Reliability and stability in shortened versions of an auditory functional localizer

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Summary

- **Functional language localizers** are effective tools for independently defining neural sensitivity and are designed to quickly and reliably identify the **language-sensitive regions** in individual brains [1].
- An auditory version of the language localizer was developed to be more suitable for use with children and special populations [2].
- In this work, we examine if the **auditory language localizer** can be shortened in duration and how much data is needed to provide robust functional localization of language regions without sacrificing accuracy.
- We found that **reliable activation maps** of language-selective cortex can be obtained from two, 4:35-runs of the auditory localizer without losing much accuracy and precision in contrast to further reductions in scan time.
- These data can **guide decisions for using a functional language localizer** when scan time is a limiting factor in experimental design.

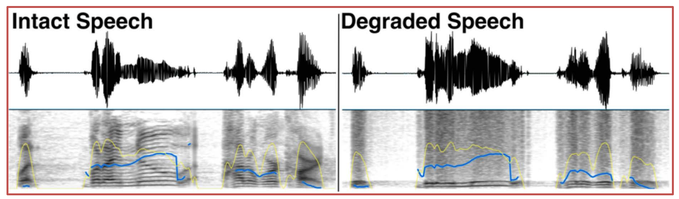
Methods

Participants: 24 fluent English-speaking adults (13 female; age 19-32 years, M = 23.50 ± 3.98 years)

fMRI data acquisition: Continuous-sampling block design, using simultaneous multi-slice imaging. TR = 750 ms, 45 axial slices, 5 simultaneous slices, 3mm isotropic voxels, 484 TRs

Task design: Participants listened passively to audio recordings of speech and unintelligible degraded speech. Two runs per session, each consisted of sixteen 18-second blocks of intact and degraded speech conditions.

Conditions



Subsetting the data: Each run (6:03 scan time) was subdivided into four spans of increasing duration to see when language-selective activation patterns stabilized:

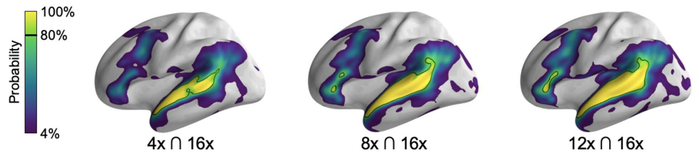
Span 1: 4 blocks (2 per condition) (1:44 scan time)
Span 2: 8 blocks (4 per condition) (3:09)
Span 3: 12 blocks (6 per condition) (4:35)
Span 4: 16 blocks (8 per condition) (6:03)

Analyses: (1) Whole-brain univariate analysis with outcome measure of Jaccard index as a measure of spatial similarity to compare the patterns of activation for smaller amounts of localizer data vs. the full dataset. **(2)** Group-constrained Subject Specific (GCSS) analysis to define regions of interest [1,3], creating parcels from group probability maps and subject-specific functional regions-of-interest (fROIs).

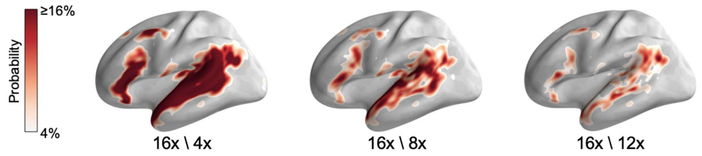
Stability: Univariate Whole Brain

Key results: All reduced spans of data were highly likely to find language areas (common voxels with Span 4). Span 3 showed the most convergence to the full dataset. Span 3 also had the fewest false negatives. The very few false positives for all spans were located in mostly non-language areas.

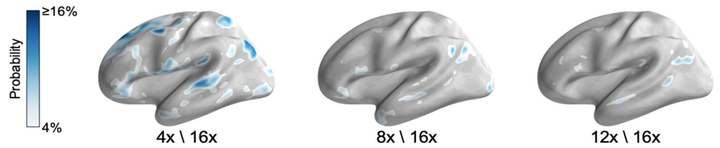
True positives in reduced localizers



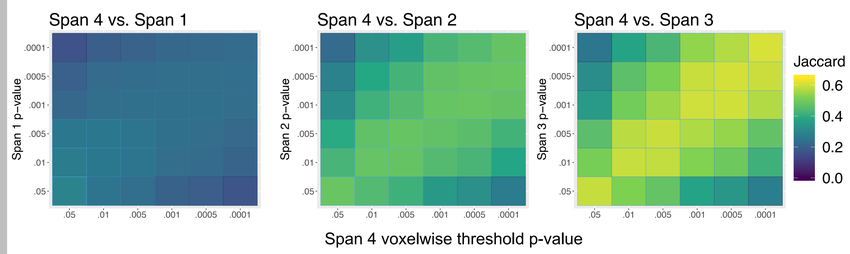
False negatives (Type-I errors) **in reduced localizers**



False positives (Type-II errors) **in reduced localizers**



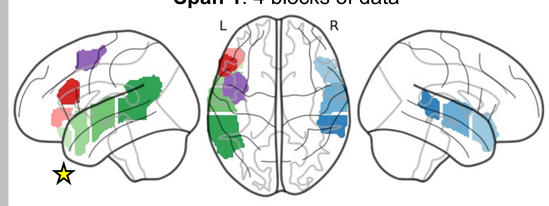
Degree of within-subject localizer map overlap



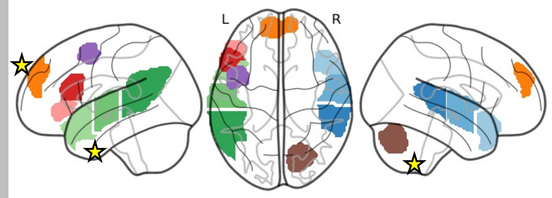
Stability: GCSS

Parcels contain language selective voxels from ≥ 80% of subjects.

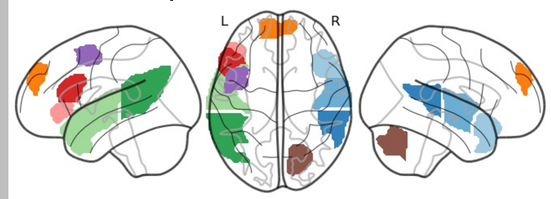
Span 1: 4 blocks of data



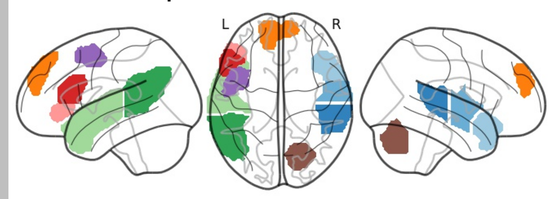
Span 2: 8 blocks of data

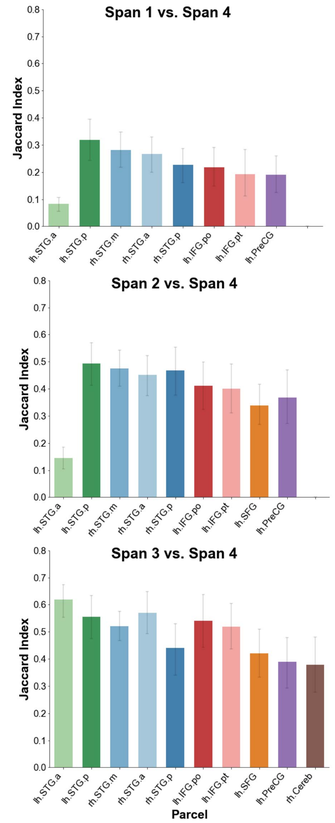


Span 3: 12 blocks of data



Span 4: 16 blocks of data

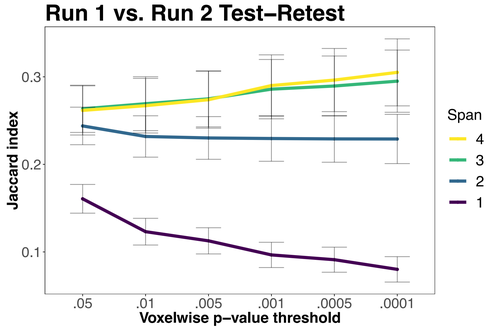




GCSS parcellation shows stability by Span 2. Small amounts of data (Span 1) show finer parcellation of left STG, but miss frontal and cerebellar parcels (shown by ☆).

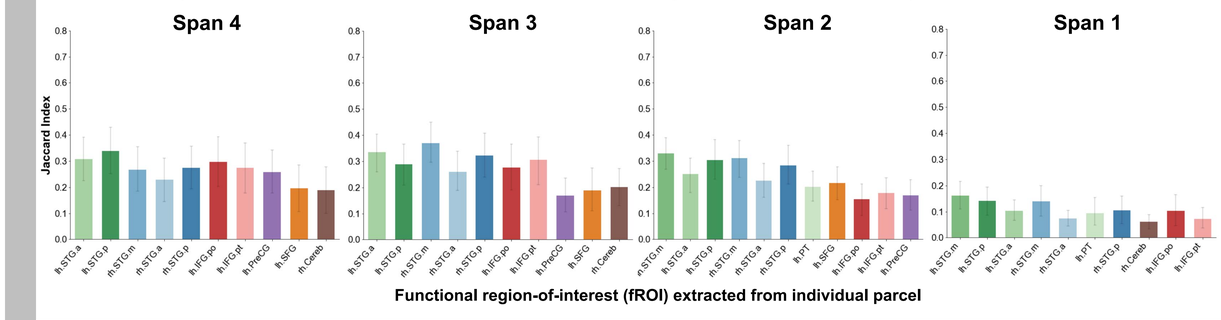
Reliability: Univariate

Test-retest reliability (Run 1 vs. Run 2) is similar for Spans 3 & 4 and increases for more conservative thresholds. Span 1 has the least test-retest reliability.



Test-Retest Reliability: GCSS

The overlap in individually-specified fROIs (defined by the top 10% of voxels from each subject's parcels) were compared via Jaccard index between Run 1 and Run 2. Span 3 and Span 4 had the greatest consistency in between-run fROI location, with diminishing between-run reliability for less data.



References

[1] Fedorenko et al. (2010). *Journal of Neurophysiology*, 104(2): 1177-1194.
[2] Scott, Gallée, & Fedorenko (2017). *Cognitive Neuroscience*, 8(3): 167-176.
[3] Nieto-Castenan & Fedorenko (2012). *NeuroImage*, 63(3): 1646-1669.

Acknowledgements

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