The neural circuits recruited for the production of fingerspelling and signing

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Introduction

• Fingerspelling (FS) is a complex motoric task in which sequences of handshapes are rapidly produced to spell out words, with each handshape representing a distinct alphabetic letter.

• Lexical signs in American Sign Language (ASL) contain at most two distinct handshapes and can be produced with contact on the body, unlike fingerspelled words which are always produced in "neutral space" in front of the body.

Our question

Given the variation in handshapes and body contact, what neural circuits are recruited for the production of fingerspelled words and ASL signs?

Methods

Participants: Eleven native deaf ASL signers (5 females; mean age = 27 years). All were right-handed and born severely to profoundly deaf.

Imaging methods:

Acquisition

• Siemens ECAT HR+ PET scanner, in 3D mode
• [^{15}O]water method, 15 mCi per injection

Post-processing

• Normalized activity to global 1000 counts
• Spatial normalization to a Talairach-compatible atlas using AIR 5.2.5
• Smoothing: 16mm FWHM Gaussian filter

Statistical analysis

• General linear model (custom software) to generate *t*-maps
• Familywise type I error controlled with random field theory

Tasks

1. Fingerspell a printed English word.

tip

T I P

2. Produce the ASL translation for a printed English word. ASL translations were of the following types:

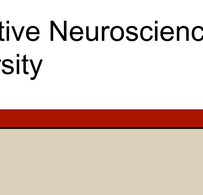
a) one-handed signs produced in neutral space

plane

PLANE

b) one-handed "body-anchored" signs

white



WHITE

3. **Baseline task:** Respond #YES or #NO to indicate whether a printed English word contains a descending letter.

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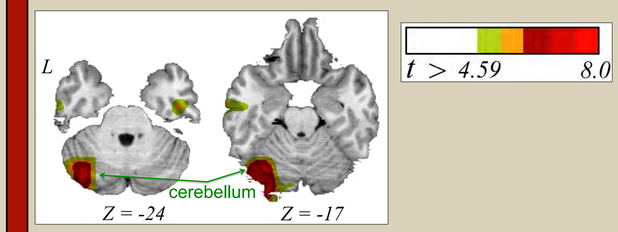
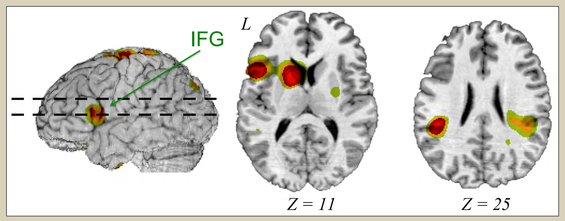
Results

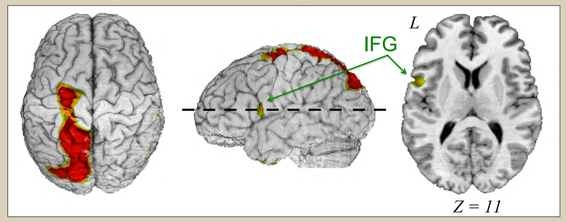
FS words > baseline



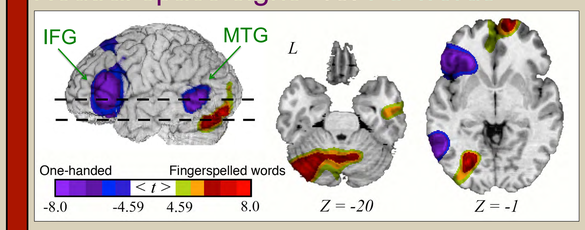
Neutral space signs > baseline



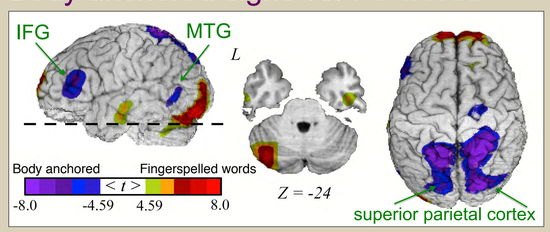
Body anchored signs > baseline



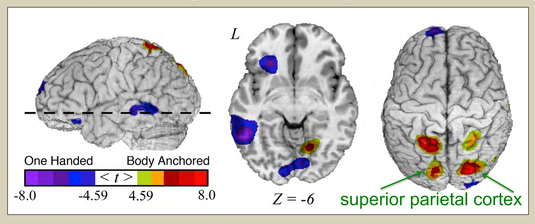
Neutral space signs vs. FS words



Body anchored signs vs. FS words



Neutral space signs vs. Body anchored signs



Conclusions

• Cerebellar activity for fingerspelled words may reflect the increased number of complex hand configurations required and/or the execution of less rehearsed motor sequences.

• Sign production recruited left inferior frontal cortex and middle temporal cortex to a greater extent than fingerspelling or the baseline task, which may reflect lexical search and selection components of the translation task.

• Overall, the pattern of activation across contrasts suggests that superior parietal activity is primarily associated with signs that move toward the body.