simulate\_sentence\_response.m

Simulate model response to specific sentences by calling the function DEM\_MDP\_ambiguity\_hybrid(sentence) and save results in a .mat file

sig\_gen\_dictionary2

Generate sentence stimuli from single syllables using a “dictionary” that contains the syllabic composition of each word. Both syllable and sentence are in the form of spectro-temporal patterns.

Get\_Sylb\_Params.m

Compute the spectro-temporal matrix ST from the acoustic signal of each syllable via function get\_aud\_spectrogram(sent\_ID, addr, SNR), as well as the Hopfield attractor I for each gamma unit (8 per syllable) using get\_syl\_parameters(sentence, syllable\_boundaries).

DEM\_MDP\_ambiguity\_hybrid(sen)

Main function of the model. It simulates the model response to the input sentence sen, which is an index pointing to the stored sentence stimuli in the form of spectro-temporal pattern. The generative model is initialized in a structure called **mdp**, which includes a continuous part **demi** and a discrete part. The continuous model is initialized by the function spm\_MDP\_DEM\_speech\_gamma() and provided with the input sentence, whereas the discrete part is initialized within this main function by defining the **A, B, D** matrices for each level. After initialization, it calls the routine spm\_MDP\_VB\_X\_hybrid() that simulates the model by variational Bayesian model inversion, and plots the simulation results in the form of posterior probabilities (Figure 2 in the manuscript) with the function spm\_MDP\_VB\_ERP\_ALL\_hybrid(MDP).

spm\_MDP\_DEM\_speech\_gamma(sig, file)

Function for the initialization of the continuous model using stored I vectors passed from the input file. Also provides the model with the acoustic input sig.

spm\_MDP\_VB\_X\_hybrid(MDP, prediction)

Function for model inversion. The generative model is passed as an input parameter MDP. The input prediction determines whether the model applies informative (prediction=1) or uninformative (prediction=0) top-down predictions for model inversion. The inversion of the context and semantic model is implemented by custom algorithm described in the Method section of the manuscript. The rest of the model inversion is implemented by adapting existing routines spm\_MDP\_VB\_X() and spm\_MDP\_DEM\_model() in the SPM software package.

spm\_MDP\_VB\_X(mdp, OPTIONS)

Function for variational Bayesian inversion. Same as the original routine in the SPM software package except: 1) a “prediction” option was added to determine what type of top-down predictions are sent to subordinate models, 2) the step number of the gradient descent process was fixed to be 16. There are also a few more minor changes for custom needs, but they do not influence the algorithm.

spm\_MDP\_DEM\_model(DEM,demi,O,o)

Variational Bayesian inversion of the continuous model demi using the subroutine spm\_ADEM\_y. Similar to the original function in the SPM package except that the evidence accumulation is enabled for every possibilities (very unlikely possibilities were ignored in the original version). There were also a few modifications to accommodate the acoustic input.

spm\_MDP\_VB\_ERP\_ALL\_hybrid(MDP)

Plot posterior (or prior) estimates from a MDP structure. The factors and the estimations (prior or posterior) to be plotted can be customized. Calls the function spm\_MDP\_VB\_ERP\_hybrid()

and spm\_MDP\_VB\_ERP\_YS() to concatenate multidimensional MDP data matrices into 2D (states X timepoints) matrices, then use spm\_MDP\_VB\_ERP\_align to align matrices of different hierarchies. See comments within each function for detailed explanation for the algorithms.

compare\_context\_hybrid.m

Compare IT metrics (entropy and divergence) across different values of model contextual bias (Supplementary Fig 1 in the manuscript) with the same sentence.

compare\_sentence\_hybrid.m

Contrast IT metrics for the same model in response to two different sentences.

compare\_sentence\_info\_all.m

Compare the entropy and divergence of two sentences at desired processing levels.

KLDiv(r, step)

Calculate the entropy, KL divergence, and cross entropy from the 2D (states X timepoint) posterior distribution **r** with time step size **step**.