Dynamic neural representations of auditory selective attention

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PDF & references

Listening in complex, multi-talker settings is challenging.

People use selective attention to track one talker while ignoring other sound sources.

Attention's neural mechanisms differ depending on key features.

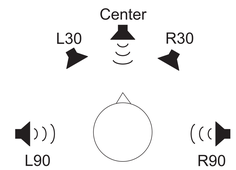
Representational similarity analysis lets us investigate dynamics of executive control.

Stimuli and Task

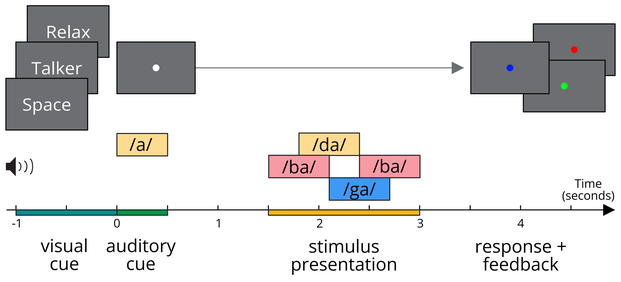
Target embedded in multi-talker babble comprising /ba/, /da/, and /ga/ syllables.

Spatialized to five positions using generic head-related transfer functions.

Visual cue gave each trial's attention type, then auditory cue gave the exact target.



After four overlapping syllables were played, subjects reported target's identity and received feedback.



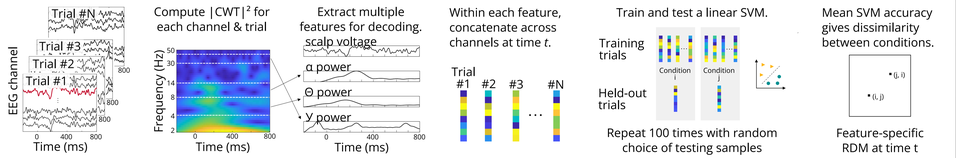
Condition-Rich Design

Spatial Attention								Talker Attention						Passive Listening
Left				Right				Male			Female			Same stimuli as Spatial and Talker Attention, grouped into 7 new conditions.
Near Distractor		Far Distractor		Near Distractor		Far Distractor		Colocated Distractor	Near Distractor	Far Distractor	Colocated Distractor	Near Distractor	Far Distractor	
Same Gender	Different Gender	Same Gender	Different Gender	Same Gender	Different Gender	Same Gender	Different Gender							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 16 17 18 19 20 21

EEG Representational Similarity

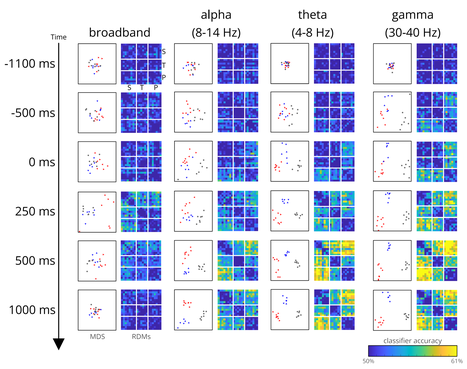
After preprocessing, evoked & oscillatory activity were extracted from each trial & channel.

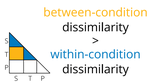
For each subject, feature, timepoint, and pair of conditions, SVM classifier performance estimated the dissimilarity between them.



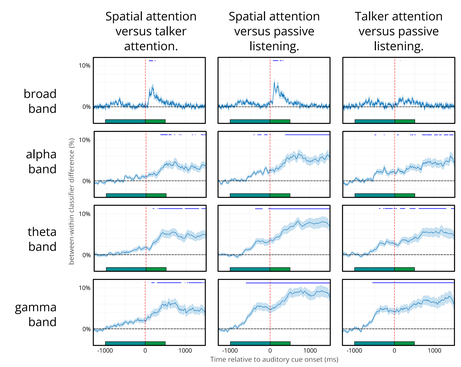
Preparing to Listen

Broadband, evoked activity carries transient information, while oscillatory activity carries sustained information about upcoming attention.



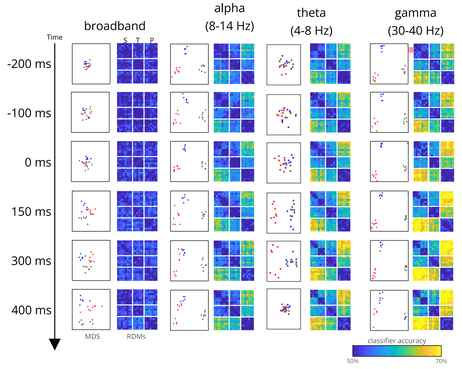


Transient broadband information is likely a stimulus-driven ERP. Oscillatory activity carries info from both attention type and target cues.

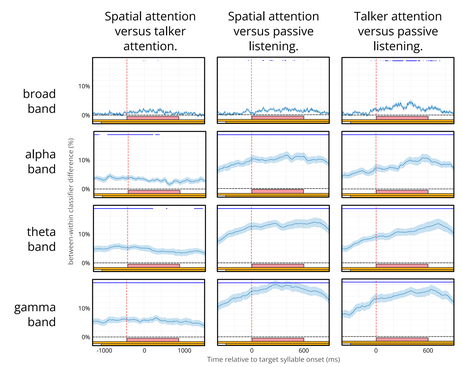


Detecting a Target

Attention type is represented, with relatively slow dynamics, in multiple frequency bands. It is not appreciable in the broadband data.



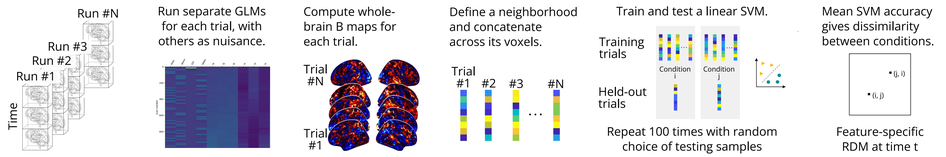
During stimulus presentation, many frequency bands carry information about attention type, but target-locked effects are minimal.



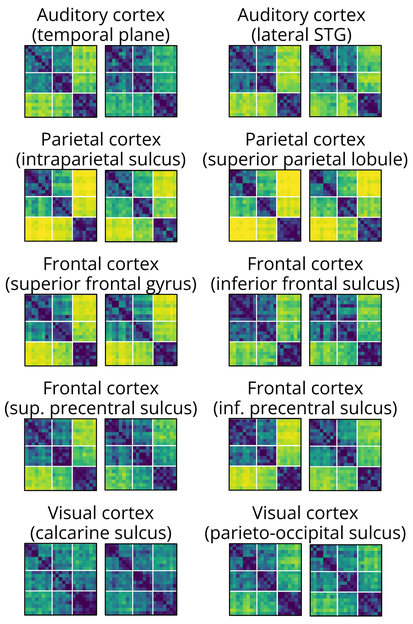
fMRI Representational Similarity

After preprocessing, data were fit with single-trial GLMs, yielding whole-brain maps of coefficients for each trial.

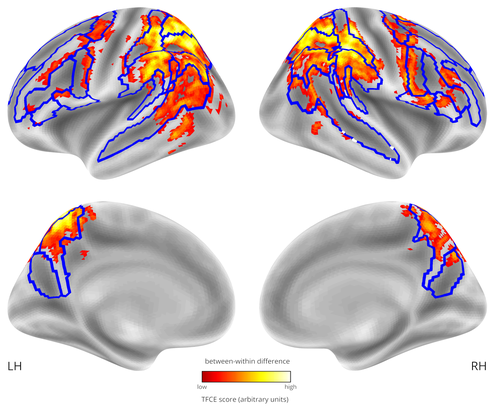
For each subject, searchlight neighborhood, and pair of conditions, SVM classifier performance estimated the dissimilarity between them.



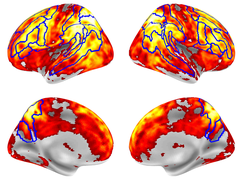
Attention Across the Brain



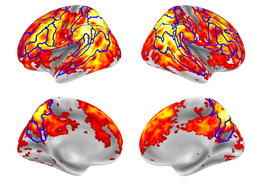
Spatial attention is separable from talker attention in frontal, parietal, and posterior temporal regions.



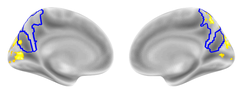
Spatial attention versus passive listening.



Talker attention versus passive listening.



Left versus right attention.



Conclusions

Successful use of RSA to track executive control in both EEG and fMRI.

Information dynamics across frequency bands and distributions across space will help describe large-scale networks for attention.

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Illustrations from https://blackillustrations.com & https://neuroscience-graphic-design.com. Thanks to Alexander Pei for assistance with data collection.