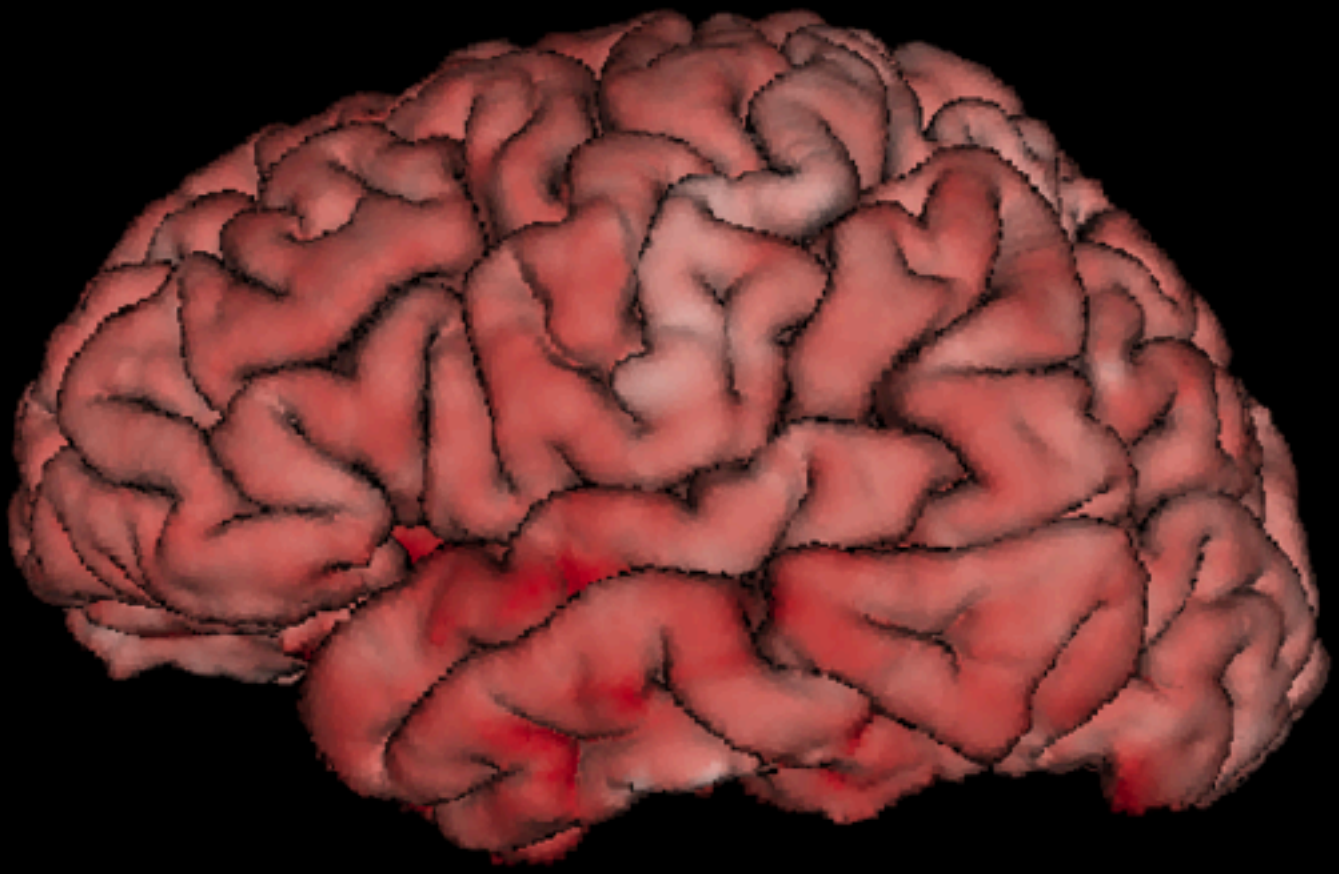
Thickness on a platter

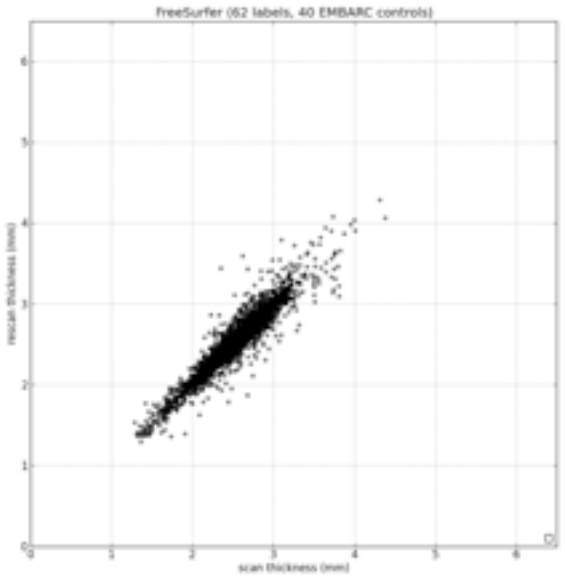
@rno klein

Sept. 24th, 2012



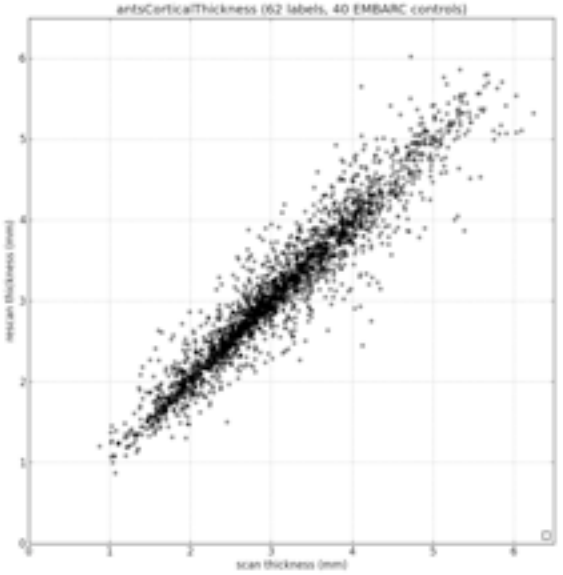
Scan-rescan reliability (40 EMBARC controls)

FreeSurfer



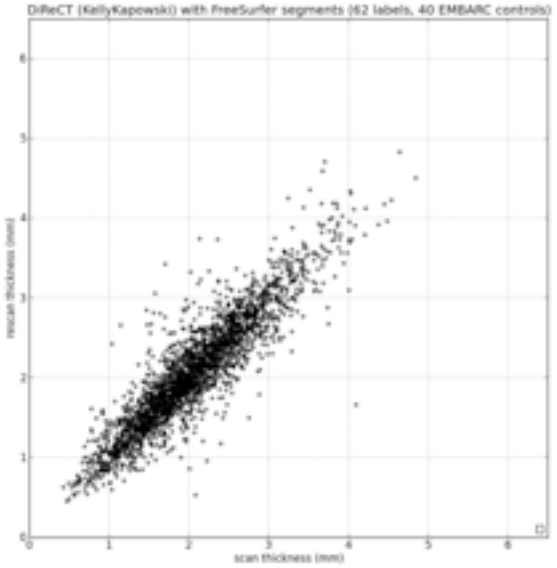
Underestimation due to surface errors?

antsCorticalThickness



Overestimation due to gray assigned to white?

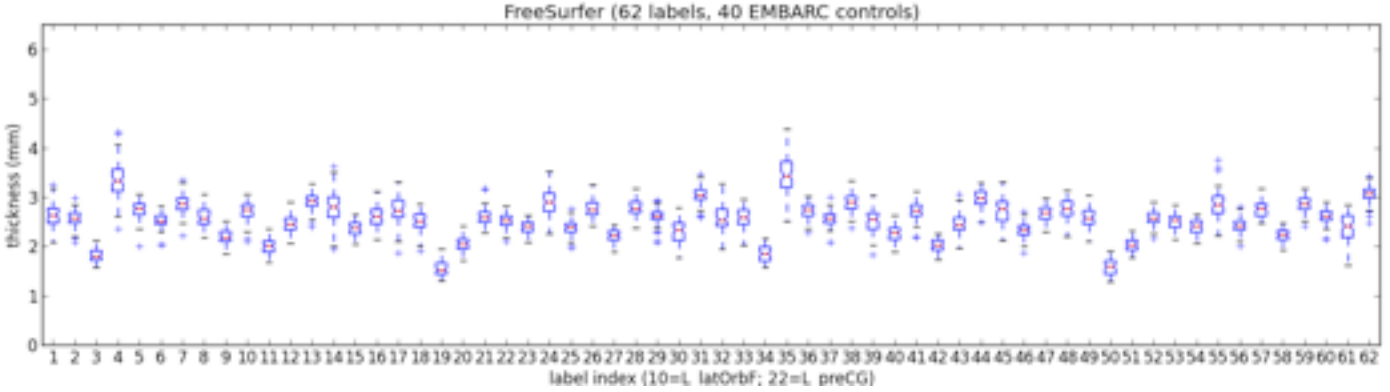
DiReCT (FS segments)



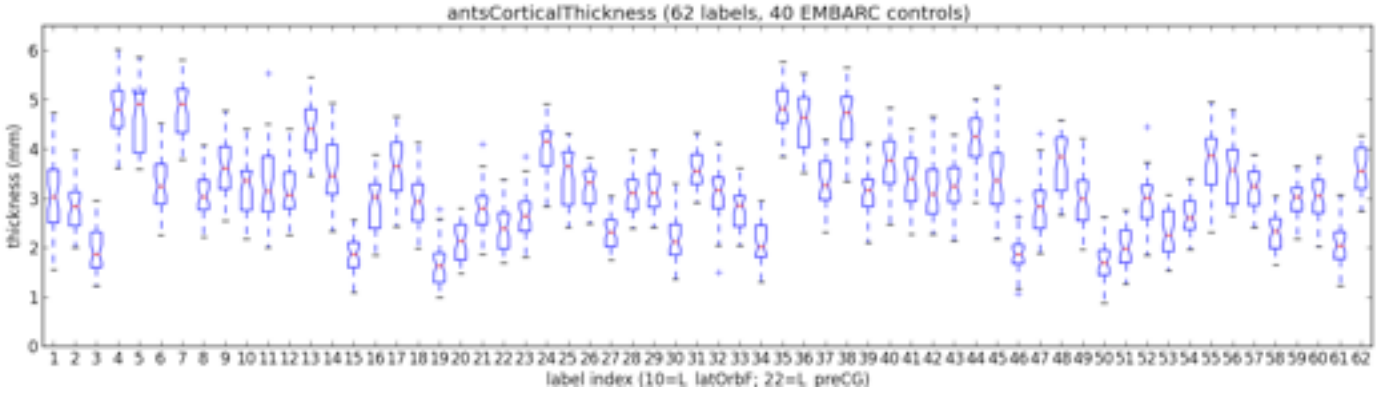
Approximately ANTs reliability with FS range

Inter-subject reliability (40 EMBARC controls)

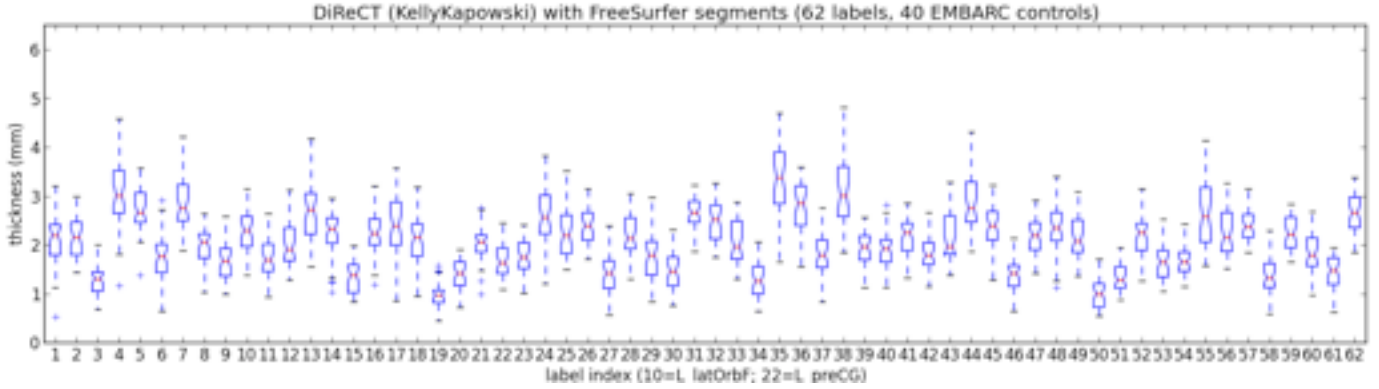
FreeSurfer



antsCT



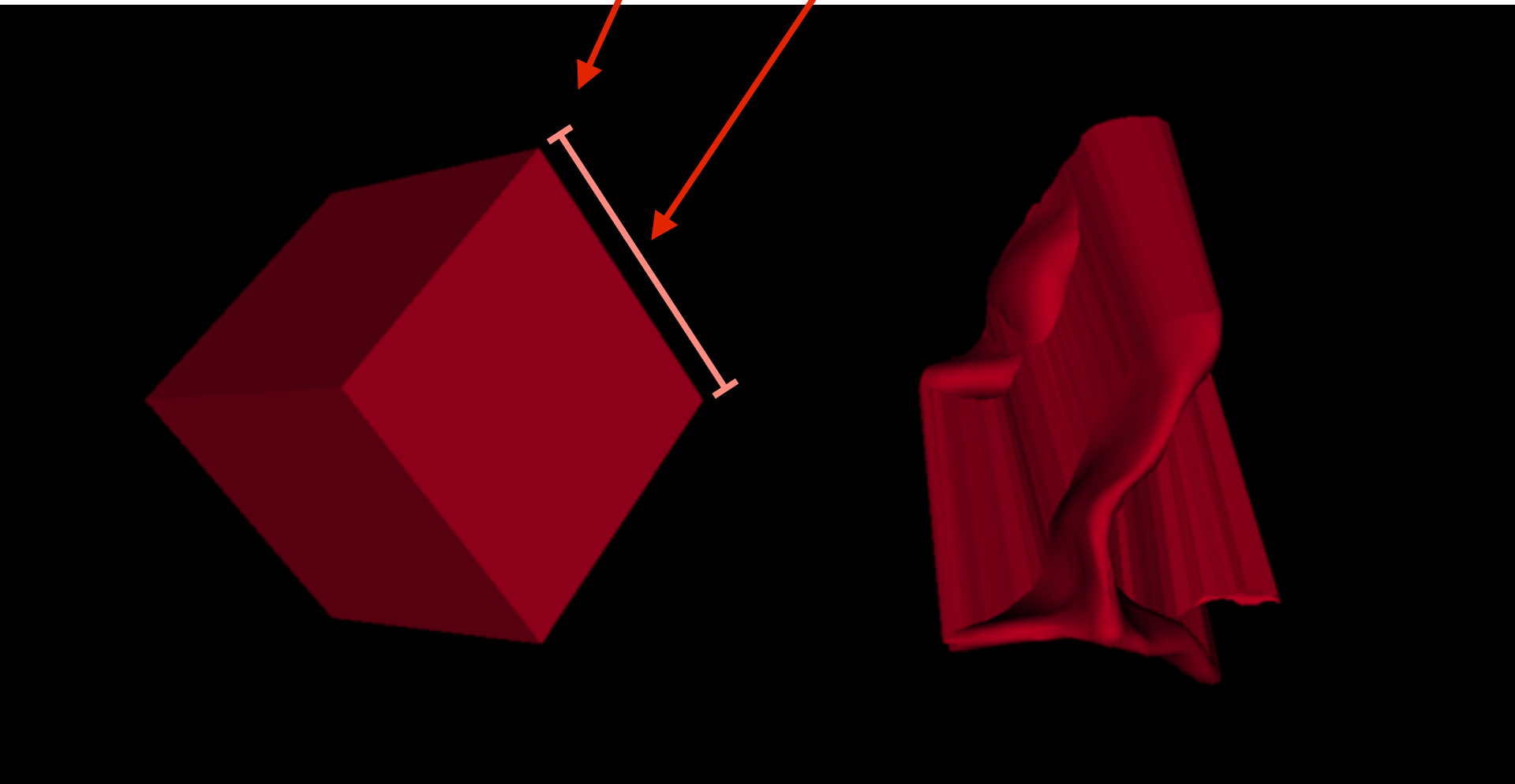
DiReCT
(FS seg)



Simple thickness definitions

Thickness = volume / area

Thickness per label = Label volume divided by area



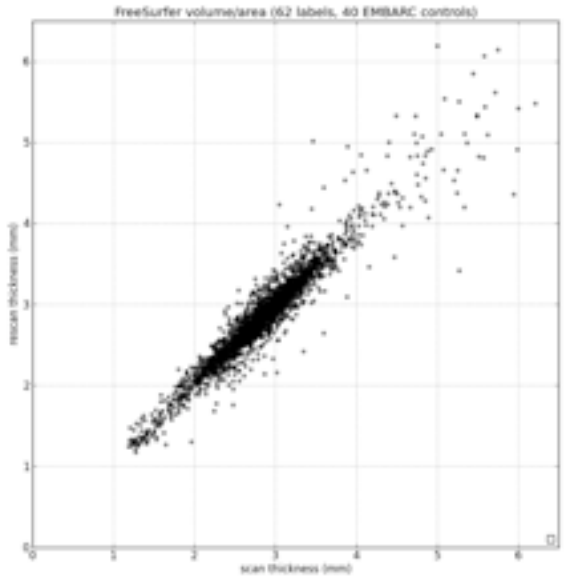
Simple thickness definitions

New program: “Thickasabrick”

Thickness per label = Label volume divided by average of inner area and outer area (2x scale)

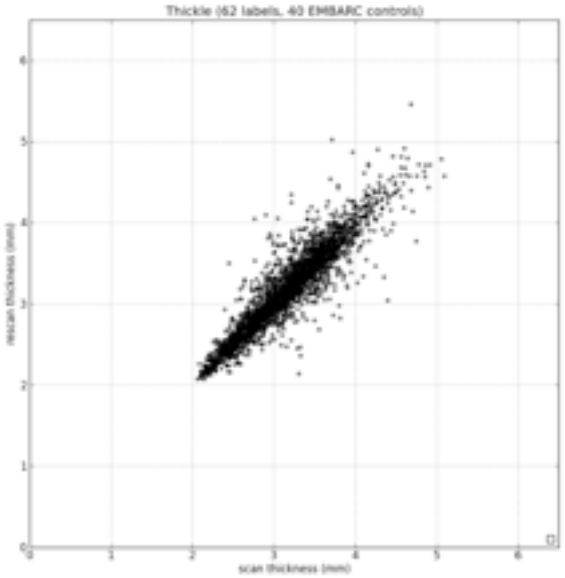
Scan-rescan reliability (40 EMBARC controls)

FS vol / area



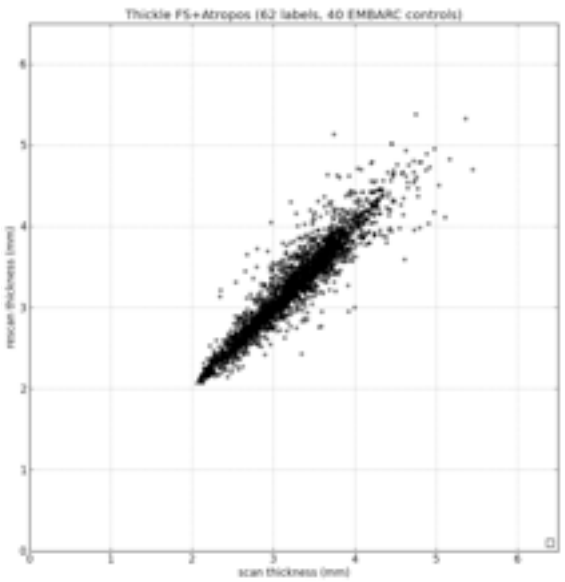
Poor reliability of inflated values

Thickasabrick (FS segments)

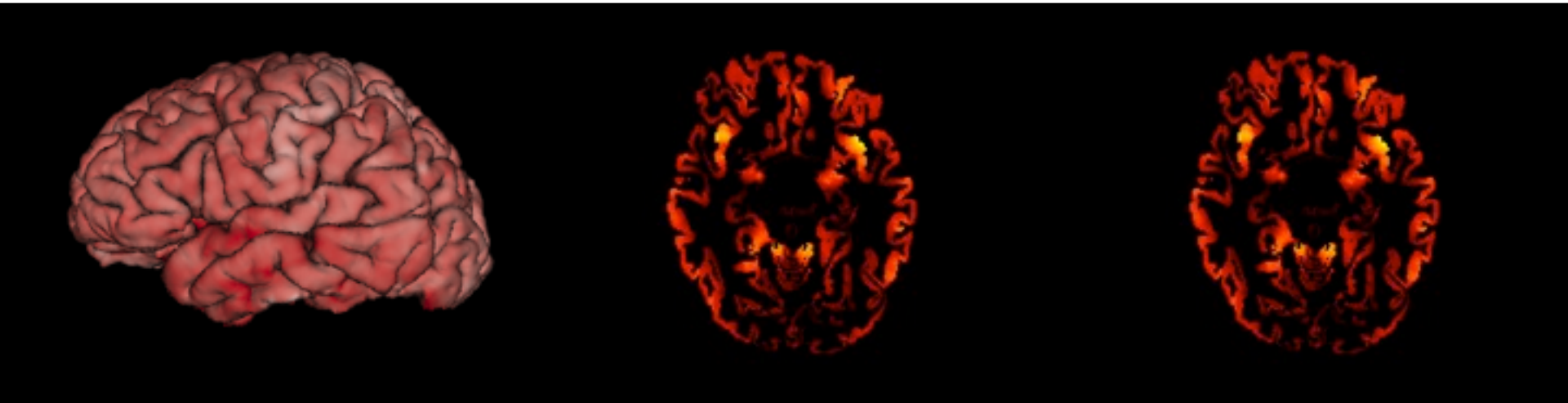


More reasonable distribution with same data!

Thickasabrick (FS+ANTs)

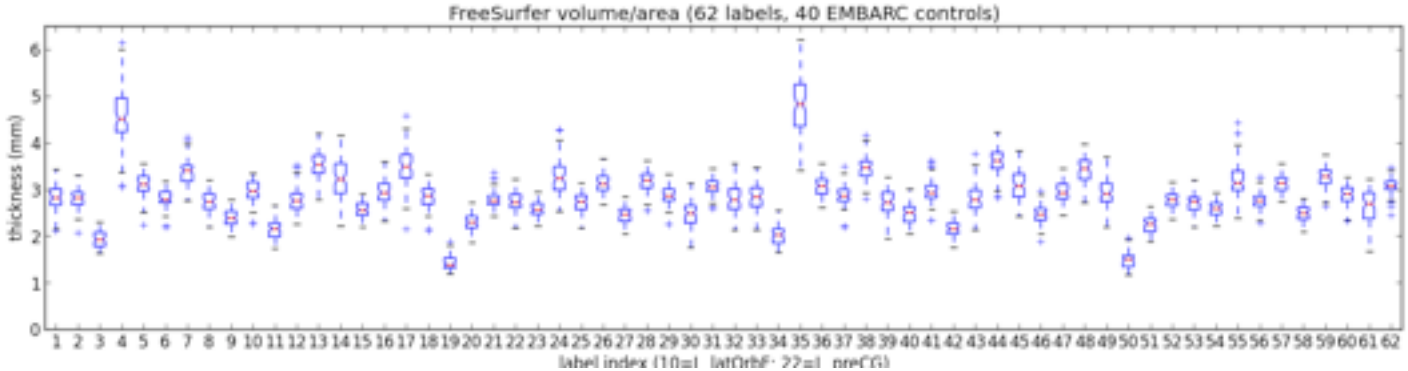


Similar distribution even with ANTs gray!

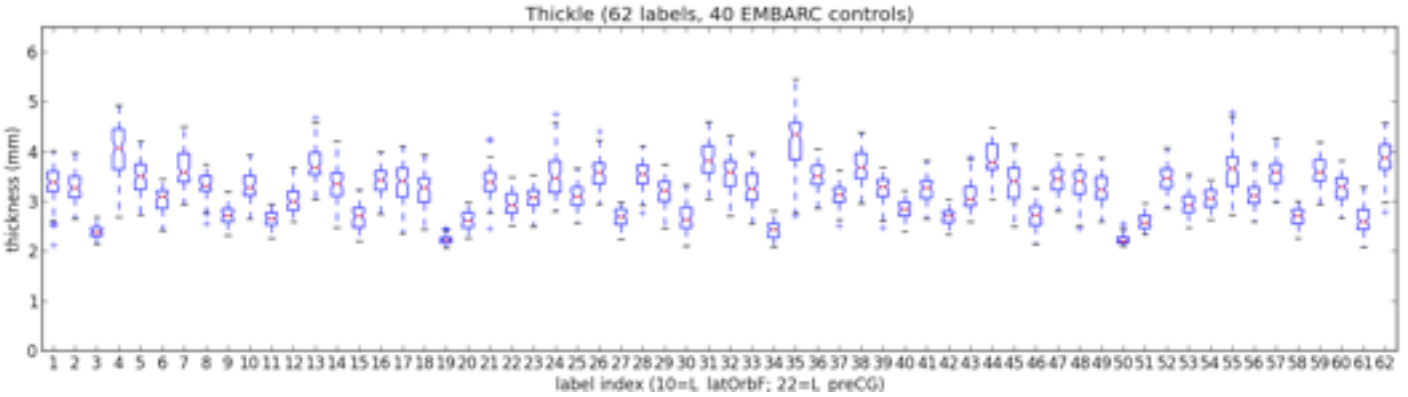


Inter-subject reliability (40 EMBARC controls)

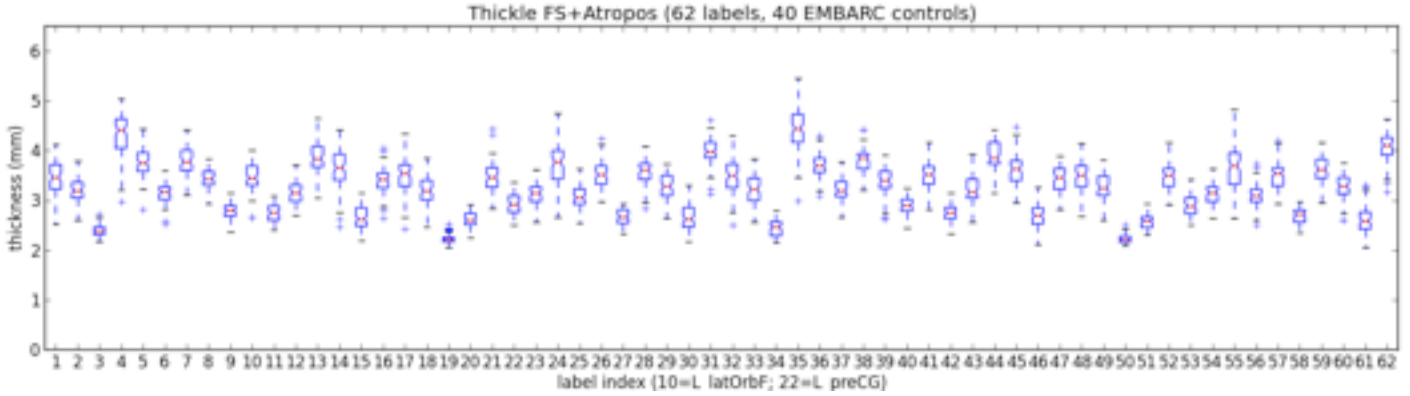
FreeSurfer vol / area



Thickasabrick (FS seg)



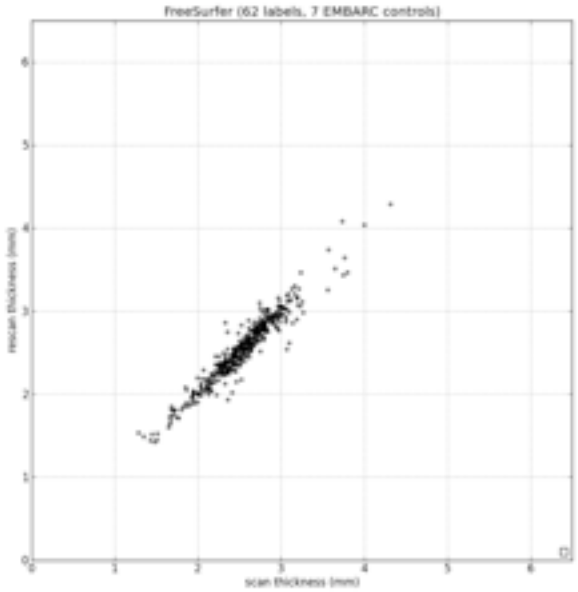
Thickasabrick (FS+ANTs)



Effect of hybrid segmentation

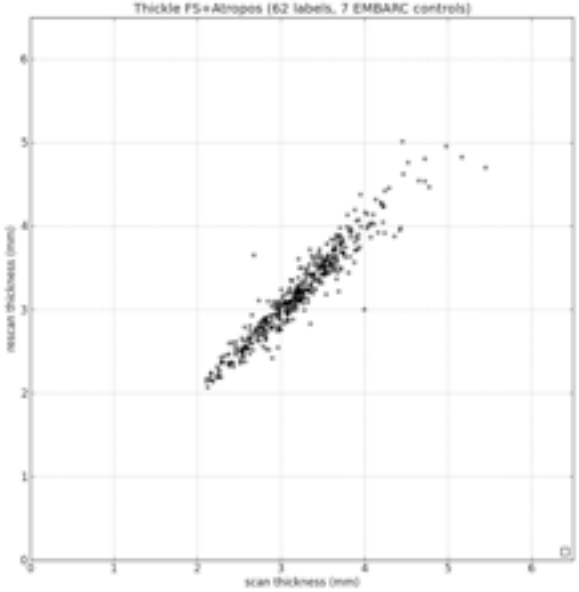
(7 EMBARC controls)

FreeSurfer



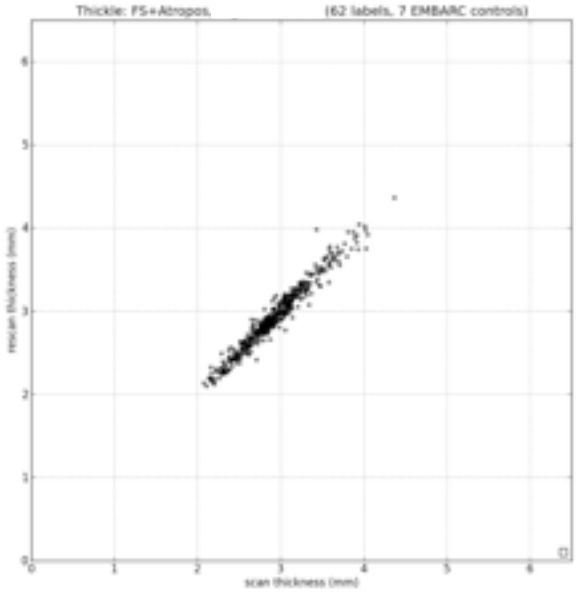
Subset has good reliability

Thickasabrick (FS+ANTs)

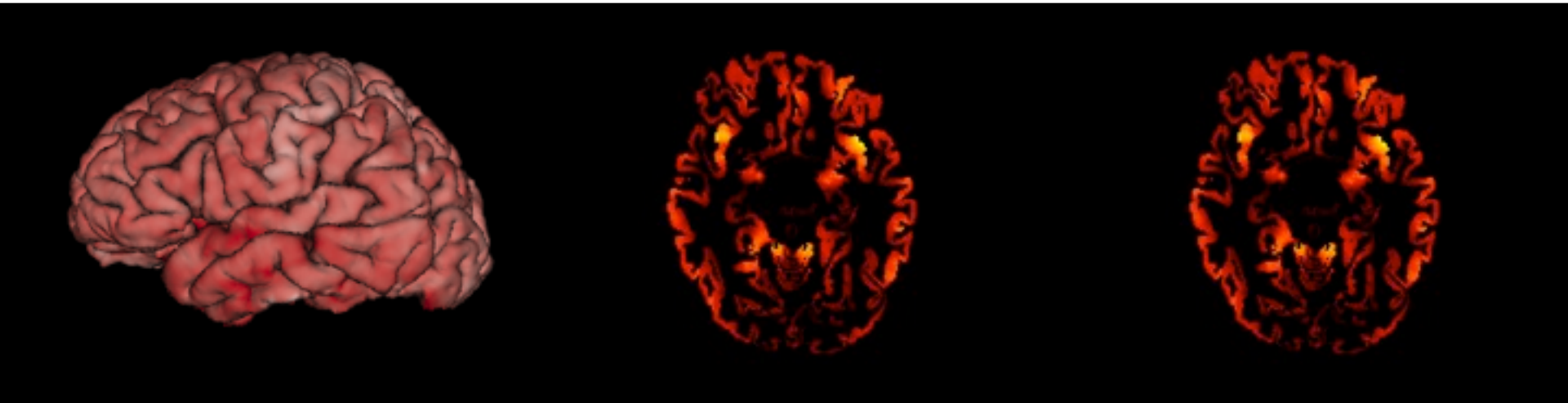


Subset spreads out for higher values

Thickasabrick (FS+ANTs, white/gray)

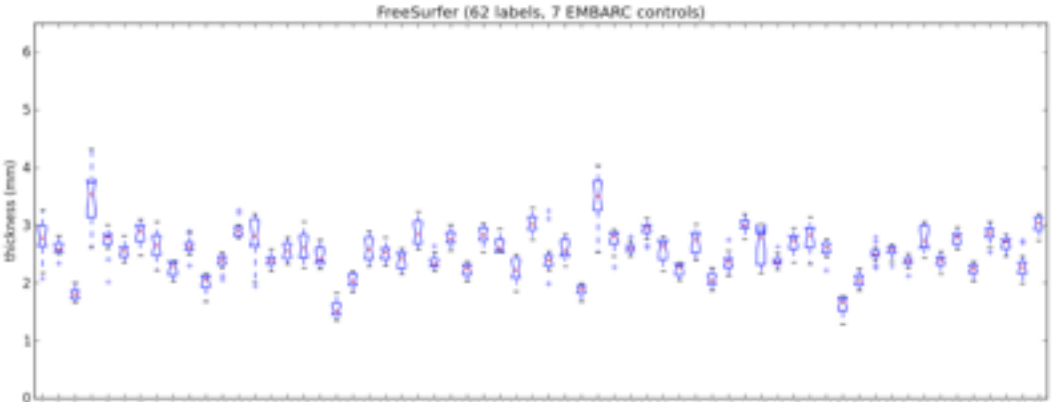


Union white / union gray has great reliability!

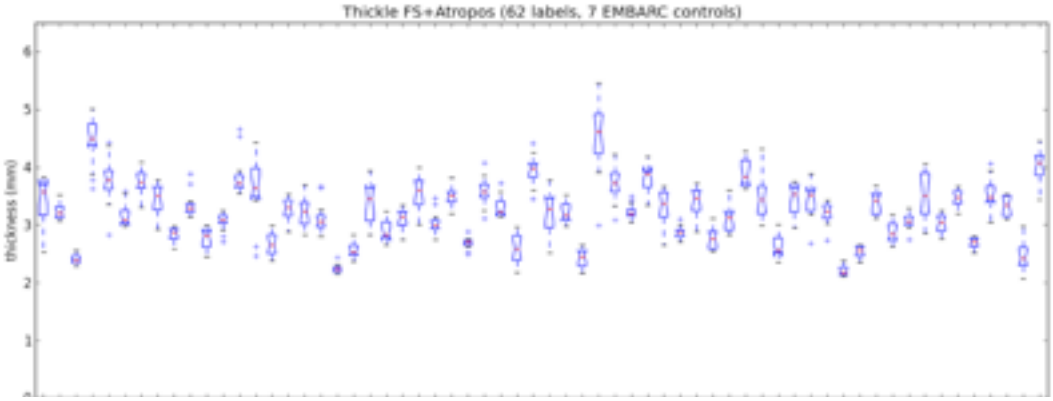


Inter-subject reliability (7 EMBARC controls)

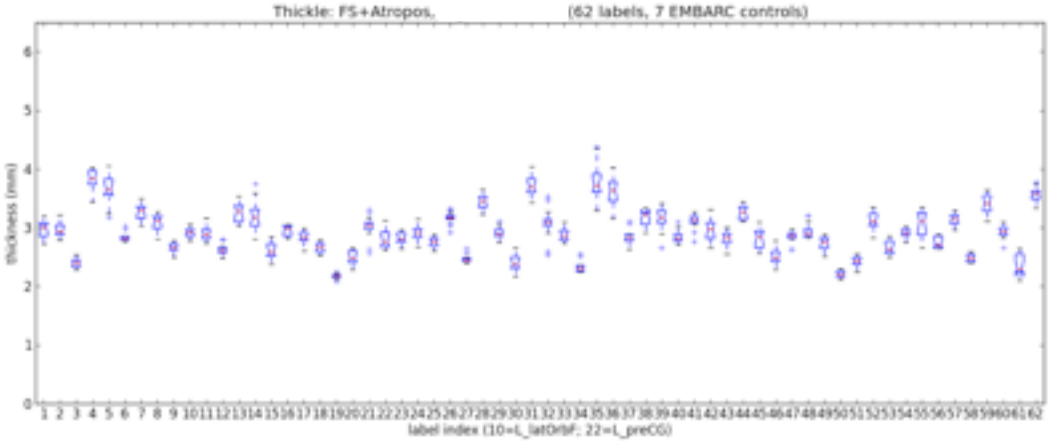
FreeSurfer
vol / area



Thickasabrick
FS+ANTs



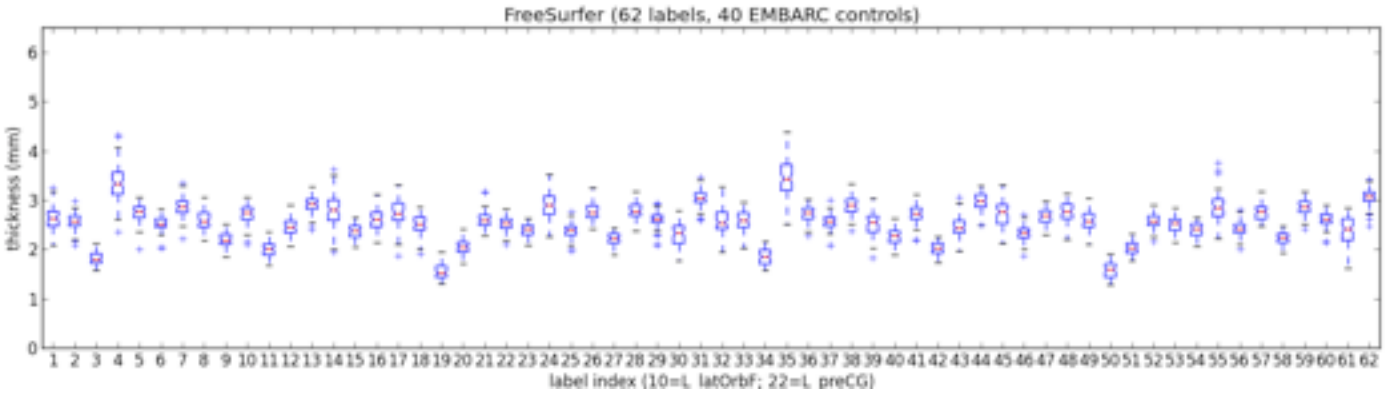
Thickasabrick
FS+ANTs
white/gray



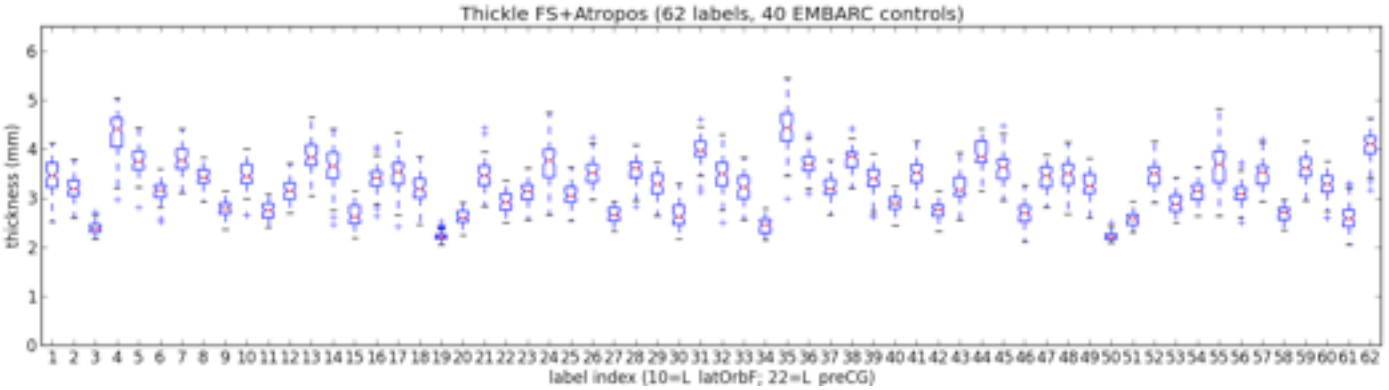
Inferred accuracy

Automated thickness ranges

FreeSurfer



Thickasabrick
(FS+ANTs)



Inferred accuracy

Manually measured thickness ranges (Kabani, 2001)

Thickness Range for Both Left and Right Hemisphere Using Manual and Automatic Methods

Region	Von Economo	Left hemisphere thickness range		Right hemisphere thickness range	
		Manual	Auto	Manual	Auto
Anterior cingulate	2.5*	3.4–5.3	2.7–7.9	2.0–6.3	2.8–8.0
Cuneus	1.3–2.6	2.2–5.3	1.7–5.9	2.2–4.5	2.1–4.9
Insula	2.8–3.5	3.5–5.5	4.4–13.7	3.5–6.9	4.1–18
Parahippocampus	2.7*	2.1–5.3	2.2–8.7	2.1–5.5	2.6–8.1
Posterior cingulate	2.5–3.0	2.4–5.3	2.8–7.1	2.4–4.8	1.7–5.9
Precentral (lateral surface)	3.2–4.5	2.8–6.4	2.2–7.4	3.1–5.4	2.0–5.8
Postcentral	3–3.3	2.2–3.7	1.9–4.8	1.8–3.7	1.9–4.5
Superior frontal (6)	3.2–4	2.3–6.6	2.8–7.7	2.5–8.4	3.3–8.3
(8)	2.9–3.5				
Supramarginal	3–3.5	2.9–4.9	2.7–6.6	2.8–4.8	1.9–5.3
Superior temporal	3.0*	2.8–5.8	2.8–6.4	3.1–5.6	2.5–5.2

Our data: 16 labels (without cingulate) x 40 subjects = 640 labels

How many of the FreeSurfer and Thickasabrick labels within range?

Inferred accuracy

Manually measured thickness ranges (Kabani, 2001)

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(8)	2.9–3.5				
Supramarginal	3–3.5	2.9–4.9	2.7–6.6	2.8–4.8	1.9–5.3
Superior temporal	3.0*	2.8–5.8	2.8–6.4	3.1–5.6	2.5–5.2

FreeSurfer: 40% of 640 labels within range

Thickasabrick: almost 90% of 640 labels within range
(FS+ANTs)

Benefits of volume-based approaches

antsCorticalThickness, DiRecT, Thickasabrick

- Hybrid volume-based segmentation more robust than surface-based segmentation

- Volume images MUCH EASIER to fix (with ITK-Snap) than surface meshes

- Saves time -- No need to generate, check, or correct surfaces!

- We understand the code bases better than we do FreeSurfer's code base

Benefits of Thickasabrick over ANTs

- Much higher reliability across scans and across subjects per label

- More reasonable range of thickness values

- Extremely intuitive definition; clear and concise implementation in Python

NEXT: Apply Mindboggle labels vs. FreeSurfer labels
so we are completely free of surfaces!