# Reliability of fMRI data during speech production tasks across scanning sessions

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## Introduction

- Most neuroimaging studies of speech production look at the average neural activity across a group of subjects during a particular speaking task compared to baseline.
- When studying speech disorders that result from idiosyncratic lesions such as stroke or traumatic brain injury, it may be more appropriate to focus on *individual activity patterns*.
- As a first step toward characterizing the speech production network in individuals post-stroke, we sought to quantify the reliability of speech activation in healthy individuals across multiple sessions and speech tasks.
- Brain activity from healthy subjects who participated in two similar speech production studies in our lab was compared to assess reliability across scanning sessions.

## Methods

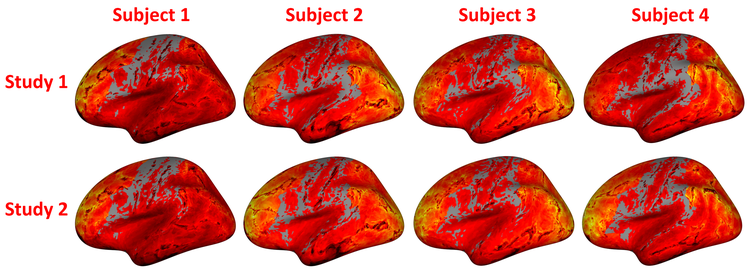
### Data

- **Test Set:** 14 subjects (7M/7F) participated in two pseudoword production fMRI studies; 112 *speech > baseline* contrasts, 28 mean functional masks
  - Mean speaker age: 29 (19-44)
  - Days between sessions: 13 (6-52)
  - Effect-size maps were **masked to only include areas in the speech network**, and thresholded at **the highest 10% of vertices**
- **Distractor Set:** 62 subjects (119 *speech>baseline* contrasts, 68 mean functional maps) were processed similarly to be used for training and testing a classifier.

### Analyses

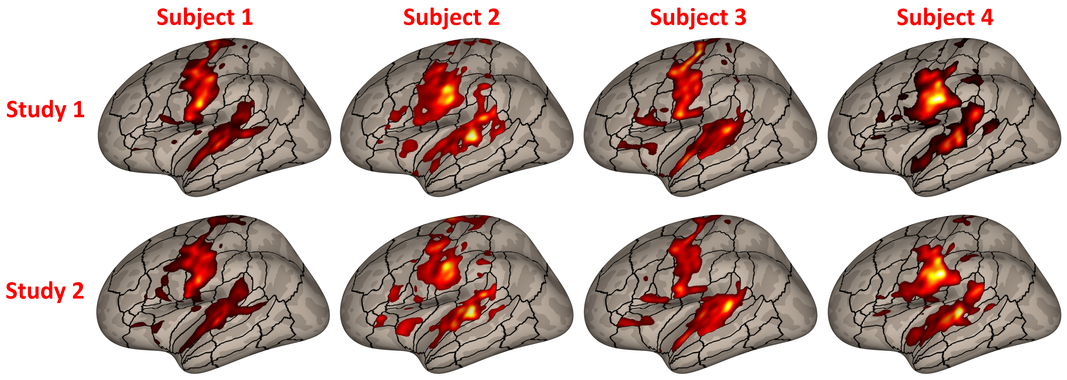
- Classifier analyses (see figure 5)
- Similarity measures:
  - Dice coefficient (Bennett and Miller, 2010)
  - Whole-brain intraclass correlation coefficients calculated using ICC(C, 1) from McGraw and Wong (1996).

## Fig. 1: Baseline: Mean Functional Activation



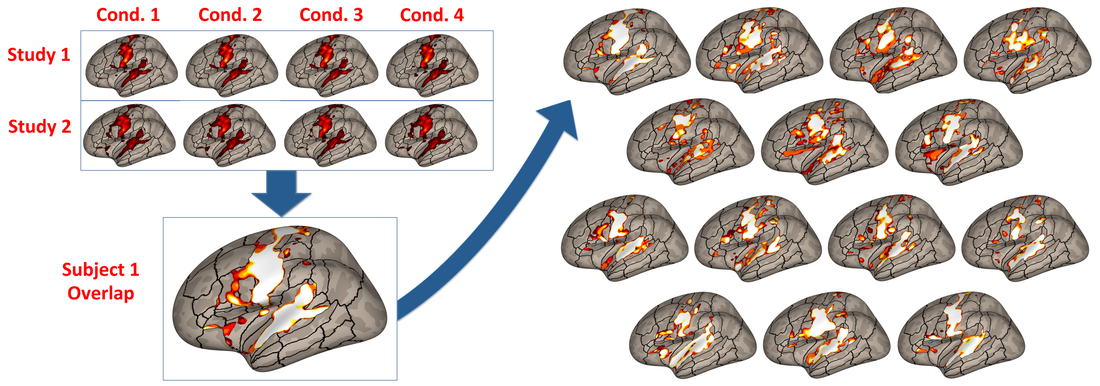

- Mean BOLD signals (thresholded data in grey used for analysis).
- We classified test subjects with **100% accuracy** from among **76 subjects**, using **25 principal components**.
- Subjects' average functional BOLD signals were **highly reliable**: **ICC** and **Dice coefficient** were both **0.71**.
- **The ICC** across subjects was **0.57**.

## Fig. 2: Speech-Baseline Activation



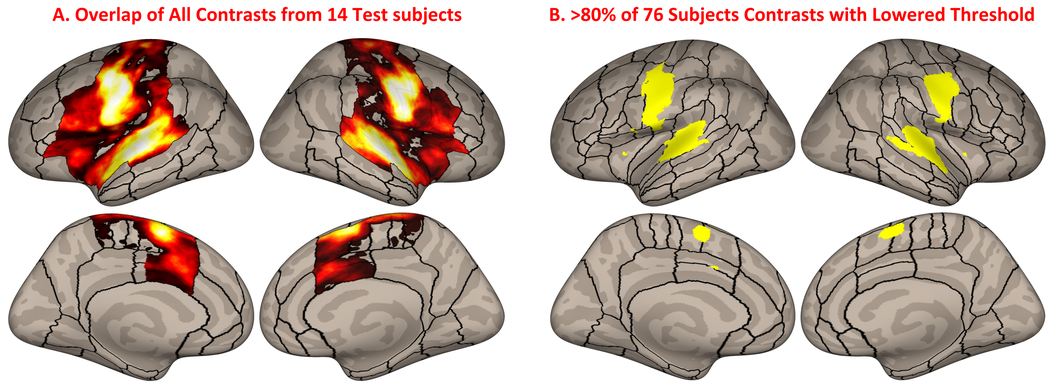

- Speech activation is **highly reliable** for each subject across two studies.
- We could classify individuals with **100% accuracy** from among **76 subjects**, using only **25 principal components.**

## Fig 3. Single Subject Overlap



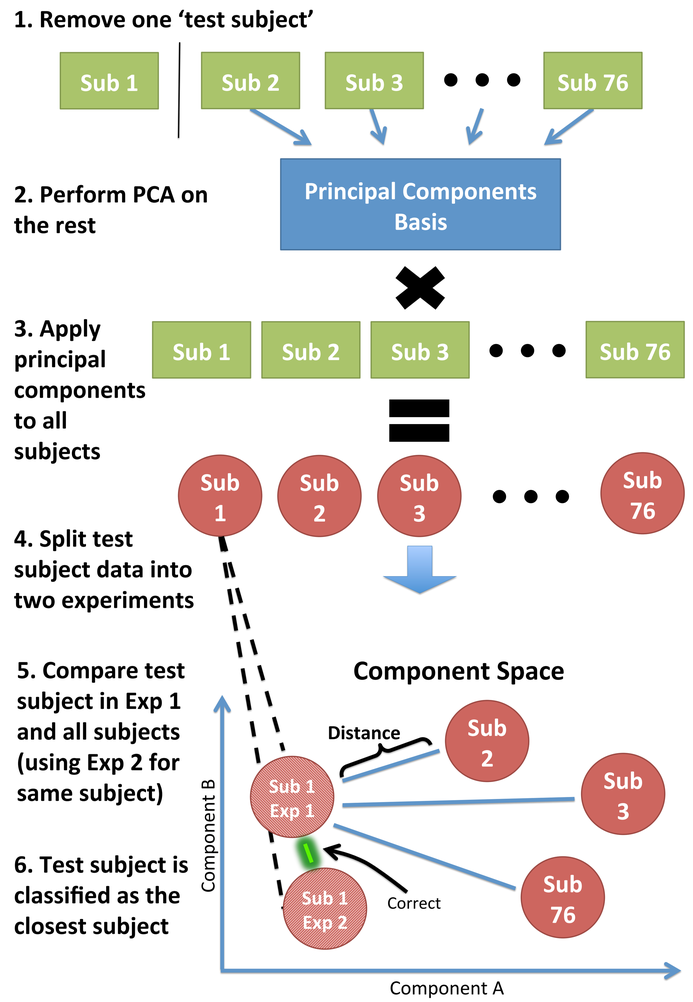

- For speech activation, average **intra-subject ICC** was **0.88** as compared to an **inter-subject ICC** of **0.64.** Average intra-subject **Dice coefficient** was **0.73**.
- As the right side shows, each subject has a unique pattern of intra subject overlap.

## Fig. 4: Grand Overlap Speech Maps




- Most subjects showed large areas of activation in ventral motor and premotor cortex, auditory cortex, and medial premotor cortex during speech production.

## Fig 5. Classifier Analysis




## Conclusions

- Classifier success suggests that intra-subject variability is smaller than inter-subject variability.
- Subjects' mean functional and speech>baseline activation are highly reliable across scanning sessions
- This suggests that healthy speakers have a unique neural "fingerprint" that can be observed during speech production.
- Over 80% of contrasts from 76 subjects showed activity in large swaths of common speech production areas.
- Overall, this suggests that single-subject studies are likely to yield reliable results.

## References

Bennett, C.M., & Miller, M.B. (2010). How reliable are the results from functional magnetic resonance imaging? *Annals of the New York Academy of Sciences, 1191*(1), 133-155.

McGraw, K., & Wong, S (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods, 1*(1), 30-46.

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