Exploring the Structural Correlates of Individual Differences in Speech Motor Adaptation

Goitom, E.,[1,2] Wheatley, K.,[1,3] Beal, D.[1,3]
[1]Bloorview Research Institute, [2]McMaster University, [3]University of Toronto

Background and Rationale

Speech Adaptation

Using the sound of our own voice, speech is continually refined by comparing expected and actual auditory feedback[1]

Contemporary frameworks propose that adaptation depends on how confidently the brain weighs new sensory information against established motor patterns[1]

However

People differ substantially in how much or how little they adapt[1]

The structural neural basis of this variability remains poorly understood[1]

Research Question

Are structural properties of cortical speech regions and white matter pathways associated with individual differences in speech motor adaptation?

Design and Methods

Participants

40 Healthy Adults
Ages 18-36

Speech Adaptation Task

Real-time auditory perturbation,150 Trials

F1 ↑ 25% F2 ↓ 12.5% formant shifts

MRI Acquisition

Structural (T1) and multi-shell diffusion MRI collected

Image Analysis

Cortical thickness in FreeSurfer, white matter in MRtrix3

Statistical Analysis

Correlated with F1/F2 adaptation magnitude; FDR-corrected

Grey Matter Analysis

Cortical thickness measured in five speech regions via **FreeSurfer.**

Thickness values correlated with F1 and F2 speech adaptation.

White Matter Analysis

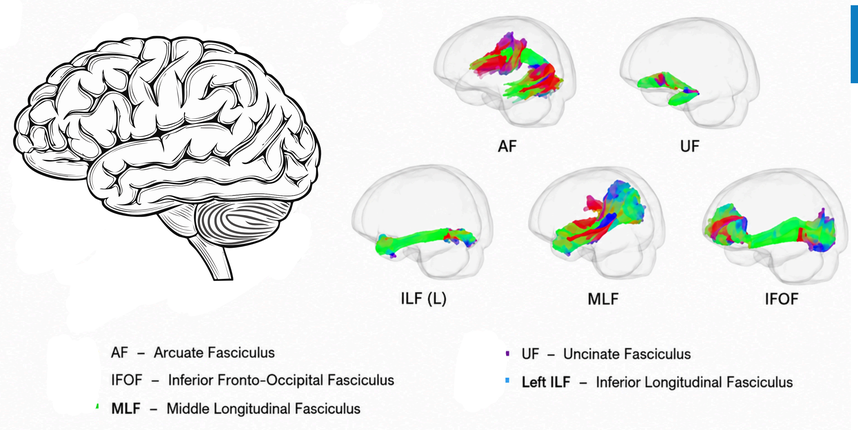
MRtrix3 fixel-based analysis measured:

1. Fibre Density (FD)
2. Fibre Cross-Section (FC)
3. Fibre Density & Cross-Section (FDC)

Five bilateral speech pathways analysed

Stronger white matter connectivity is associated with greater reliance on **established motor patterns** over correcting for sensory input.

White matter pathways associated with speech adaptation



Scan for references!

Results and Key Findings

In **grey matter**, there were no significant associations across all 5 bilateral cortical regions ($p > .05$, FDR corrected).

In **white matter**, greater FDC was associated with smaller F1 adaptation across bilateral regions (AF, IFOF, MLF, UF, ILF).

($\rho = .34–.47$, all $p < .05$, FDR corrected)

After FDR correction, no significant white matter associations were found **in F2.**

Greater structural connectivity (FDC) predicted less adaptation across 5 tracts ($\rho = .34–.47$).

Relevance to Holland Bloorview Families

Although this study examined adults, our findings help map the need for future personalized rehabilitation in children with **autism, cerebral palsy, or brain injury,** by identifying biological factors underlying speech motor learning.

Conclusions and Next Steps

Findings suggest that stronger white matter connectivity is associated with greater reliance on established motor patterns over correcting for sensory input.

Future Research Consdierations

- Replicating these findings in pediatric and clinical populations.
- Investigating how structural connectivity influences other speech-motor frameworks, such as prediction-error processing during speech adaptation.

We are grateful for the Ward Family funding this summer student program, as well as the COS-RASI program for supporting this research.

Holland Bloorview Kids Rehabilitation Hospital
UNIVERSITY OF TORONTO
CONNECT Leveraging neurodevelopmental diversity for innovative interventions