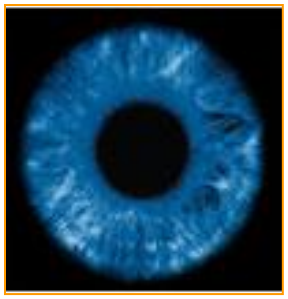

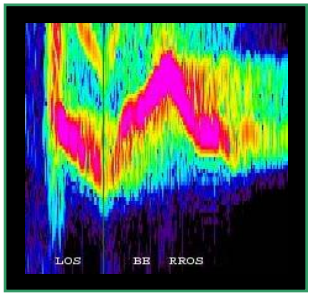

Deafness Signed Language and Cochlear Implants

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VL2 VISUAL LANGUAGE & VISUAL LEARNING

National Science Foundation

NIDCD National Institute on Deafness and Other Communication Disorders
Improving the lives of people who have communication disorders

Outline

- Introduction to deafness
- Approaches and Interventions
- ASL as a natural language
- Neural representation of signed languages
- Bilingualism and the Deaf community
- Neural Representation of language in ASL-English Bilinguals
  - Deaf
  - Hearing
- Bimodal bilingualism
- Concluding Remarks

What is deafness ?

- deaf –Audiological condition
  - someone who is partially or wholly lacking hearing, either when they were born, through pernicious disease early in life, or later in life

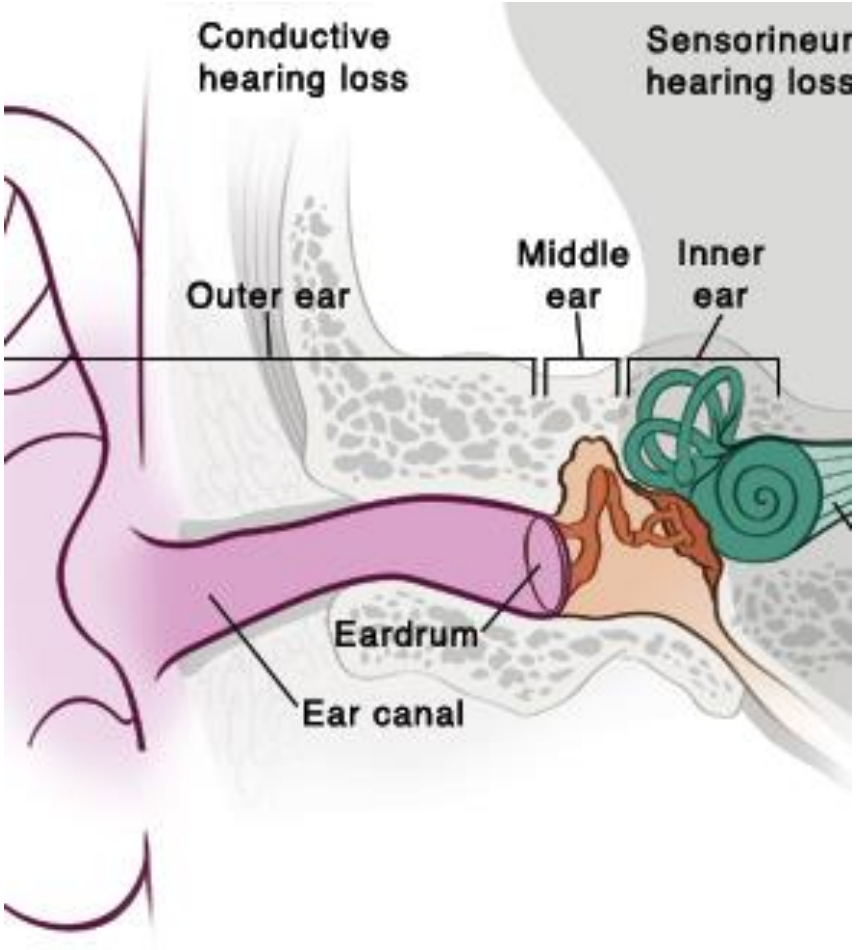
- Deaf
  - any person or persons who "identifies him/herself as a member of the Deaf community, and other members accept that person as a part of the community"
  - Many Deaf perceive their community akin to other language minority communities and share a sense of Deaf Culture.

Deafness

- The global deaf population is roughly estimated to be 0.2% of the total population (2 in 1000)

- Approximately 50% is inherited.

Type of Deafness



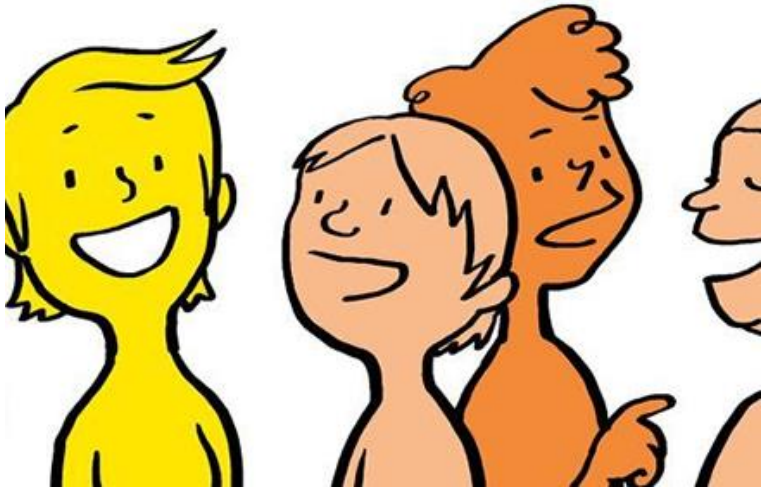
- Conductive hearing loss: results from abnormalities of the external ear and/or the ossicles of the middle ear.
- Sensorineural hearing loss: malfunction of inner ear structures (i.e., cochlea).
- Mixed: combination of conductive and sensorineural hearing loss.
- Central auditory dysfunction: damage or dysfunction at the level of the eighth cranial nerve, auditory brain stem, or cerebral cortex.

Severity of hearing loss.

Hearing is measured in **decibels** (dB).

Conversational speech 50-60dB hearing level

- Mild (26-40 dB)
- Moderate (41-55 dB)
- Moderately severe (56-70 dB)
- Severe (71-90 dB)*
- Profound (> 90 dB)*



*Typical candidates for cochlear implants

Childhood Deafness

- Congenital
  - Deaf from birth
- Acquired
  - Lost hearing due to sickness (e.g. meningitis, rubella)

Onset of deafness

- **Onset**
  - **Prelingual hearing loss** is present before speech develops. All congenital (present at birth) hearing loss is prelingual,
  - **Postlingual hearing loss** occurs after the development of normal speech*.
  - *may have partial effects (e.g. meningitis when infant 2.5 years. Some spoken language have taken place, but not complete).

Impact on Society

- $300,000/individual (U.S. Dollars)
  - 67% reduced productivity
  - 21% additional special education costs
- Lifetime costs/prelingual congenital deafness
  - $1 million USD /individual

- Impact on Individuals
  - Academic achievement
  - Poorer career and financial achievement

(Mohr et al 2000)

BUT

- Many deaf are highly successful

- Better education
- Better access to services
- Improvement in audiological **and** linguistic interventions

What to do ?

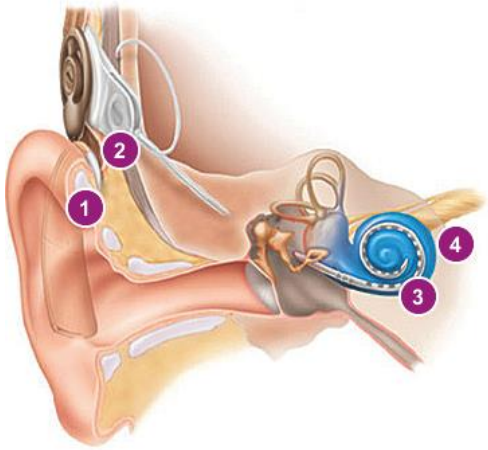
Audiological Interventions: hearing aids

- Hearing aids
- As early at 4 weeks of age.
- Non-invasive

  - Amplify sounds
  - Fit to children ear
  - Customizable
  - FM systems

Audiological Interventions: Cochlear Implant

- Cochlear implant is a surgically implanted device that helps overcome problems in the inner ear, or cochlea



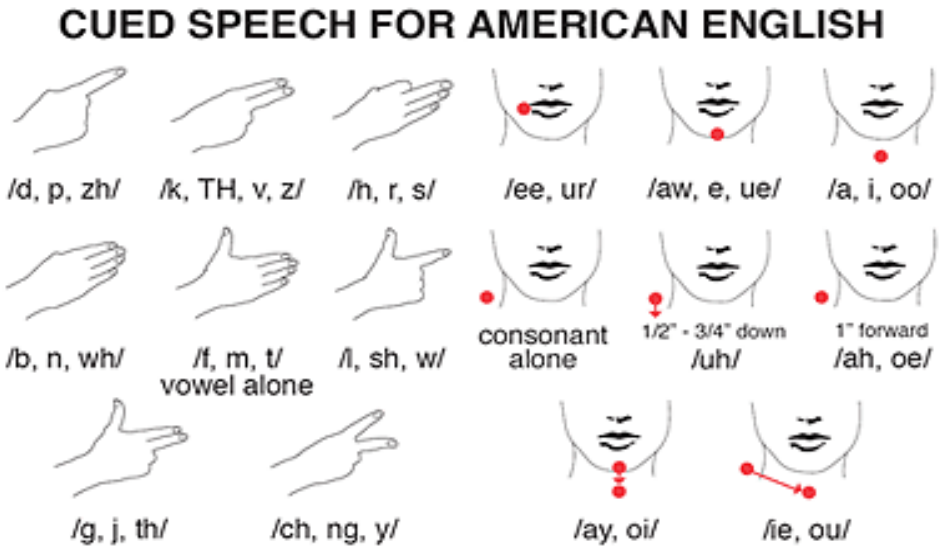
- Completely bypassing the damaged part of the cochlea, the cochlear implant uses its own electrical signals to stimulate the auditory nerve, allowing the person to hear.

- 12months of age.

Linguistic Interventions

- Accessible Language
  - Cued Language
    - A mean to differentiate phonemes by giving additional visual hand cues.
  - Visual Language e.g. American Sign Language, Hong Kong Sign Language etc.

Cued Language



Can be quite successful, but not widely used.
It’s a code for English not a language.

Signed Languages

- Sign languages are **natural** languages.
  - ASL is not an "invented" language
- "Sign language" is not universal.
  - There are many distinct sign languages
- Acquisition milestones similar to spoken language.
- Brains treat signed languages just as they treat spoken languages

Strobe photograph of ASL signs "join" and "inform." (Reprinted by permis-

Children are language ready

- Children able to acquire any language that they are exposed to in a consistent manner.
- Innate predisposition to learn LANGUAGE not just speech.
- Experimental evidence
  - Preferential looking studies

Early Language

- Early Language
  - Social-emotional development

    labeling ones emotion

Cognitive Development

Labeling work around us

Reading

Must have foundation to read.

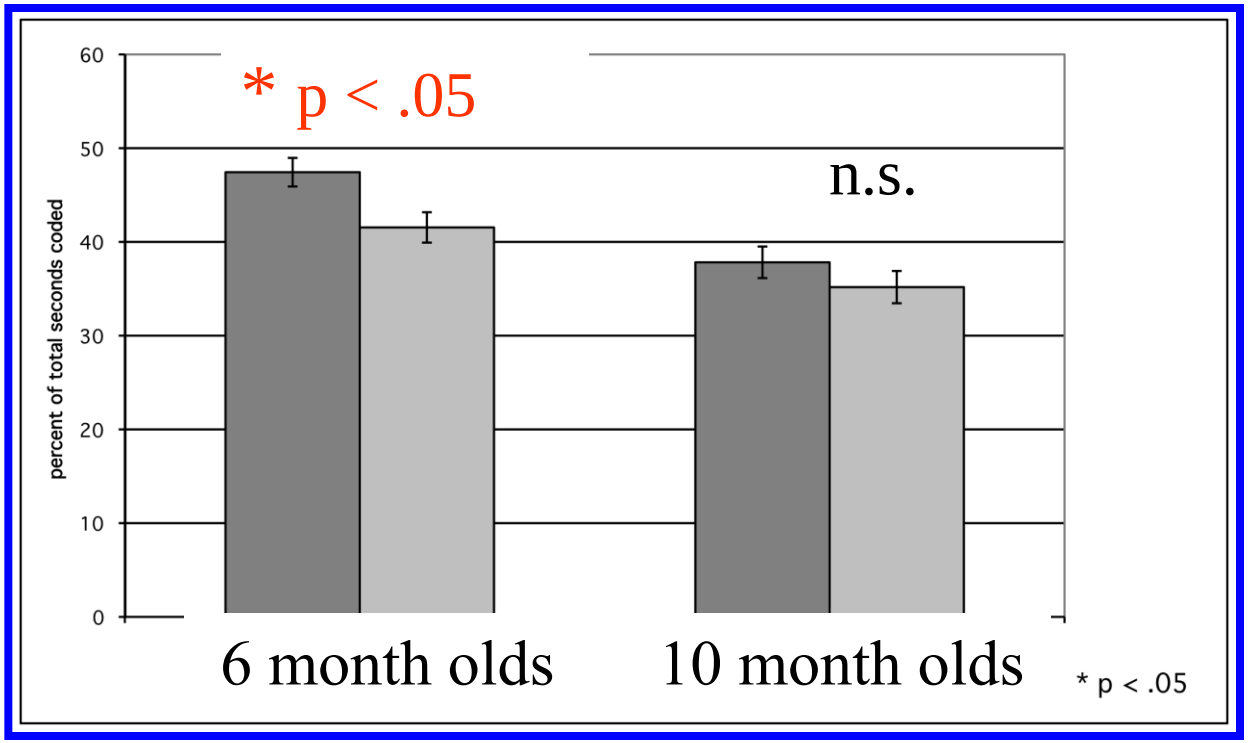
Preferential looking paradigm

Hildebrandt & Corina (2007) Dev. Science

Looking times for sign language and pantomime in hearing 6 and 10-month-olds

Sign

Pantomime

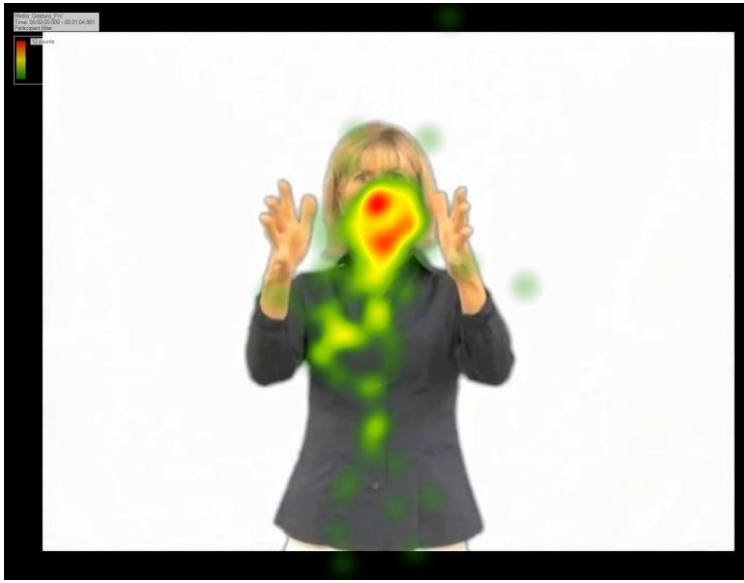


- 6 month olds look significantly longer at the ASL
- 10 month olds do not show a preference.

Hildebrandt & Corina (2007) Dev. Science

ASL versus gesture
A replication

Gestures



Signs

Structured and rhythmic properties of natural languages are important

Bosworth, Hwang & Corina (in prep)

Figure 1

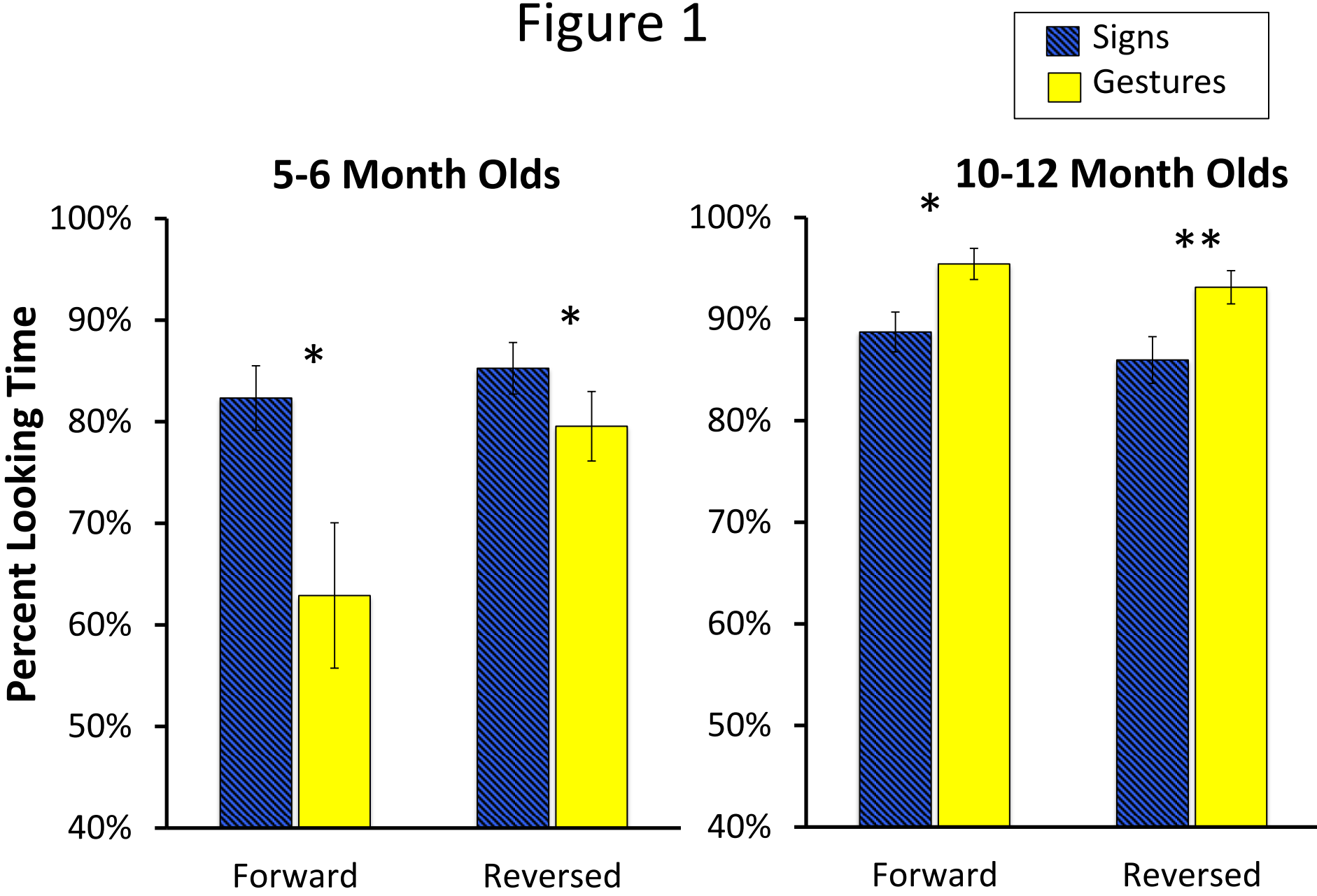


Figure 1. Average percent looking time for the midline collapsed. Two-tailed t tests were used to compare signs vs. gestures. * $p < 0.05$, and ** $p < 0.005$

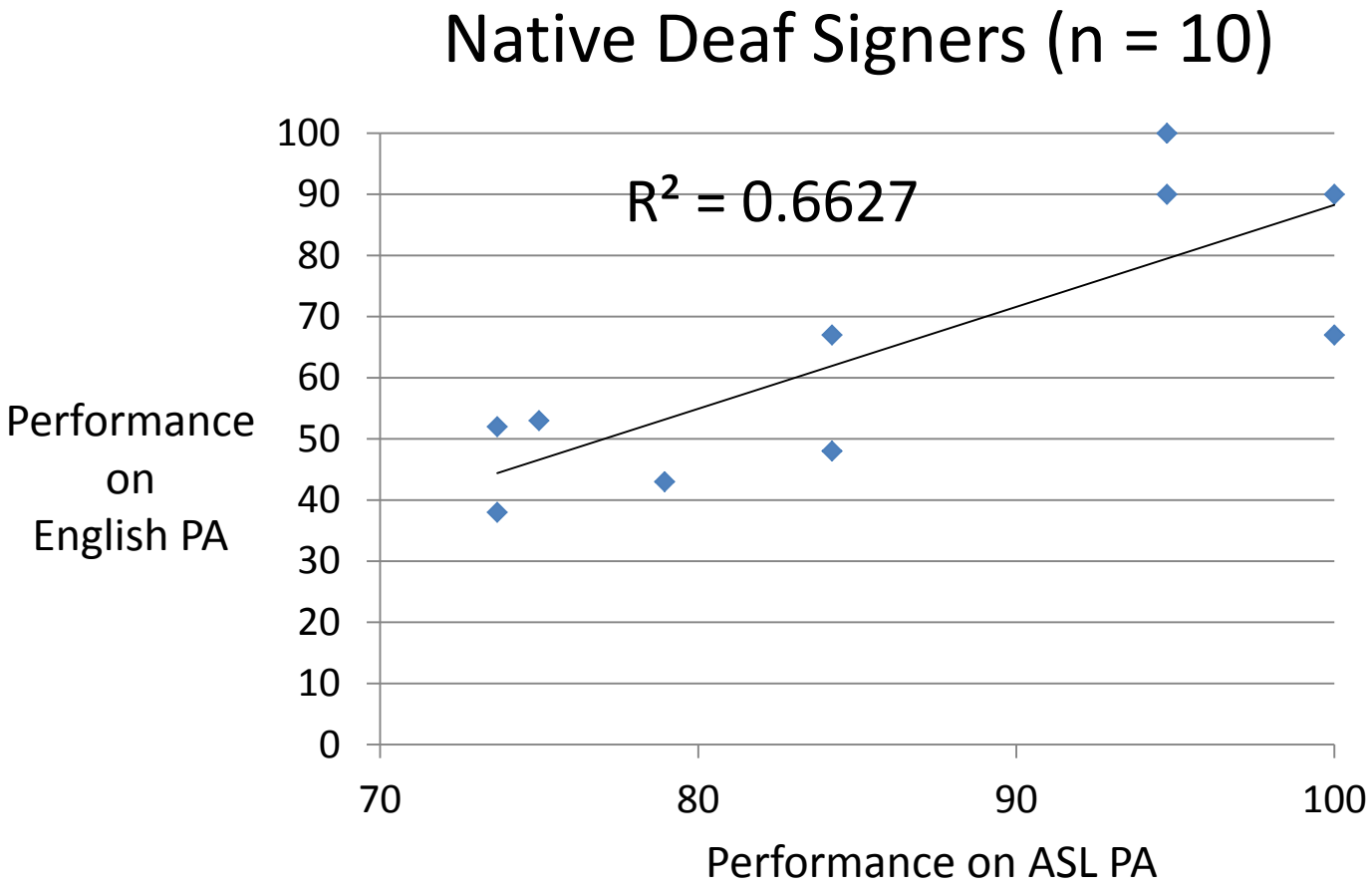
Early Language is Vital

- Cognitive Development
- Social-emotional development
- Memory
- Executive function
- Sequence learning

Pisoni et al 2010; Calderon & Greenberg, 2003

Early language (including signed languages) provides a foundation for reading

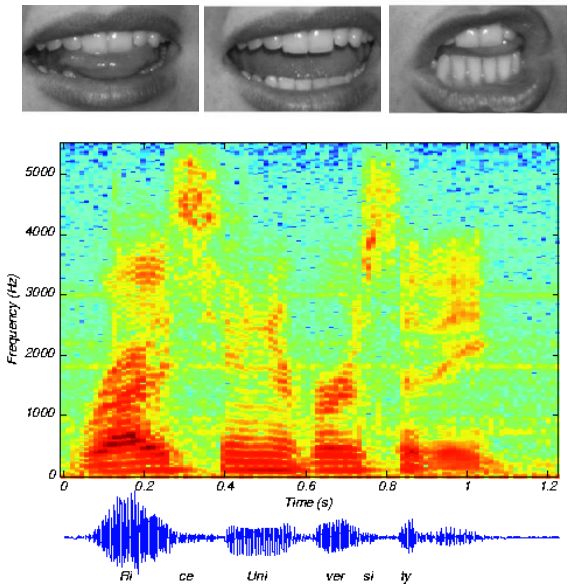
Relationship between ASL Phonological Awareness and English Phonological Awareness



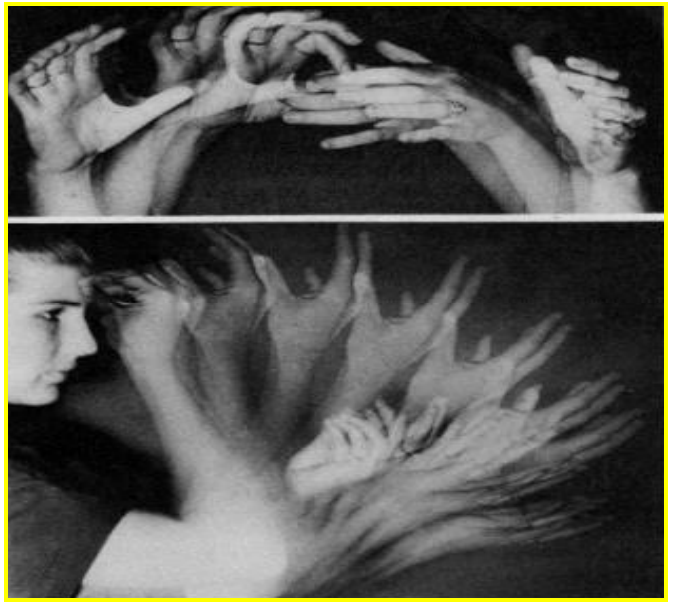
Human Languages

- Importance of communities of users.

Human Language



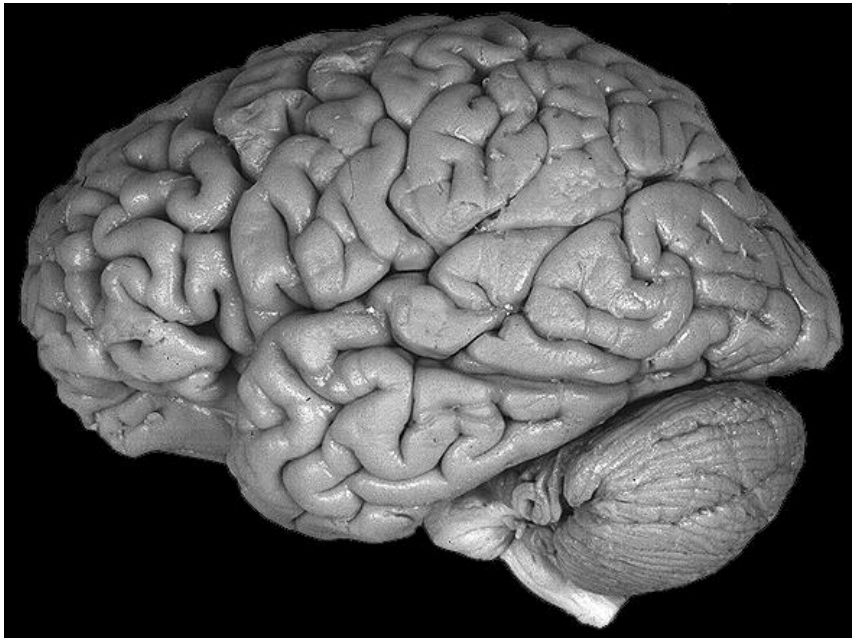
Spoken Languages



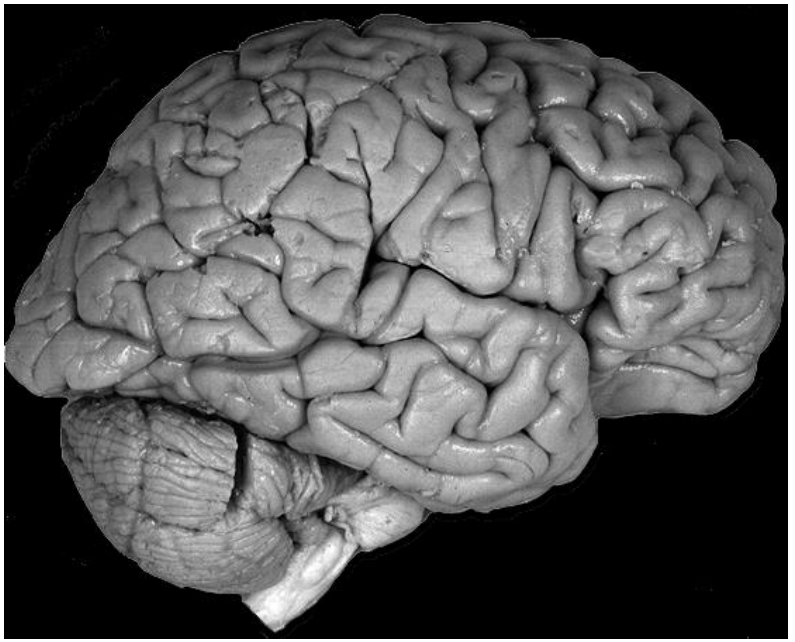
Signed Languages

Human languages are not limited to the vocal modality

Neural Processing of Signed Languages

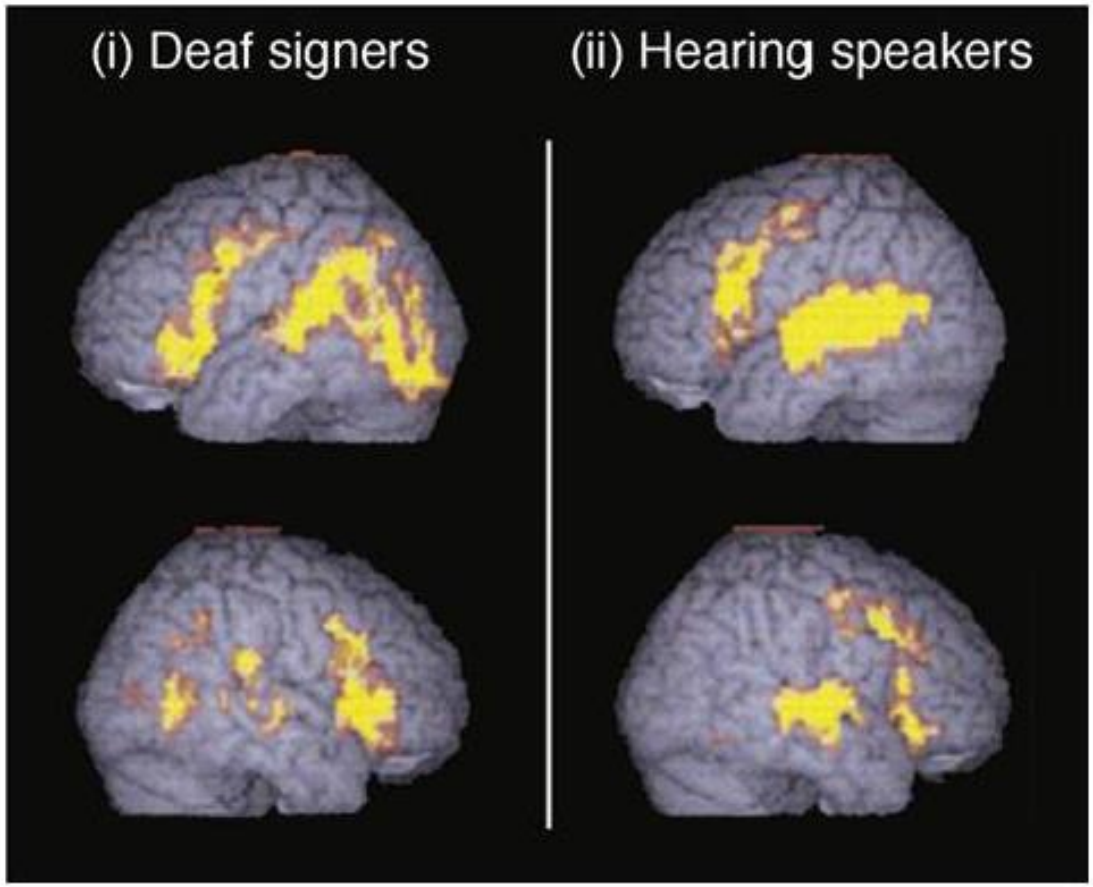


Left hemisphere



Right hemisphere

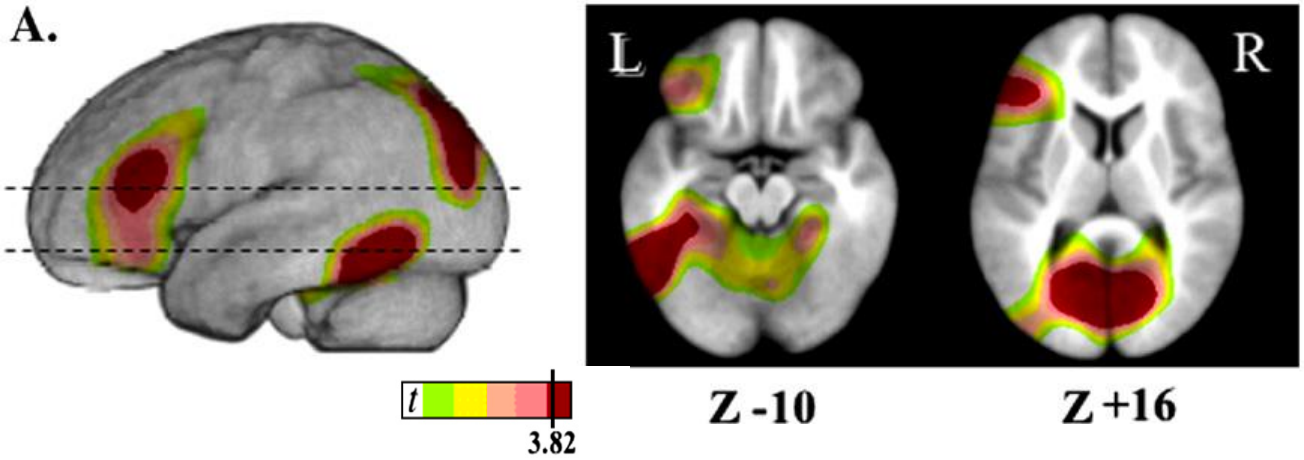
Sentence processing in Sign (BSL) and Speech (English) activates highly similar areas in left and right hemisphere



(MacSweeney et al 2010)

Lexical Production

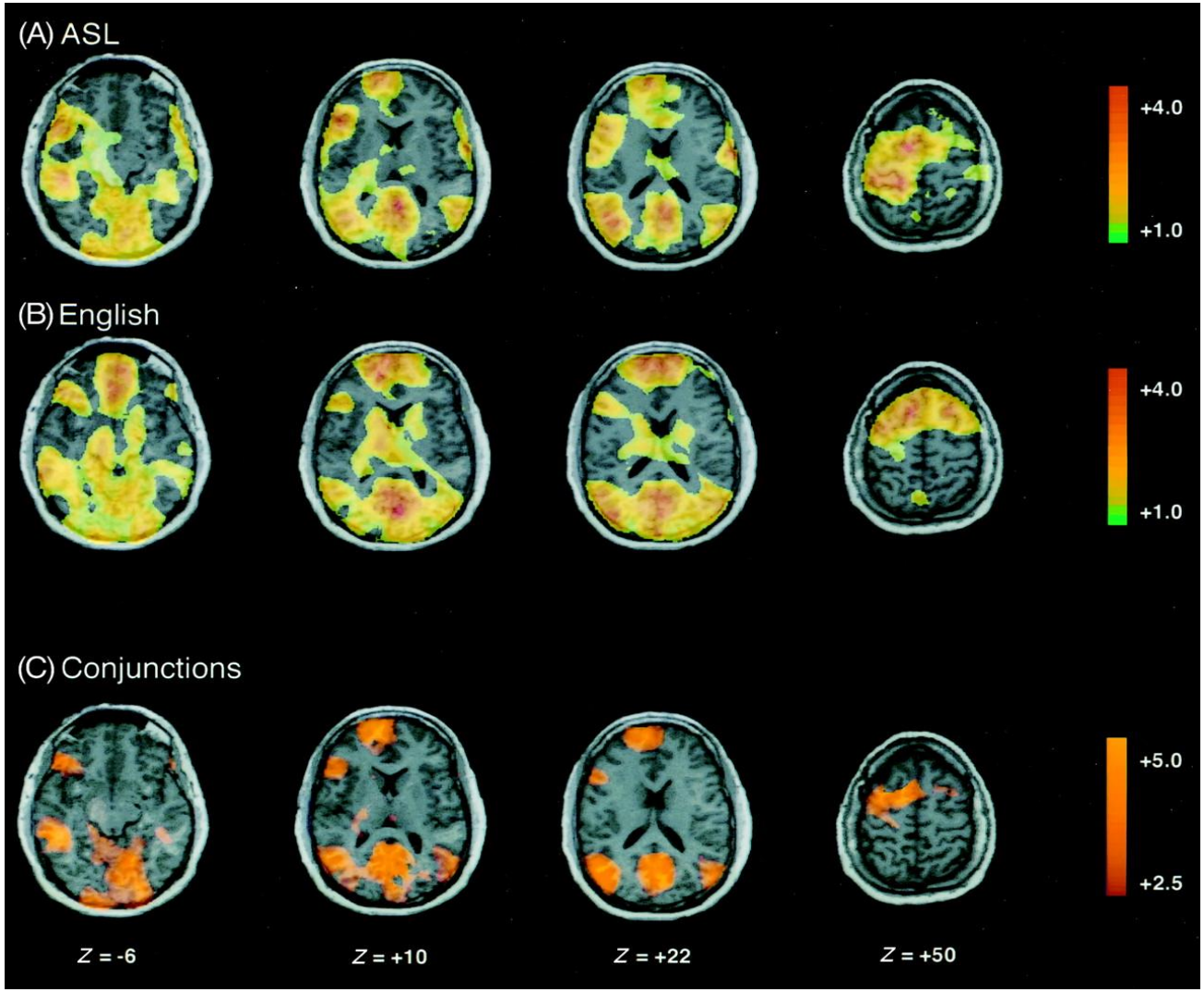
Data from deaf signers and hearing non-signers



Overlapping activation during sign and speech naming

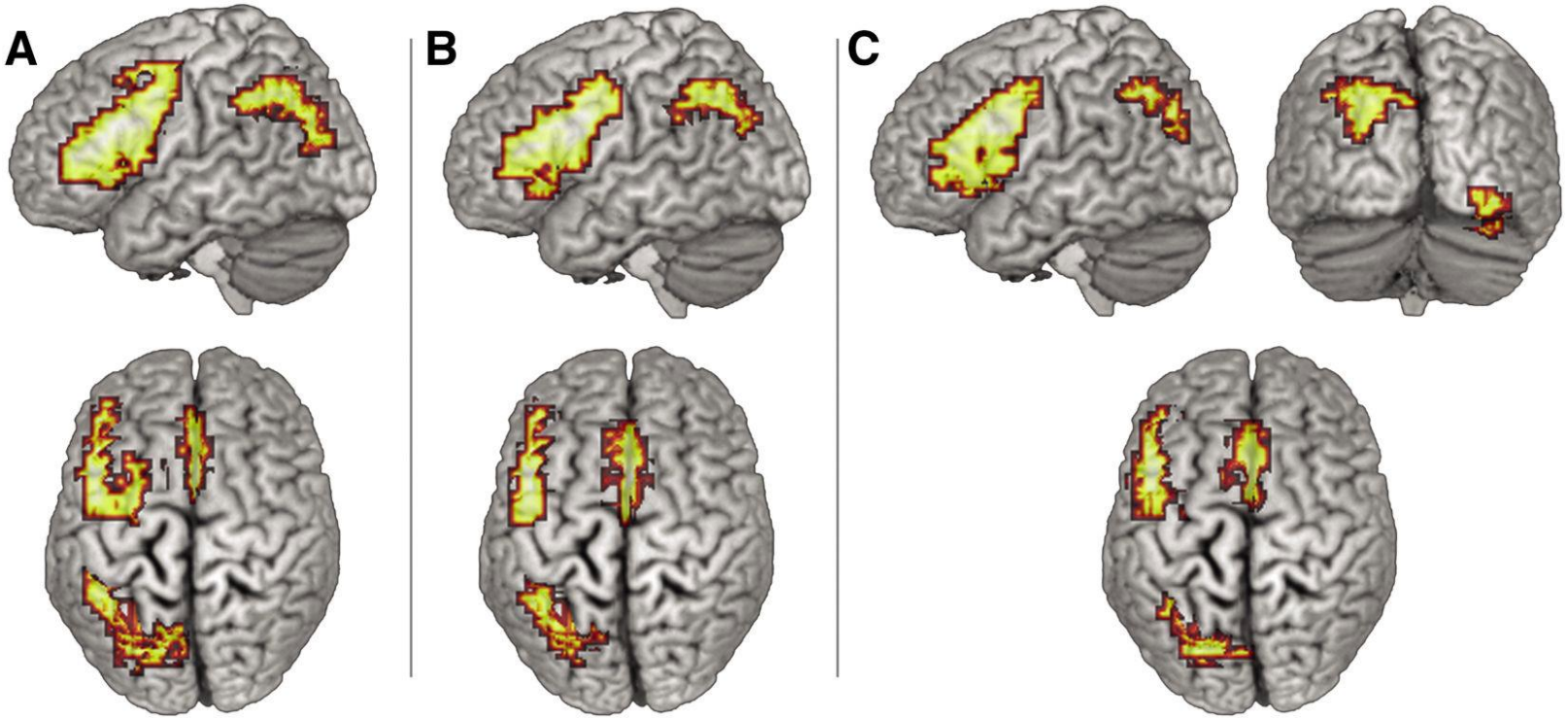
Emmorey, Mehta & Grabowski (2007)

Discourse Production:



Braun et al (2001)

Meta-Linguistic Tasks

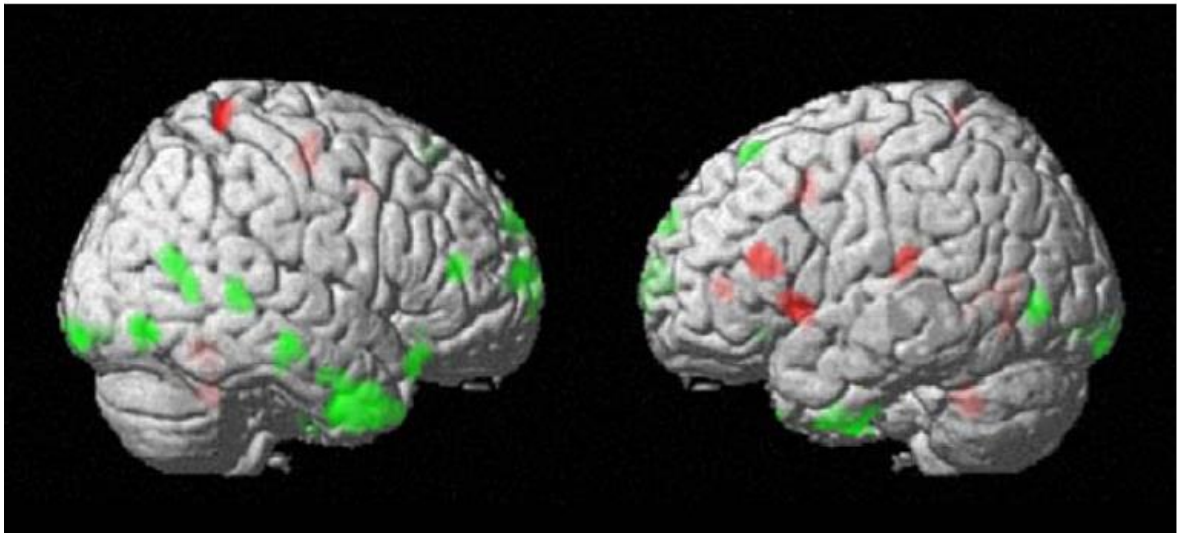


DEAF: BSL DEAF:RHYME HEARING:RHYME

Highly similar systems engaged during meta-linguistic *phonological* judgments.

MacSweeny et al (2009)

Brain distinguishes ASL from gestures



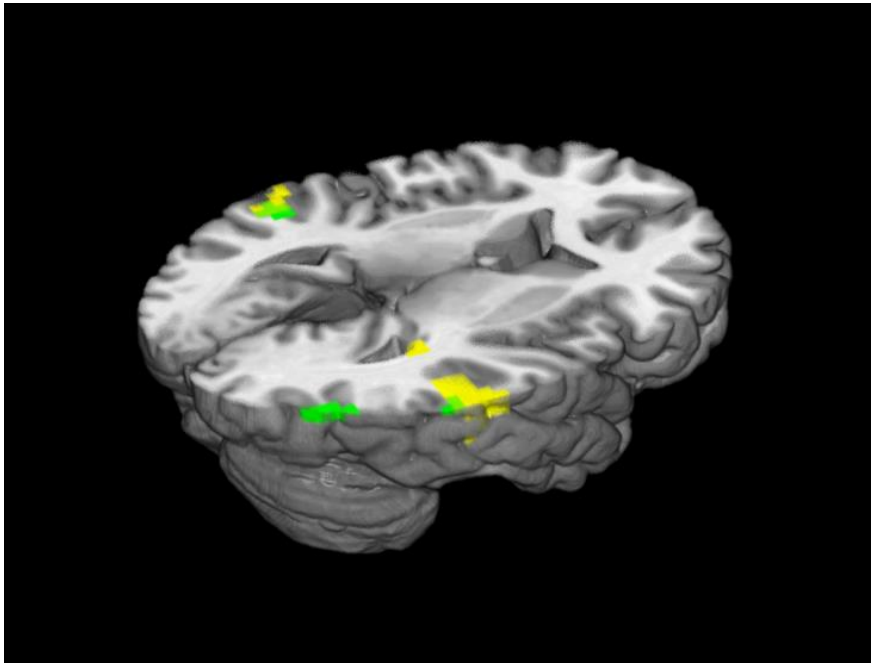
Non-language actions

ASL Signs

Corina, Chiu, Knapp et al ((2007)

Language selectivity in posterior STS

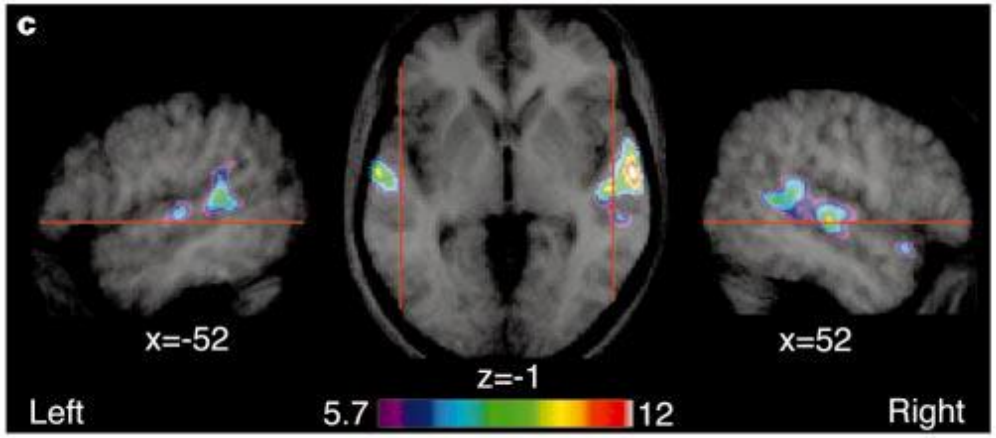
Sign versus Gesture



Sign

Gesture

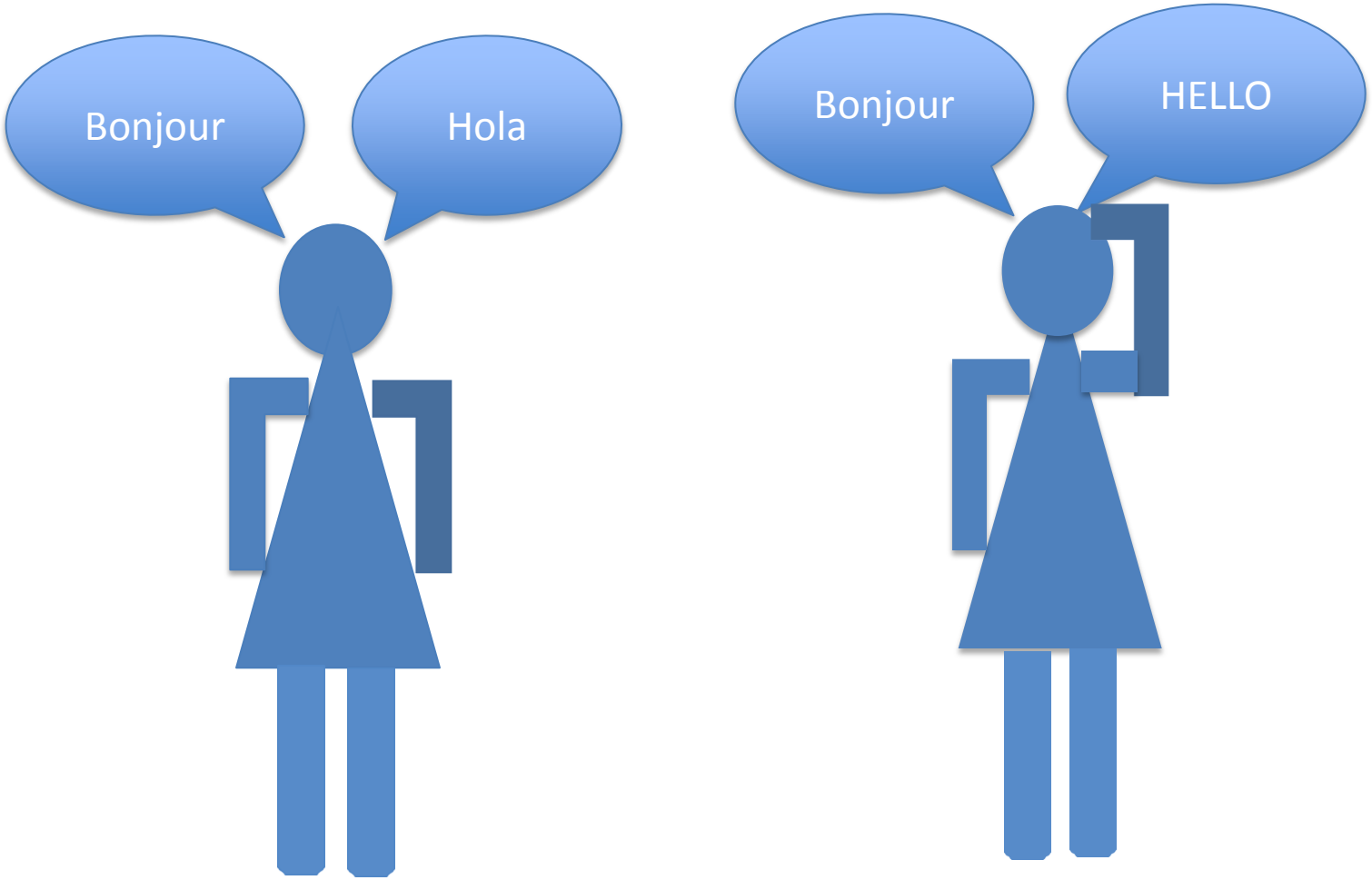
Voice versus Non-Language



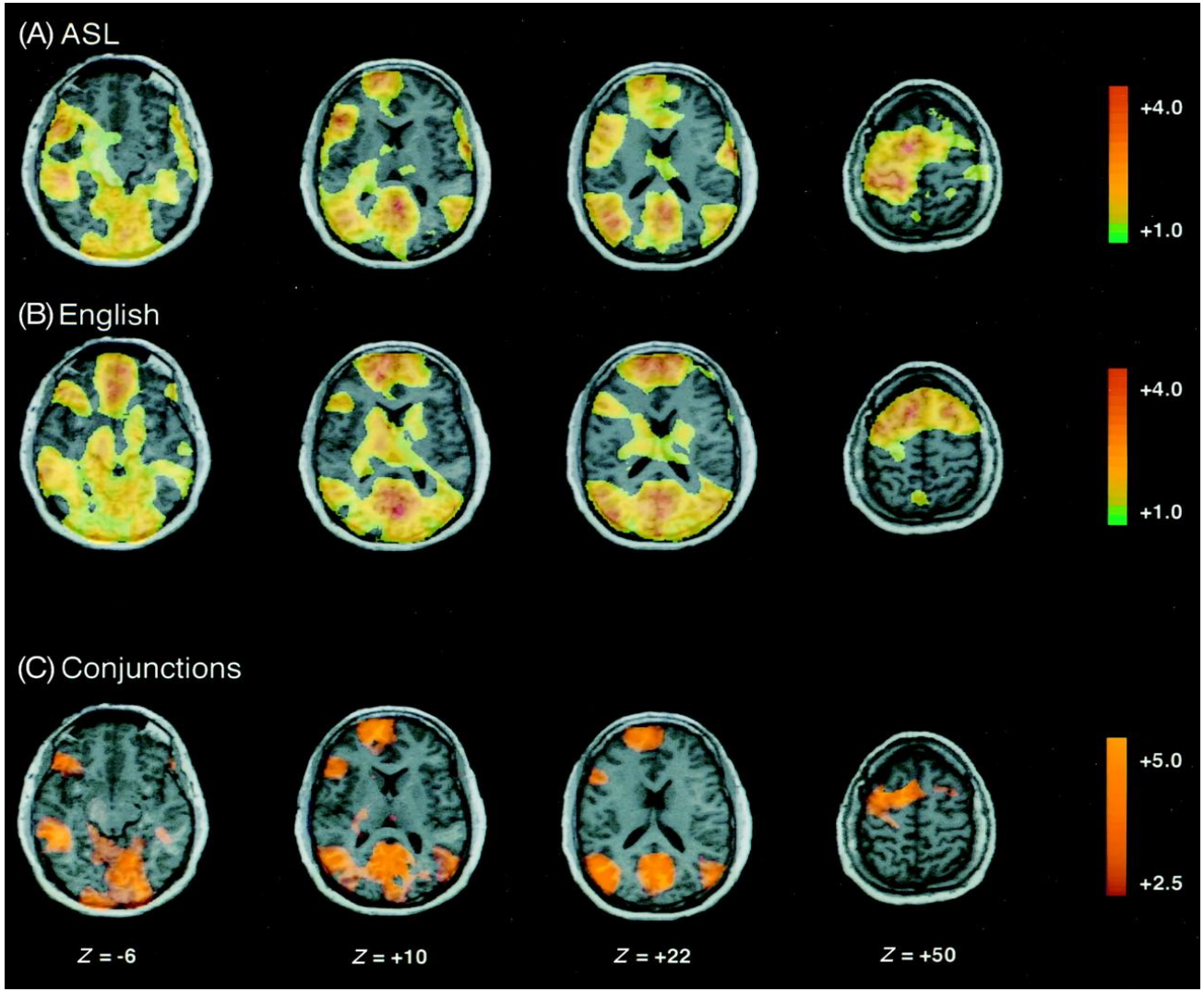
Belin et al. Voice-selective areas in human auditory cortex. Nature 403, (2000)

Words versus laughs, sighs, grunts, onomatopoeia, and other non-vocal sounds

Brain representation in bimodal-bilinguals

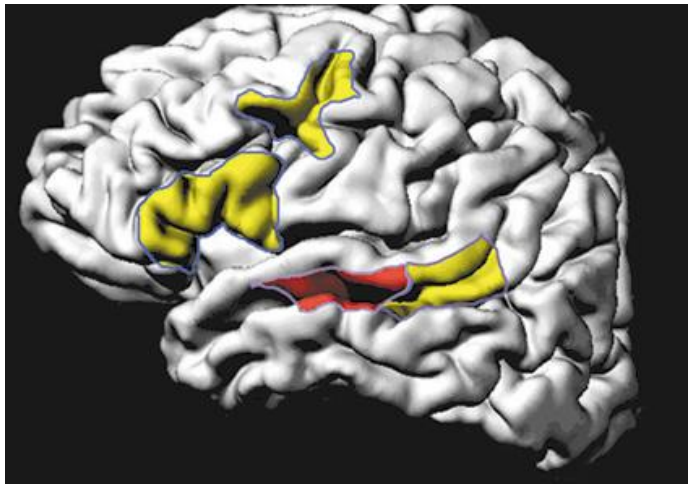


Bimodal Bilinguals:

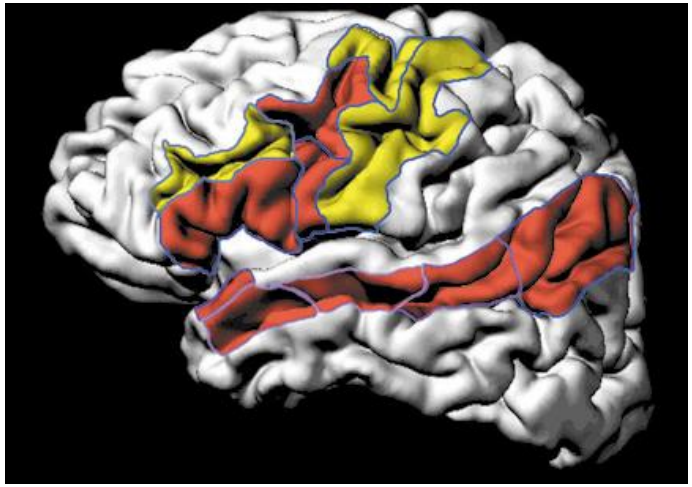


Braun et al (2001)

Hearing English-ASL Bilinguals

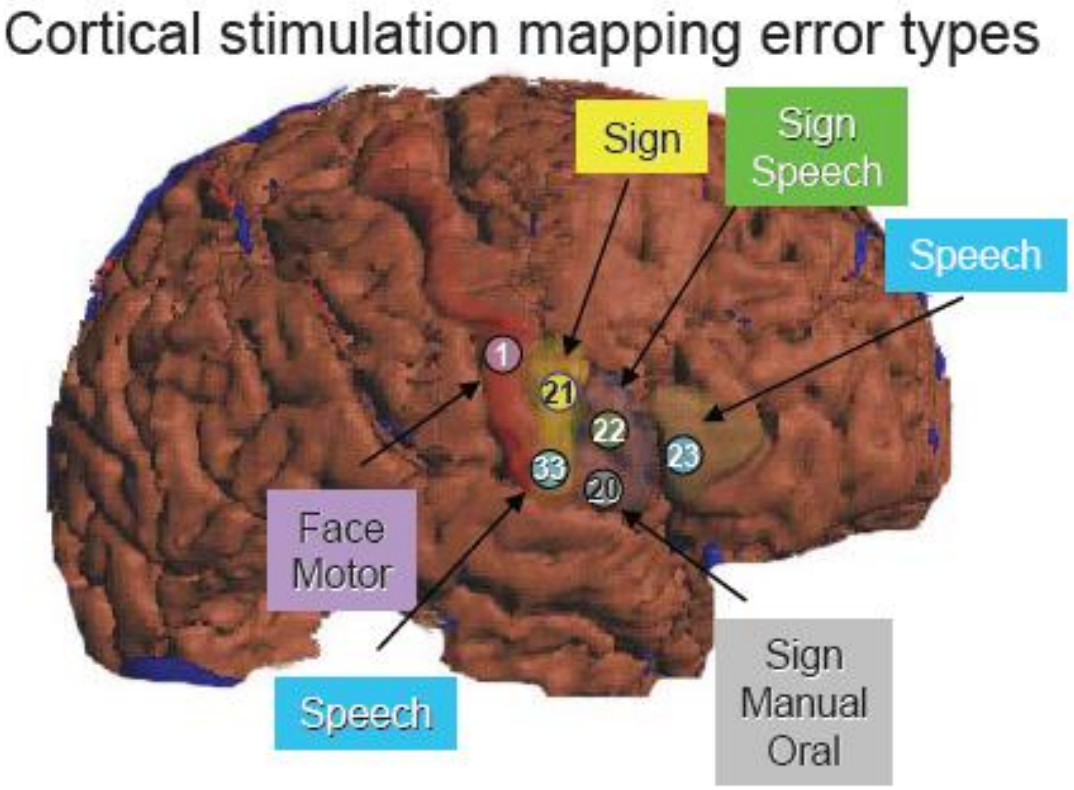


Written English



American Sign Language

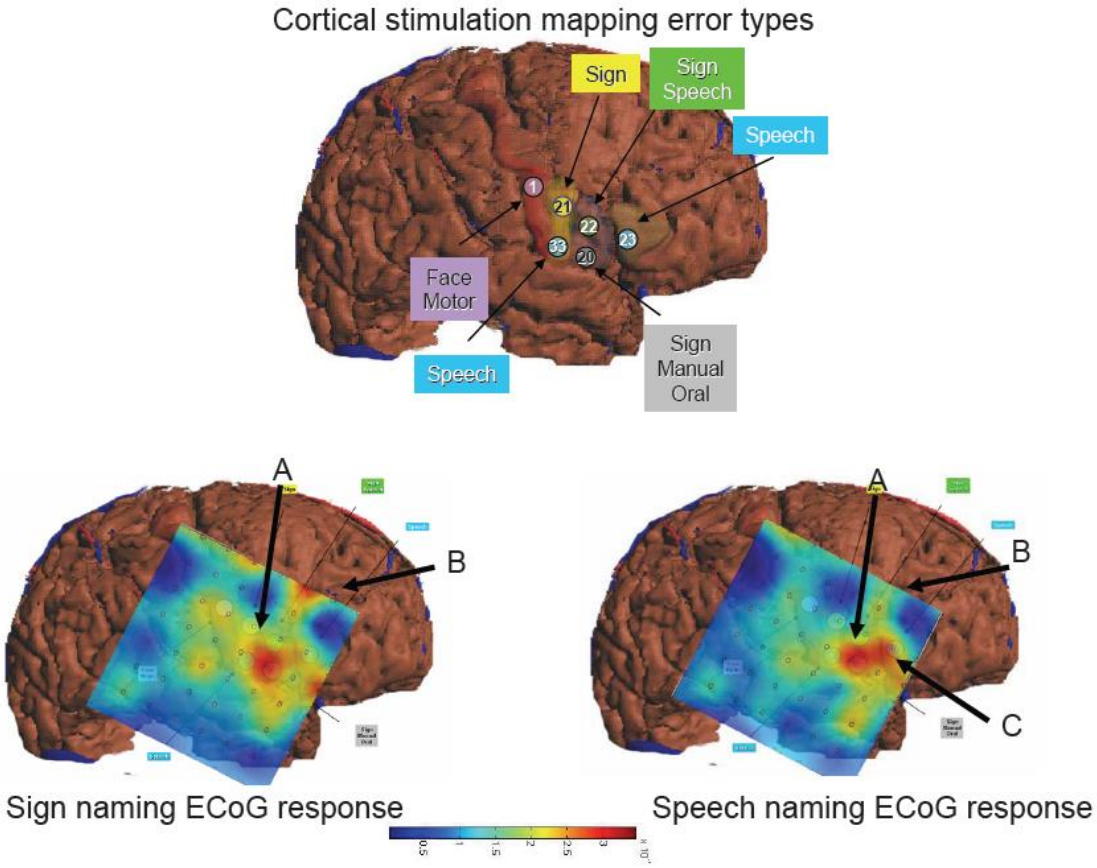
Neural Organization: English-ASL Oral Deaf Bilingual



Inferior frontal regions show a mix of overlapping as well as language specific responses

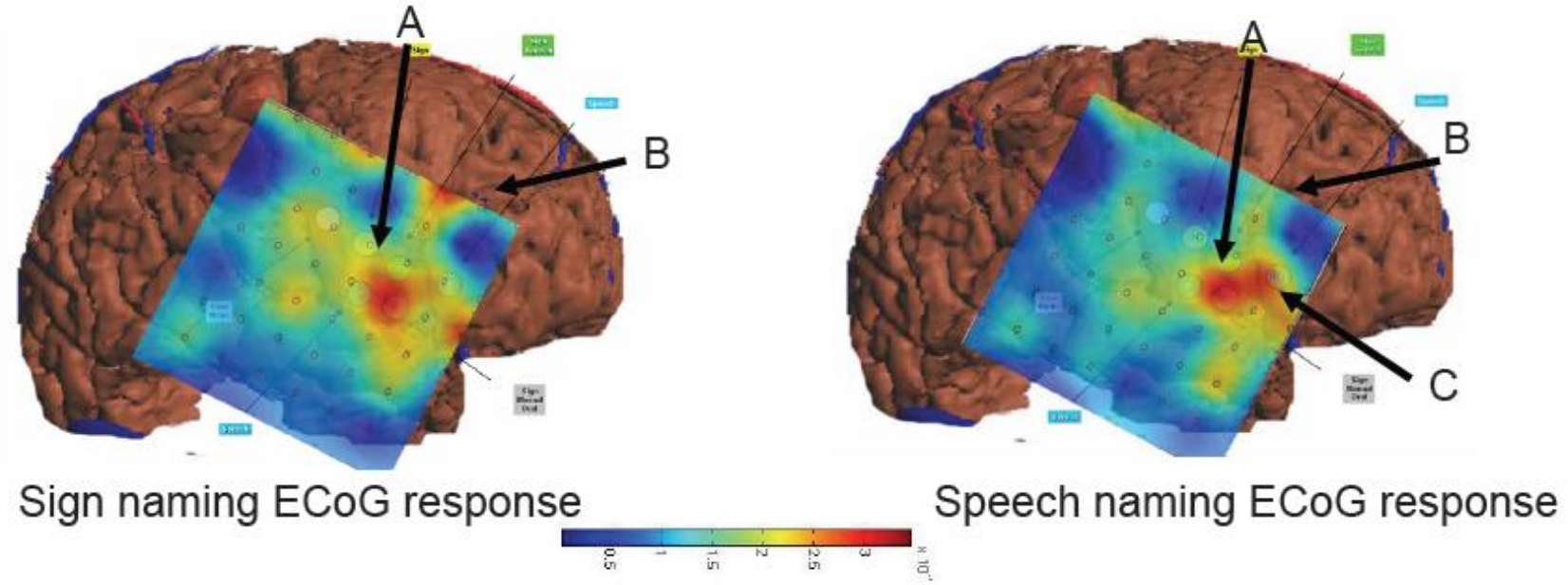
Corina et al 2006

Neurolinguistics of ASL



Rare Opportunities

Neural Organization
ENGLISH-ASL Oral Deaf Bilingual



Subtle differences in ECOG during sign versus speech naming

Corina et al 2006

Bilingual Neuroplasticty

- Increased reliance upon executive control networks
- Anterior cingulate
- DLPC/IFG
- Caudate

Abutalebi et al., 2008; Ali, Green, Kherif, Devlin, & Price, 2010

Could learning a signed language interfere with learning a spoken language?

Children learning speech and sign Language

- “CODA”
- Hearing children with deaf signing parents

  - No “competition” between language modalities
  - Sign doesn’t displace speech
  - Visual language not antagonistic

- How about deaf children with CI ?

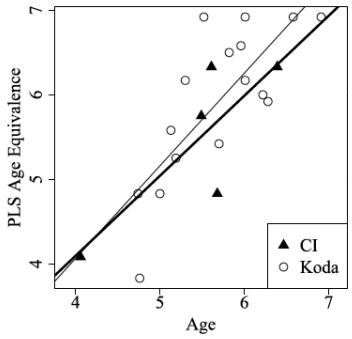
Native ASL-Users versus KODA

- Davidson, Lillo-Marting & Pichler (2013)

- HERE--

Performance on Tests of English

General Language: Preschool Language Scales

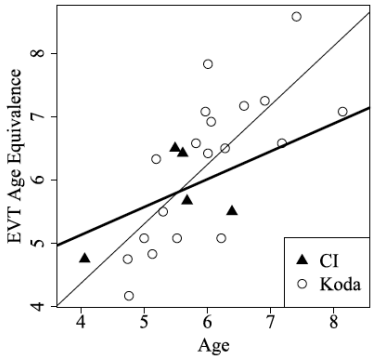


PLS age equivalent scores were sig. predicted by **age** (β =0.95, p<0.05) but not **audiological status** (CI/ Koda) (β =1.42, p=0.53) and no interaction (β =-0.22, p=0.58)

→ Bilingual CIs indistinguishable from bilingual Hearing peers

12

Vocabulary: EVT (Williams, 2007)



Participant	Age	EVT Standard Score
PAM	4;00	110
NIK	5;05	112
GIA	5;07	108
FIN	5;08	100
MAX	6;04	90

EVT age equivalent scores were predicted by **age** (β =0.86, p<0.001) but not **audiological status** (β =0.001, p=0.997)

13

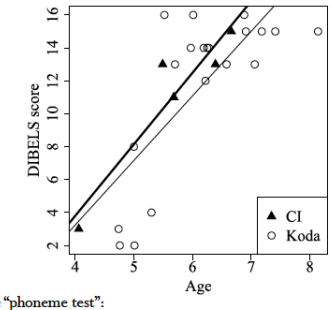
Phonological Awareness: DIBELS

(Good, Laimon, Kaminski, & Smith, 2007)

Metalinguistic: Initial Sound Fluency portion ("Which begins with /m/?")

Report raw scores (out of 16 questions)

A linear model with age and status shows **age** to be a significant predictor of success, (β =3.60, t=5.04, p<0.001) but not **audiological status** (β =-1.28, t=-0.79, p=0.44)



James et al. (2008) comparable "phoneme test":
"Early implanted" children with CIs (Mean age implant 2 years, age at test 7 years) were 57% accurate, while hearing age-matched controls were 89% accurate

15

Articulation: Goldman Fristoe

Articulation measure, includes testing of word-medial sounds

Participant	Age	GFTA Standard Score
NIK	5;05	109
GIA	5;07	112
FIN	5;08	100
MAX	6;04	102
Kodas	4;09-8;02 Mean=6;0	Range 86-116 Mean=108 SD=7.5

14

Role of Language Experience ?

- "…studies of deaf children have demonstrated that (when) CI is less effective…(it) appears to be related at least in part to communication though sign language, because of cortical reorganization of the auditory cortex (Charroo'-Ruiz et al 2013)".

Scale Slide Here

- Balance between visual and auditory processing

Providing Linguistic Intervention

- Natural Visual Language input ASL, HKSL etc
  - Affords early language benefits
- Best achieved through consistent and community based usage.
- Bilingual benefits