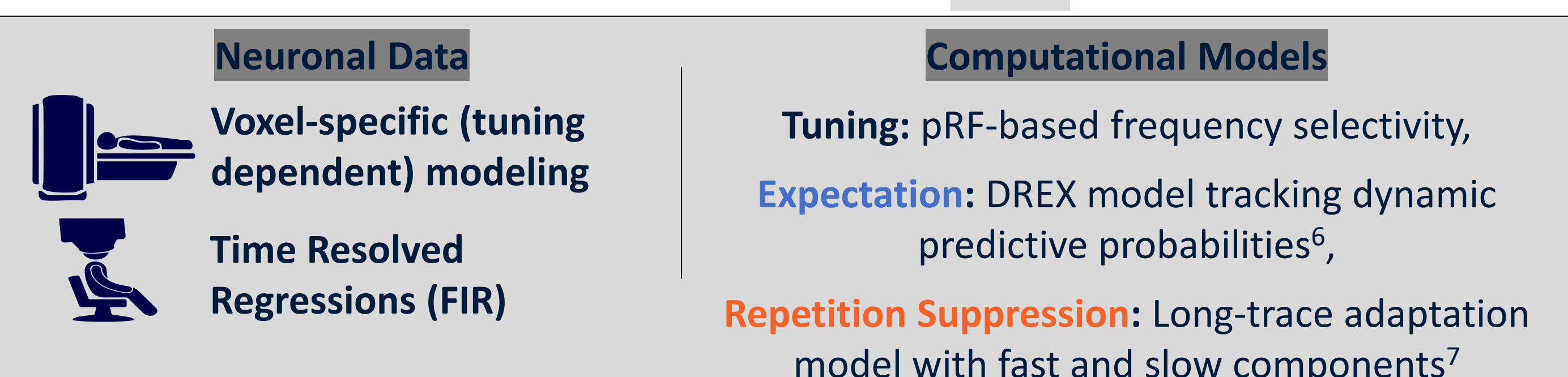
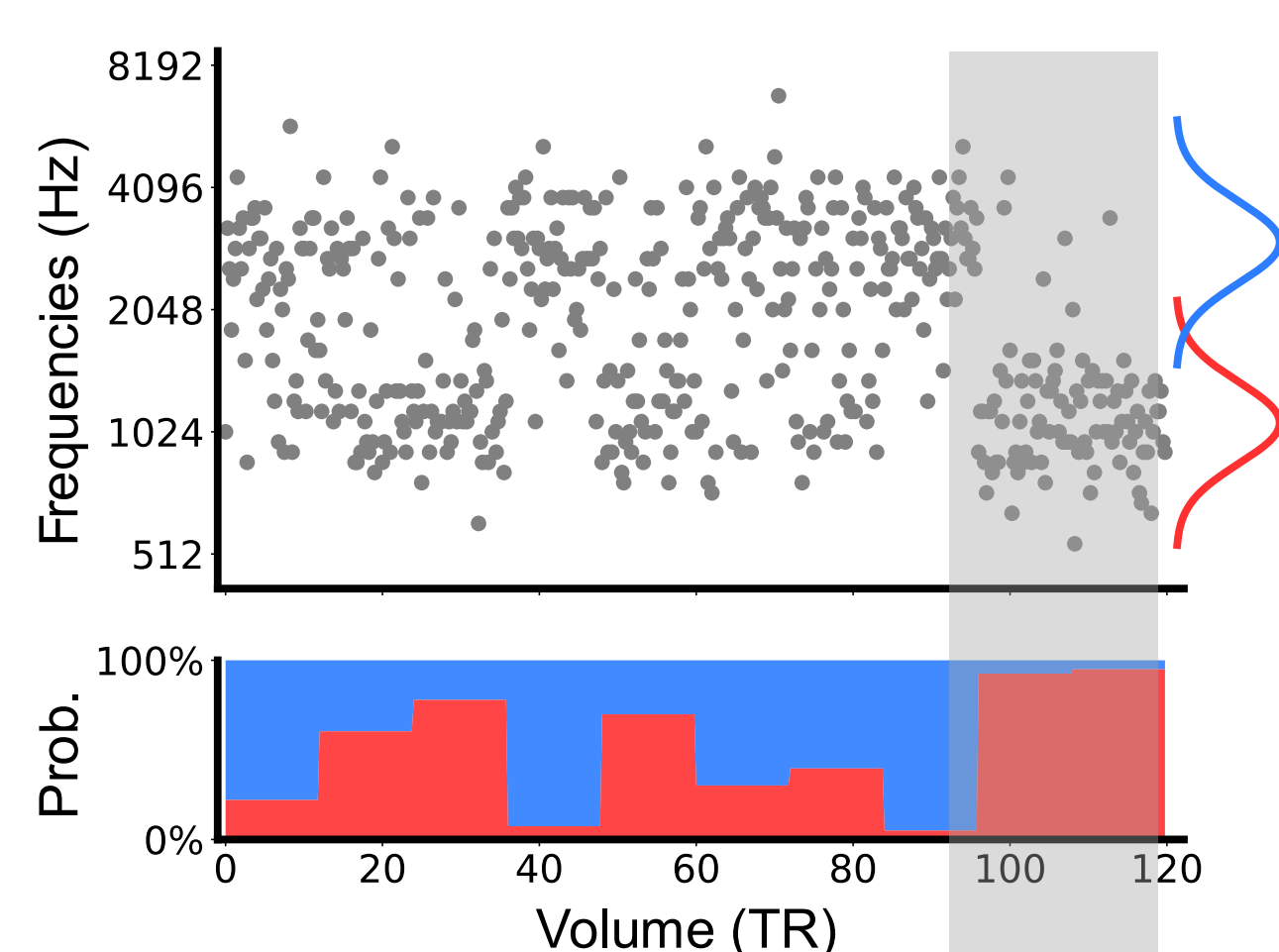
Standard oddball paradigms miss the probabilistic and dynamic structure of real-world auditory environments⁴, limiting our ability to determine their relative impact⁵.

RESEARCH QUESTION

How much do predictive inference and repetition suppression contribute across cortical depth (fMRI) and time (MEG), and what insights does this offer into their operation?

APPROACH

To assess the relative contributions of predictive inference and repetition suppression, we presented sequences of pure tones stochastically sampled from two Gaussian distributions with shifting probabilities, generating periods of relative stability and change in both stimulus repetition and predictive structure.



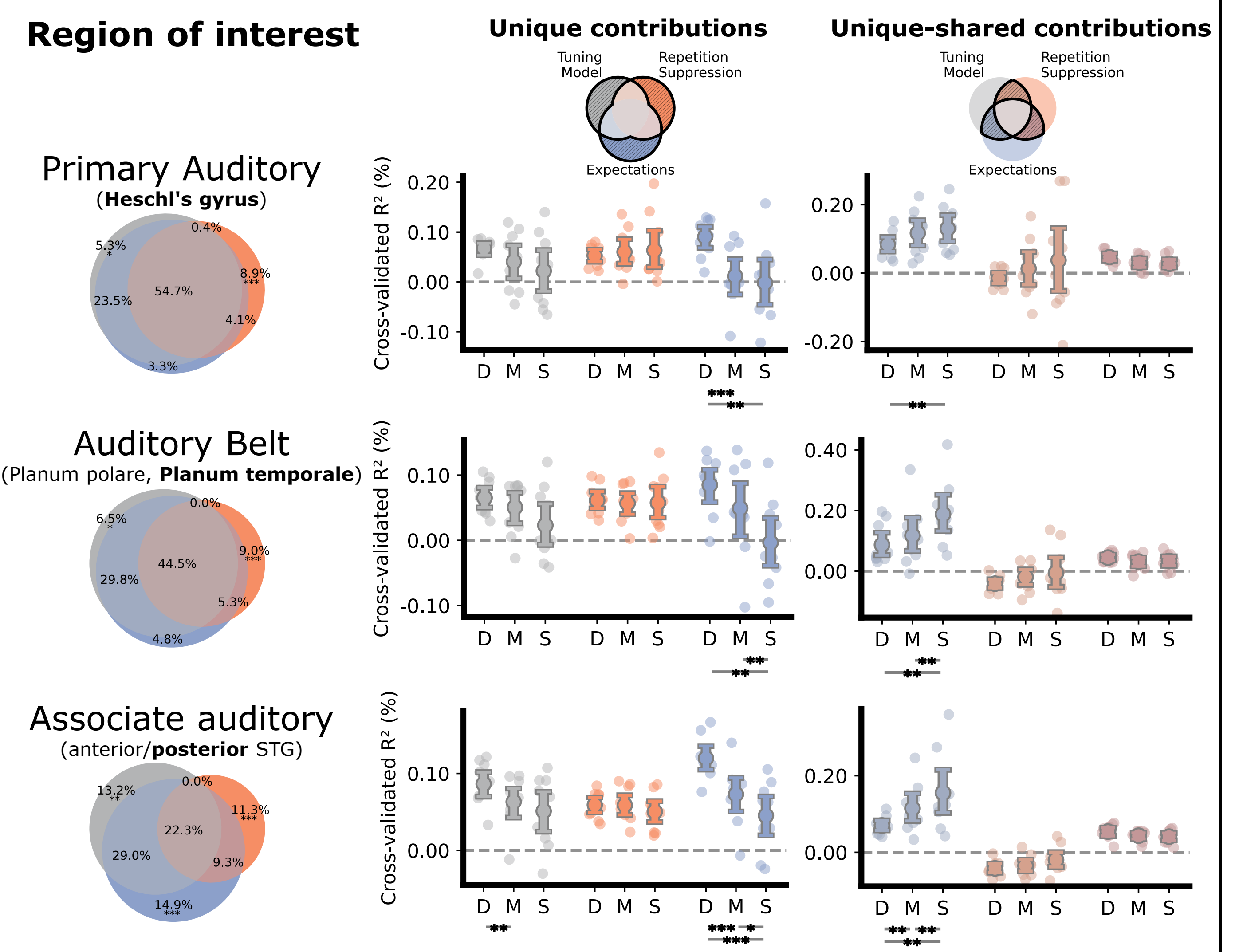
RESULTS

IN SPACE: ULTRA-HIGH FIELD FMRI (7T)

Hierarchical Emergence of Expectation Signals: Variance partitioning revealed robust tuning and repetition suppression across the auditory hierarchy, while expectation contributed more selectively and became increasingly distinct at higher processing stages — when evaluated at the region level (i.e., collapsed across layers).

Deep-Layer Bias for Expectation: Expectation-related variance consistently increased toward deep layers across regions, consistent with predictive coding accounts in which top-down signals (e.g. priors) are conveyed via infragranular pathways.

Superficial Representation of Shared Expectation-Tuning Dynamics: Uniquely shared contributions between tuning and expectation showed a robust superficial bias, suggesting that integrated expectation signals (e.g. prediction errors) are preferentially expressed towards the cortical surface.



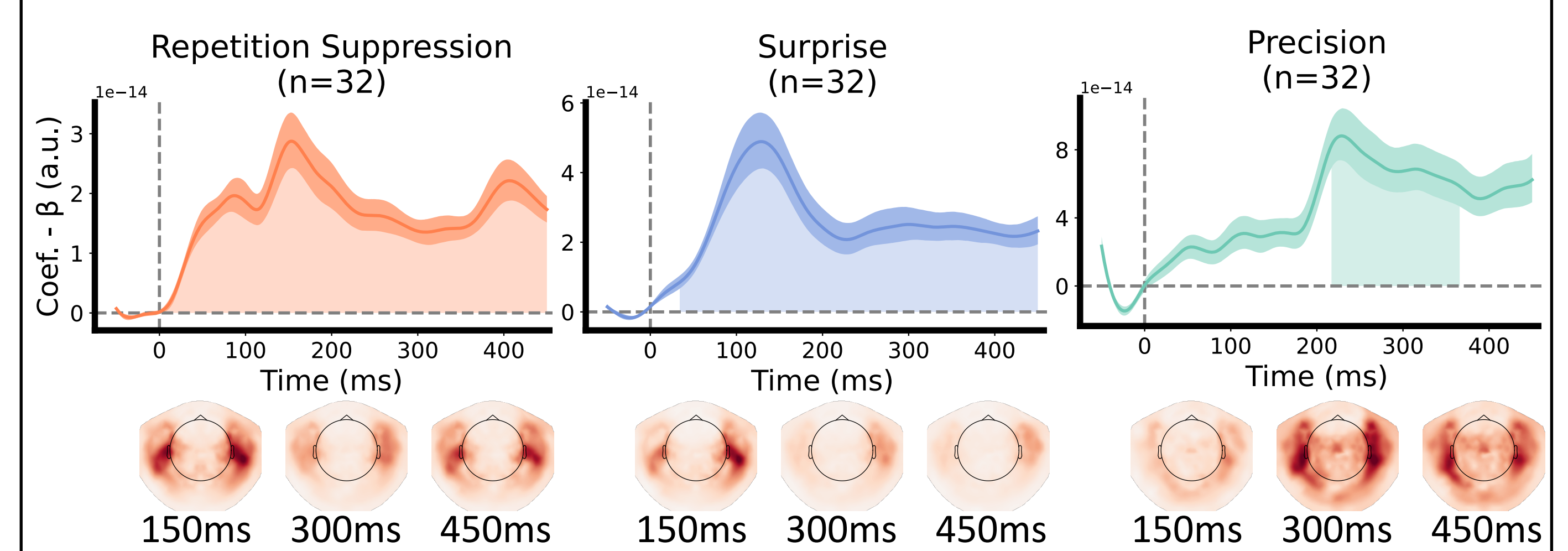
IN TIME: MEG

Time-shifted FIR modeling revealed distinct profiles for repetition suppression, surprisal, and precision.

Sustained Cumulative Adaptation: Repetition suppression appeared in temporal regions with a broad cumulative profile, sustained across the response window.

Early, Localised Prediction Error Response: Surprisal peaked sharply around 100–150ms, with activity more temporally localised, consistent with rapid prediction-error signalling.

Delayed, Widespread Precision Integration: Precision effects emerged after 100ms and extended more widely, consistent with sustained integration of contextual uncertainty into the predictive model.



Stars indicate significance levels (FDR-corrected): * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

CONCLUSIONS

Repetition suppression provides a robust, tuning-linked mechanism for encoding recent auditory history, acting as a depth-invariant local gain control sustained over time. Predictive inference operates in parallel, with deep layers hosting content-specific predictive models and supporting later model updates, while superficial layers register prediction-input alignment and generate early transient errors.

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