

## QIBA fMRI Biomarker Committee (BC) Call

Wednesday, December 16, 2020 at 11 a.m. (CT)

### Call Summary

#### In attendance

Feroze Mohamed, PhD (Co-chair)

Jay Pillai, MD (Co-chair)

David Soltysik, PhD (Co-chair)

Cathy Elsinger, PhD

Ping Hou, PhD

Ichiro Ikuta, MD, MMSc

Ho-Ling (Anthony) Liu, PhD

Nancy Obuchowski, PhD

Nicolás Sánchez Domínguez, MD

James Voyvodic, PhD

Divya Yadav, MD

Yuxiang Zhou, PhD, DABR

#### RSNA staff

Joe Koudelik

Susan Stanfa

**Moderator:** Dr. Soltysik

#### Review of Previous Call Summary

- The 11.18.2020 call summary was approved as presented

#### Language Reproducibility Study Update (Dr. Voyvodic)

[Some information taken from Dr. Voyvodic's slide presentation]

##### Duke Language Reproducibility Database

- 1300 fMRI subjects (3907 tasks in 1397 sessions)
- Selected 482 subjects (524 sessions with at least two language task scans):
  - 447 subjects underwent only one scan session
  - 35 subjects were scanned in more than one session (on same day or up to 11 years apart)
- Subject health status: 18 healthy volunteers, 383 cancer patients, 28 epilepsy patients, 13 AVM patients and 40 other patients (disease unknown)
- 1056 language task scan series: included 901 sentence completion task (S) and 146 opposite word generation task (W)
- 578 Language task comparisons (two tasks for same subject): 436 compare same task (S vs. S or W vs. W) and 142 compare different task (S vs. W)

##### fMRI Analysis

- The fMRI task scan acquisition process took 20+ years to develop and involved the use of four clinical-grade MRI scanners (1.5T to 4T) and multiple scan parameters (mostly linear EPI used); the vast majority of subjects were scanned on 3T scanners
  - Identify task “subtype” (stimulus timing info) for each task scan
  - Check alignment of each task scan to anatomical scan
  - Affine register each scan session anatomical to MNI brain
  - Use FSL “FEAT” GLM analysis to create t-value maps: rigid-body motion correction, smoothing and task and motion regressors for GLM
  - Customize automated cluster analysis
  - Generate AMPLE-normalized (half-max > 50%) maps
  - Calculate weighted Laterality Index (LI) using AMPLE maps
  - Calculate map activation statistics for anatomical ROIs
- Only one task scan for each subject was designated for use as “reference”
  - Although an arbitrary designation, typically a subjectively “good” map was chosen
  - Other task scans were designated as “comparison”

- Started with 380 parameters for each individual map
  - Scan and task parameters (e.g., mag field, scanner, vox dims)
  - QA parameters (e.g., head motion, subjective quality, peak activation)
  - Activation parameters (e.g., location, volume, amplitude in ROIs or clusters)
- For each “comparison” scan, parameters were added for “reference scan”, including 380 scan parameters plus comparison values (e.g., time between scans, ROI, and cluster overlaps)

#### *Anatomical ROIs*

- Began with using large MNI lobe ROIs based on the brain atlas map (frontal, temporal, parietal)
- An average language map (mean of all language task maps) was produced
- New clinical fMRI ROIs were generated (average map  $\geq 1.0$ , dilated  $\sim 3$  mm, and masked by left lobe ROIs)
- Left ROIs were duplicated to right side (focus on four major language areas, two on each side, left/right symmetric)

#### *Reproducibility Conclusions*

- Half-max activation language areas (LHalf) are good QC criterion
  - Volume of activation is a fairly good QC predictor, while head motion parameters are not particularly good QC predictors
- Sentence and word tasks provide similar results; SS, WW, and WS comparisons show similar reproducibility
- Frontal activation is more variable than temporal
- Reproducibility is similar in temporal and frontal areas
- Same-session and different-session reproducibility is similar
- Same or different scanners/magnetic field reproducibility is similar

#### *Language Mapping Profile v2.0 Claims*

- Two Claims will be developed: laterality and location of activation
- Laterality index (-1.0 -> 1.0) – within 0.6 of true LI
- Laterality – Dominance; match true dominance
- Cluster peak location – within 20 mm of true peak location
- Discussion re: repeatability data and whether 10 mm is a realistic goal
  - A standard in QIBA is to set Claims at 95% confidence, however, could consider different confidence rates for different measurements
  - With comparison maps that agree, confidence interval can be higher
  - Half max of four was deemed to be a very conservative threshold that may be eliminating many smaller clusters of activation in secondary language areas; some fMRI BC members take into consideration, other clusters that may not meet that very stringent threshold
    - Dr. Voyvodic clarified that half max of four is an AMPLE threshold
- Discussion re: Profile Claims will continue during the January 6 call

**Next call:** Wednesday, January 6, 2021 at 11 a.m. CT (1<sup>st</sup> & 3<sup>rd</sup> weeks of each month)

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