Neuroplasticity for phonological awareness in deaf children

[1]Melody Schwenk & [2]Bradley White
[1]Gallaudet University
[2]Independent Researcher

BACKGROUND

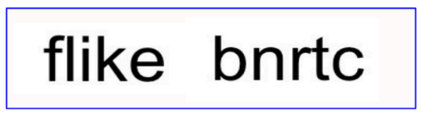
- Reading relies on the ability to recognize letters and connect them to sounds, a skill known as **phonological awareness**.
- Phonological awareness is thought to depend on hearing speech sounds, and thus, it can be challenging for deaf children to achieve.
- Deaf-signing children may use visual information instead of sounds to recognize and process printed words, creating a **visual phonological loop**.

METHODS

32 children (17 deaf signers: mean age = 6.12 ± 1.67; 15 hearing monolinguals: mean age = 5.74 ± 1.28) performed a lexical decision task during functional near-infrared spectroscopy (fNIRS) brain imaging. Children were instructed to choose which stimuli looks most like a real English word with two conditions:

1. **orthographic** (Roman font versus false font)
2. **phonological** (pseudoword versus nonword)

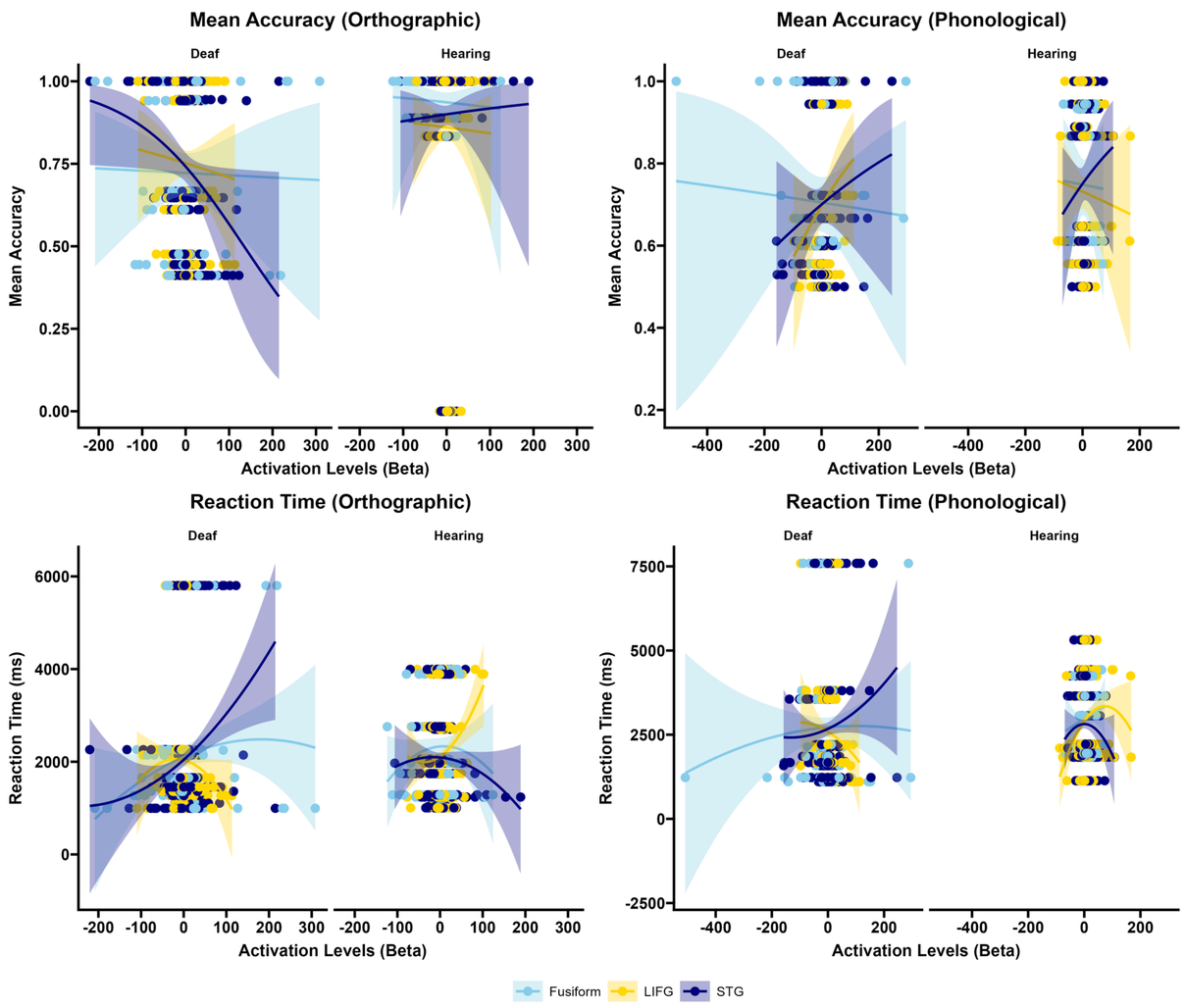
psuedoword vs. false font
(orthographic condition)



psuedoword vs. nonword
(phonological condition)

RESULTS

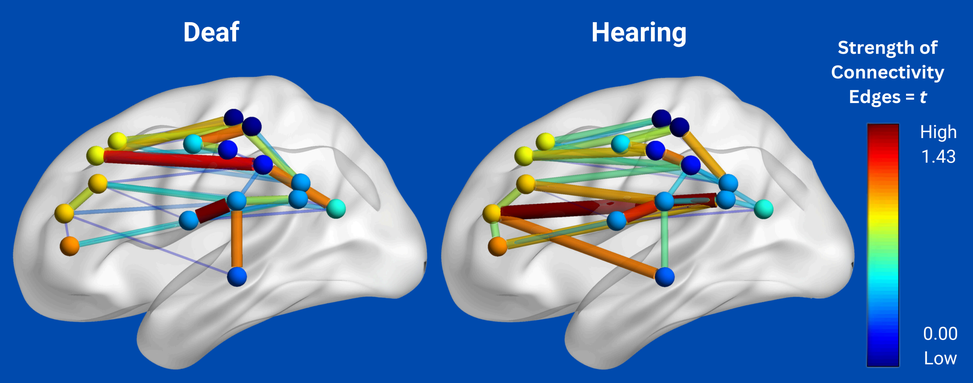
- **Deaf children** had higher accuracy but slower response times for orthographic tasks (β = -2.416, p = 0.362 n.s.) and high accuracy and faster response times for phonological tasks (β = 3.345, p = 0.004).
- **Hearing children** were more accurate and faster for phonological tasks.
- **Left fusiform gyrus (LFG)** activation interacted with response time and hearing status for phonological tasks (β = 3.35, p = 0.003).
- **Left posterior superior temporal gyrus (pSTG)** activation was negatively associated with overall accuracy (β = -1.23, p = 0.015).



Deaf children use a **visual phonological loop** to read.

Distinct brain activation patterns support **different reading pathways** for deaf and hearing children.

Aggregated Functional Connectivity During Lexical Decision Making



Brain networks for reading in deaf and hearing children.

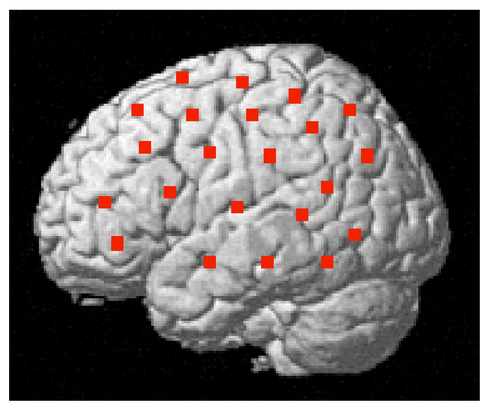
Circle colors represent left hemisphere brain regions of interest.
Line colors represent the strength of brain activation using *t*-values.
Line thickness represents the strength of connections between brain regions.

Deaf and hearing children use **distinct neural pathways**.

Deaf-signing children have stronger connections with visual areas, supporting a visual phonological loop for reading when exposed to sign languages.

A

B



A. A child with the **fNIRS apparatus**. The device captures brain activation patterns by measuring blood flow changes related to **cognition** during reading.

B. Location of fNIRS channels on the brain for **left hemisphere** visualization

CONCLUSIONS

The **VISUAL PHONOLOGICAL LOOP** identified here consists of:

1. Visual encoding: Recognizing printed words in the LFG
2. Phonological representation: Associating print patterns with sign language representations in the pSTG
3. Rehearsal and retrieval: Utilizing the **visual phonological loop** in the left inferior frontal gyrus (LIFG) for reading comprehension

Deaf children connect printed text to sign language phonology similarly to how hearing children link printed text to spoken sounds.

GALLAUDET UNIVERSITY | VISUAL LANGUAGE AND VISUAL LEARNING