

Functional Localizers for American Sign Language Comprehension

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Introduction

- **Functional localizers** are used in fMRI studies to constrain analyses to neural areas known to be relevant to a cognitive process of interest (e.g., language), called functional regions of interest (fROIs)
 - While fROIs differ across individuals, they are treated as functionally equivalent
- Standardized localizers have been developed for spoken languages, increasing study replicability [1][2]
 - Language fROIs are delimited by group-level parcels to enable comparing across groups
- **Our goal:** develop ASL localizers & group-level parcels for use in fMRI studies on ASL comprehension
 - What localizer conditions for ASL are best and how do they compare to spoken-language localizers?

English Localizer Parcels [1, 3]

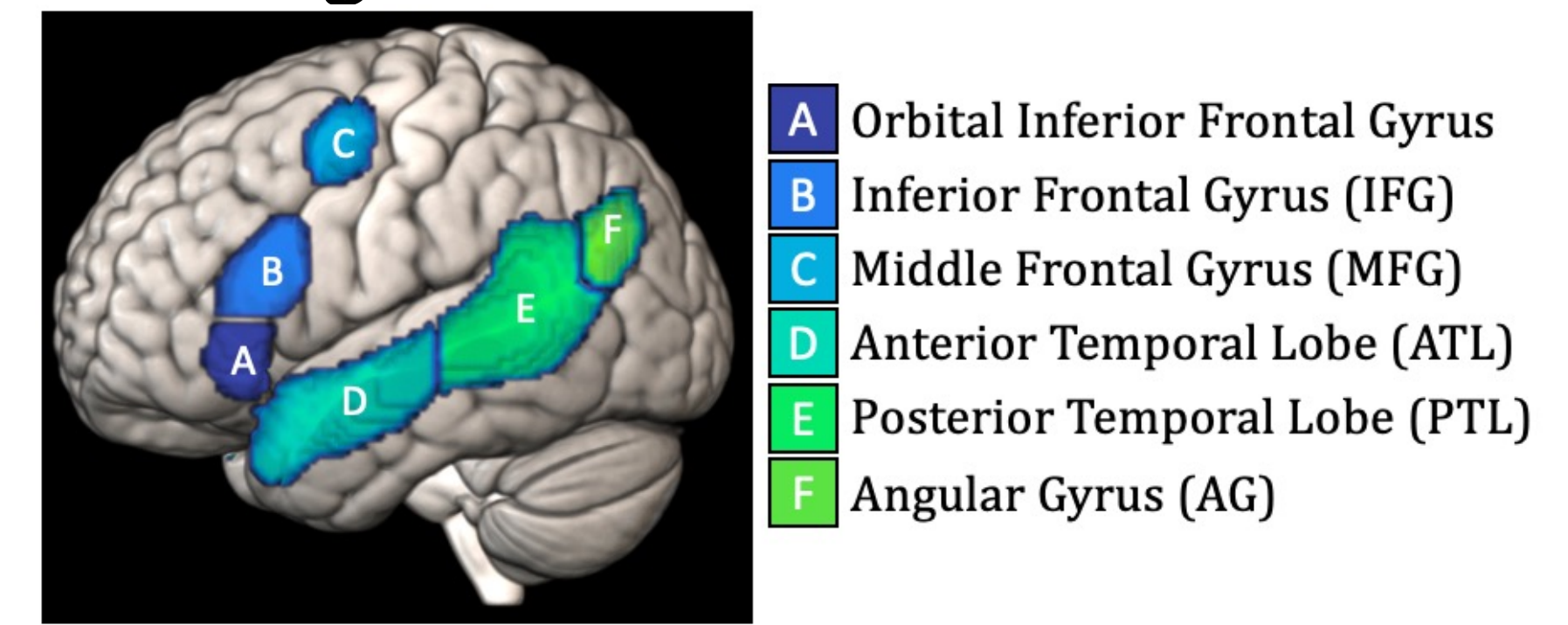
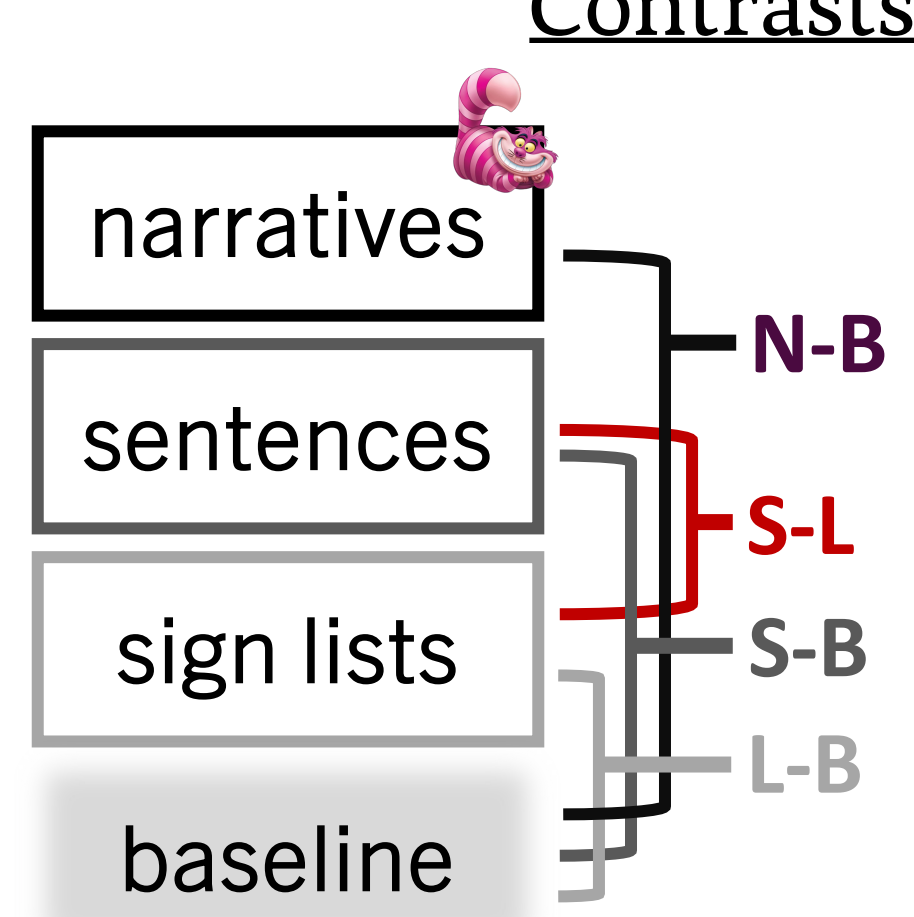


Figure 1. Group-level parcels from a written English localizer task (N = 220); LH parcels are flipped onto the RH for a total of 12 language parcels.

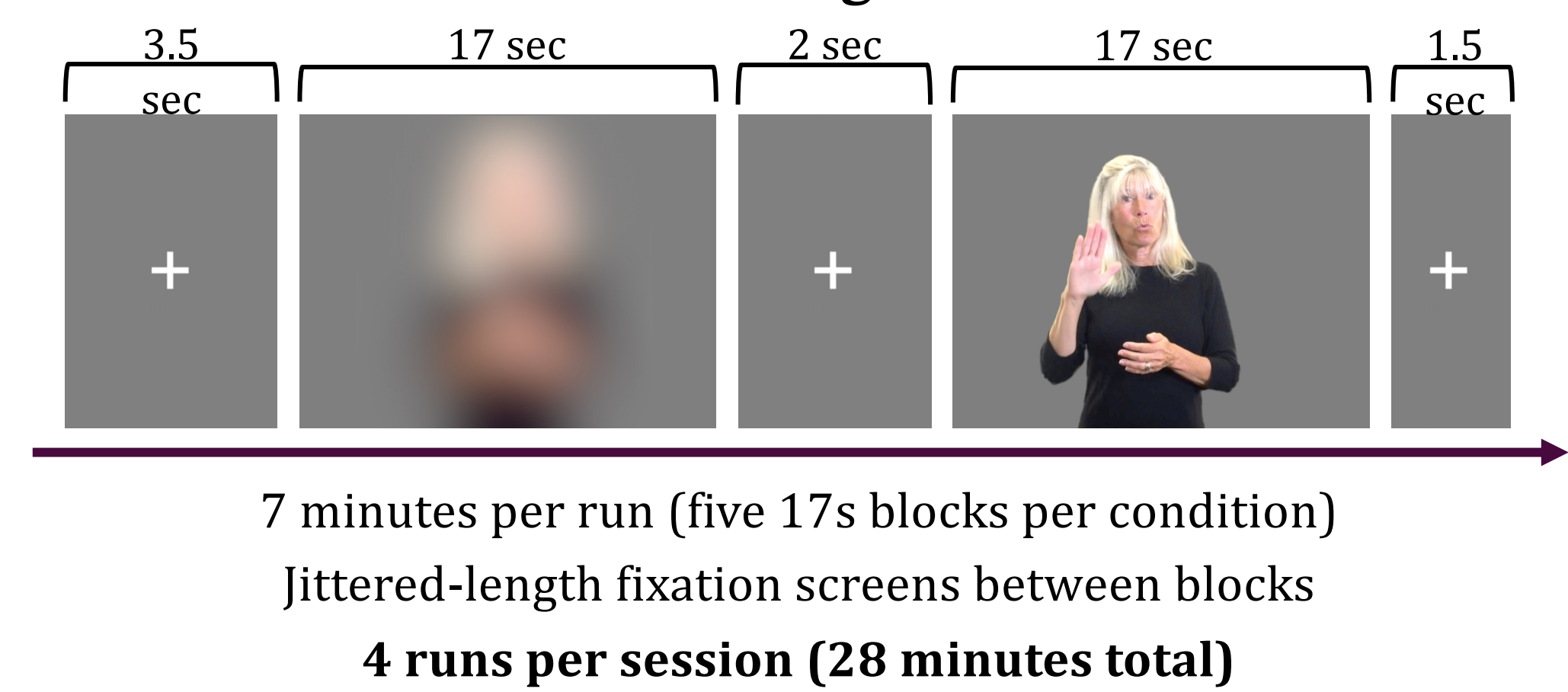
Conditions & Scanning Protocol

- We developed **three ASL conditions:** sign lists, sentence sets, and narratives (*Alice in Wonderland* excerpts)
 - The **baseline condition** consists of blurred sentence videos
 - Preserves visual information, but linguistically incomprehensible
 - Direct contrast between *sentences* > *sign lists*, which share words, isolates lexical vs. combinatorial syntactic-semantic processing
- We scanned 15 deaf native/early signers on all localizer conditions
 - Age M = 31 [24 - 49]; 7F/8M; ASL age of acquisition 0 - 5
- Data were processed with SPM and the *spm_ss* package in MATLAB [3]

Conditions



Scanning Protocol



Results

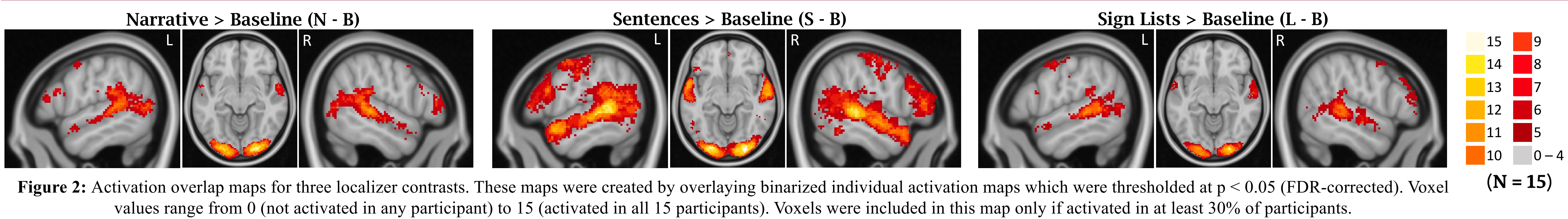


Figure 2: Activation overlap maps for three localizer contrasts. These maps were created by overlaying binarized individual activation maps which were thresholded at $p < 0.05$ (FDR-corrected). Voxel values range from 0 (not activated in any participant) to 15 (activated in all 15 participants). Voxels were included in this map only if activated in at least 30% of participants.

Parcels from ASL Sentences > Baseline Contrast

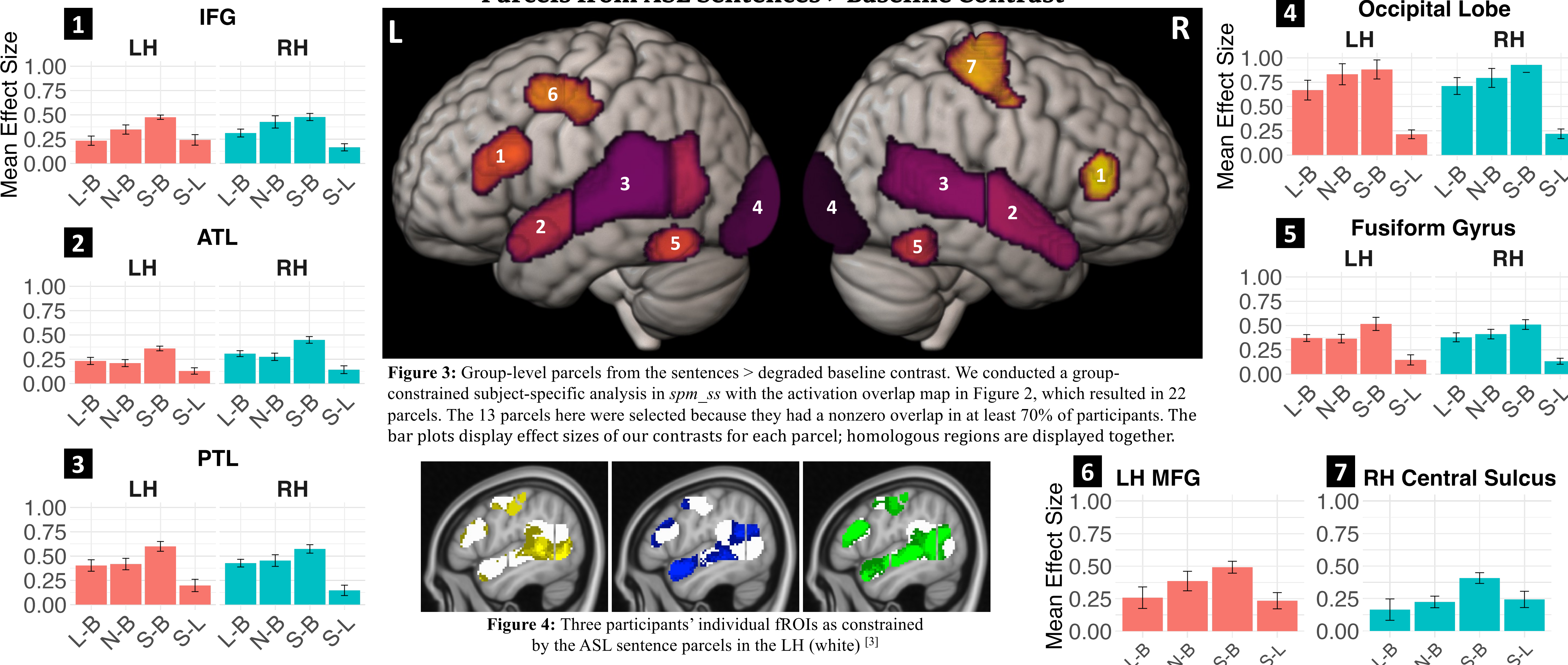


Figure 3: Group-level parcels from the sentences > degraded baseline contrast. We conducted a group-constrained subject-specific analysis in *spm_ss* with the activation overlap map in Figure 2, which resulted in 22 parcels. The 13 parcels here were selected because they had a nonzero overlap in at least 70% of participants. The bar plots display effect sizes of our contrasts for each parcel; homologous regions are displayed together.

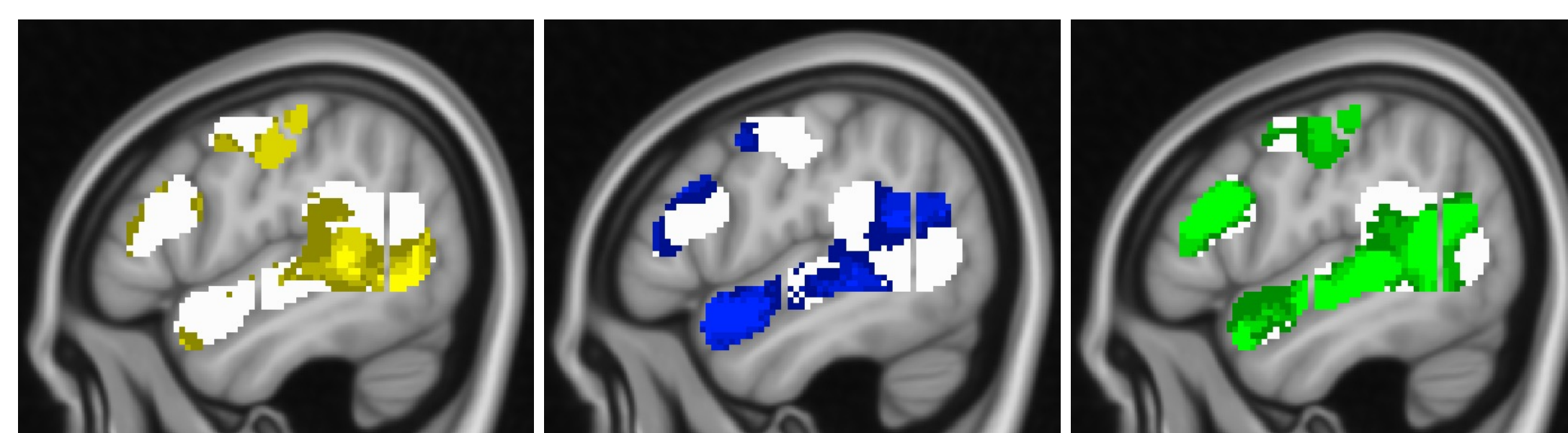


Figure 4: Three participants' individual fROIs as constrained by the ASL sentence parcels in the LH (white) [3]

Conclusions

- ASL *sentences* are the most robust linguistic localizer condition
- Our localizer activates core supramodal language regions + modality-specific regions for sign language (see Figure 5)
 - Strong bilateral activation, with largely analogous regions activated
- Our data indicate distributed activation across network for lexical vs. syntactic-semantic processes
- **Future work will:**
 - Refine the baseline condition to test whether occipital activation is driven by low-level visual processing (e.g., sharp vs. blurred edges; see Scanning Protocol for a visual comparison of conditions)
 - Add a visually-matched baseline consisting of meaningless hand movements
 - Add a phonological condition (lists of pseudosigns) as a phonological baseline, similar to nonwords used as a baseline in the written English localizer [1]

Occipital Regions

Activation may be due to low-level visual processing, but also may be modulated by top-down linguistic predictive processing of sign input

Inferior Temporal Regions

Activation may reflect linguistic processing of linguistic facial expressions and hand configurations during sign comprehension

Figure 5: Possible functions of sign-specific parcels.

References

[1] Fedorenko et al. (2010). New method for fMRI investigations of language: Defining ROIs functionally in individual subjects. *Journal of Neuropsychology*. [2] Malik-Moraleda, S., et al. (2021). The universal language network: A cross-linguistic investigation spanning 45 languages and 11 language families. [3] English localizer stimuli, parcels, and *spm_ss* package for analysis found at evlab.mit.edu