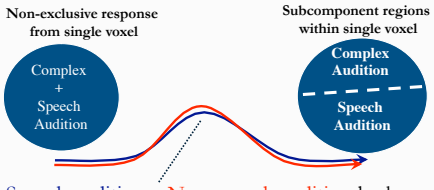
Adaptation to Phonologically Similar Words in Bilateral Superior Temporal Sulci

Kenny Vaden and Greg Hickok
Department of Cognitive Sciences, UC Irvine

Lab for Cognitive Brain Research
LCBR.SS.UCI.EDU

Cognitive subtraction logic is problematic

Speech listening vs. non-speech contrasts are ambiguous



Speech audition – Non-speech audition looks like zero, but might be processing speech.

Differences are ambiguous too, with respect to language

Acoustic? Lexical? Syntactic?
Phonological? Semantic? Phonetic?

Alternative: focused parametric variables

Superior Temporal Sulci in phonological processing

PSTS activity during speech perception: predominantly left lateralized or bilateral?

Left: Ashtari, et al. (2003), Liebenthal, et al. (2005), Dehene-Lambertz, et al. (2005)

Bilateral: Binder, et al. (2000), Wilson and Iacoboni (2006), Okada & Hickok (2006)

Often spatially broader in Left, focal in Right PSTS.

Bilateral PSTS consistent with stroke pattern in Pure Word Deafness.

Looking for phonological repetition-suppression effects

Reduced response to repetition will highlight areas processing phonological content.

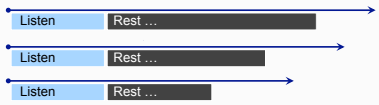
Experiment conducted in 3T Philips MRI Scanner

1 hr 15 min sessions. 8 runs of 29 trials, 5.5 minutes each

Task: listen, press a button only if list contained pseudowords.

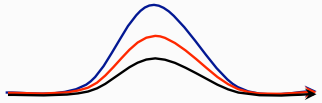
Catch trial (2 per 29 trials): "hig, sheeve, tomb, batch"

Jittered block design: 8.4, 10.5, 12.6 sec



Subjects (8M, 9F) listened to 4 CVC words:

1. Dissimilar	{cat, mop, dip, bell}	(0/3)
2. Similar	{cat, cap, cab, can}	(2/3)
3. Repeating	{cat, cat, cat, cat}	(3/3)



Predicted pattern of activity:
[Repeating < Similar < Dissimilar]

Method: Protocol, Preprocessing, and Analyses

Imaging Protocol

3T Phillips MRI at the Research Imaging Center, UCI. All images AC-PC oriented. **Anatomical volumes:** 1.5mm³ isomorphic, T1 weighted sequence. **Functional volumes:** [2.3 x 2.3 x 3mm] voxels, 34 slices, whole brain coverage, interleaved order, zero gap.

Other EPI specs: TR = 2.1s, TE = 26ms; FA = 90; FOV = 200; 150 volumes acquired in each 315 sec long run. 2 dummy scans. SENSE head-coil to increase sensitivity to temporal lobe signal, SENSE factor = 0. **Cogent 2000** synchronized sound delivery through Resonance Technologies headphones.

Preprocessing

SPM: Slice-timing correction, motion correction in six dimensions, co-registration, segmented and normalized images to MNI. Spatial smoothing, 5mm FWHM Gaussian kernel.

LMGS: Voxel-level Linear Model of the Global Signal (Macey, et al., 2004) de-trended global mean signal fluctuations.

Two nuisance variables: *Extreme intensity volumes* identified volumes that differed greatly in intensity from the rest of a run. *Extreme voxel count* identified volumes with large numbers of voxels coincidentally deviated from mean intensity.

SPM5 Analyses:

1. Linear effects of phonological repetition

Where did activity decrease as phonological repetition increased? Individual t-maps: [repeating < similar < dissimilar] contrast, submitted to group analysis.

2. Significantly different responses to repetition

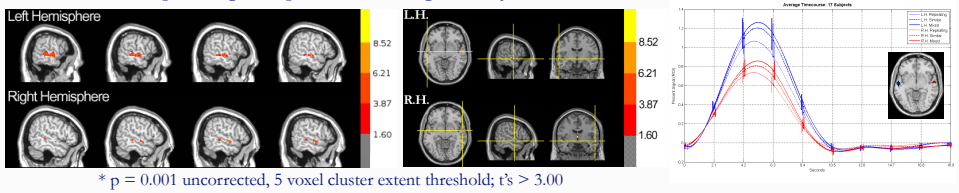
Where did significant differences emerge between decreasing activity levels, as phonological repetition increased? Individual t-maps: [repeating < similar] and [similar < dissimilar] contrasts, submitted to group conjunction analysis.

3. ROI Timecourse

What did the repetition-suppression look like? STS ROIs defined using conjunction analysis result, mean activity timecourses for each condition.

Results

1. Linear effects of phonological repetition | **2. Significantly different decreases** | **3. ROI Timecourse**



* p = 0.001 uncorrected, 5 voxel cluster extent threshold; t's > 3.00

Significant decreases in activity during word listening, as phonological repetition increased.

1. Linear contrast revealed extensive bilateral STS activity, decreasing with phonological repetition.
2. Conjunction analysis found significant differences among decreases in posterior-middle STS.
3. Functionally defined ROI shows significant repetition-suppression *(peak s.d. at p<.05 in pairwise t-tests).*

Pattern of results supports that bilateral STS processes phonological information in speech.

Conclusion

Phonological repetition-suppression in sub-regions of bilateral superior temporal sulci

Further converging evidence for phonological role of bilateral pSTS in speech recognition.

Supports that speech vs. nonspeech listening tasks may obscure speech-related, phonological activity.

Parametric designs, contrasts have advantage in highlighting functions supporting speech.

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Greg Hickok: greg.hickok@uci.edu
talkingbrains.blogspot.com