ASL & Plasticity

Plasticity

Plasticity
From Wikipedia, the free encyclopedia

Plasticity has four meanings:

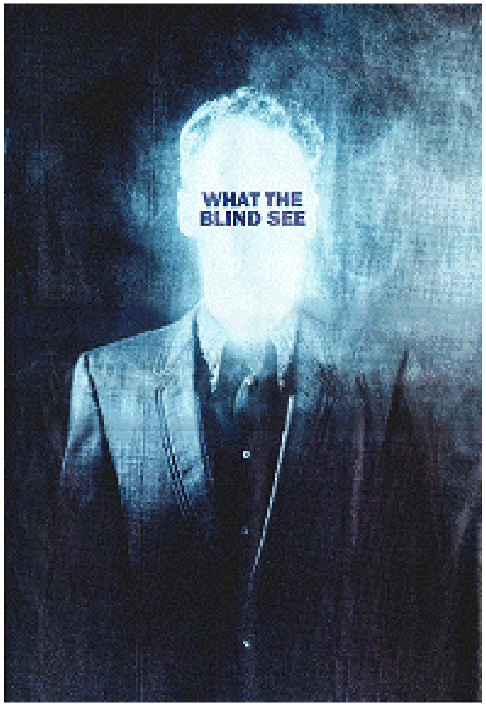
- Plasticity (physics): In physics and engineering, plasticity is the propensity of a material to undergo permanent deformation under load.
- Phenotypic plasticity: Describes the degree to which an organism's phenotype is determined by its genotype.
- Plasticity (brain): Entire brain structures can change to better cope with the environment. Specifically, when an area of the brain is damaged and non-functional, another area may take over some of the function. This is known as plasticity.
- Synaptic plasticity: In neurobiology, plasticity is a property of a neuron or synapse to change its internal parameters in response to its history.

Altered Sensory Experience

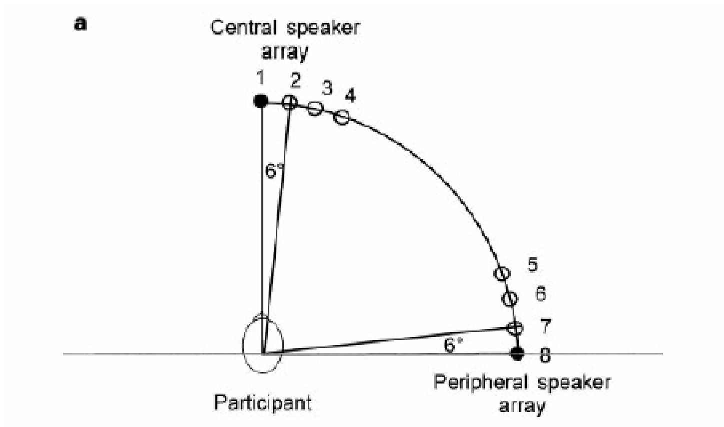
- How does altered sensory experience affect brain organization?

Auditory Attention in Blind Humans

- Roder, Teder-Salejarvi, Sterr, Rosler, Hillyard & Neville (1999)
- Auditory discrimination ability better in blind than sighted adults
- Do the blind have better sound localization ability?
  - Central Locations
  - Peripheral Locations



Experimental Paradigm



- Participants were either sighted individuals wearing blindfolds or congenitally blind
- Brief noise bursts occurred randomly from each of the 8 speakers
  - Frequent Standard
  - Rare (higher-pitched) Target
- Two Conditions
  - Attend Center (detect targets from speaker 1)
  - Attend Periphery (detect targets from speaker 8)

Behavioral Results

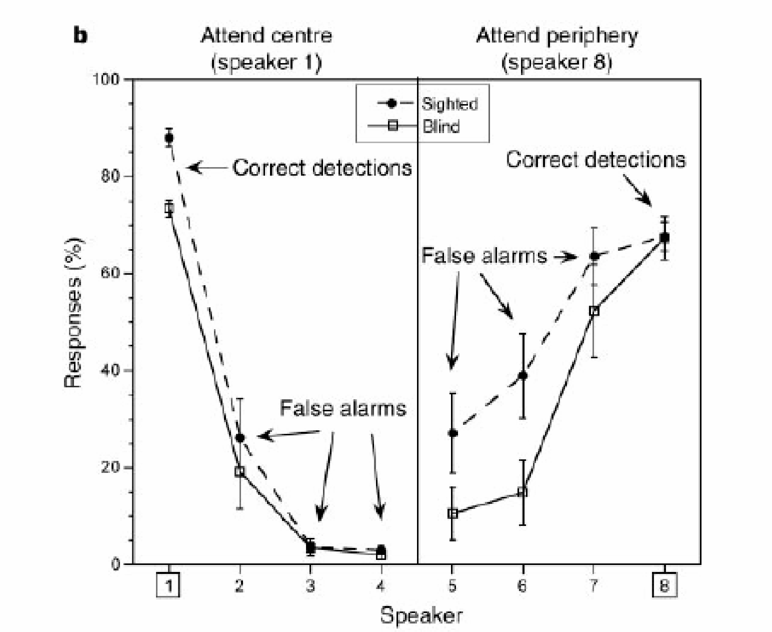
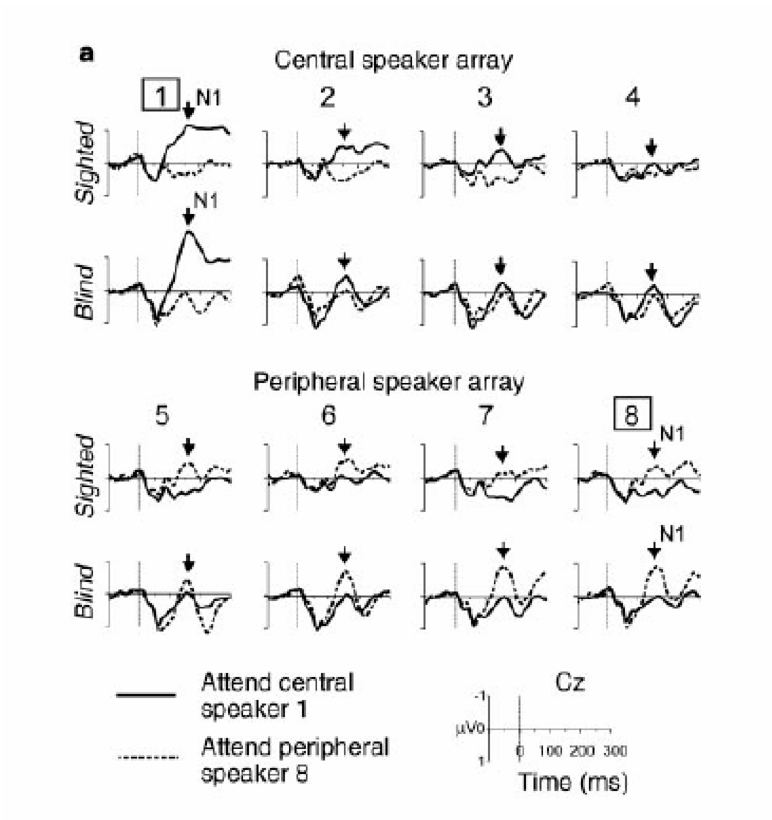


Figure 1 Speaker layout and response gradients. **a**, Central and peripheral speaker arrays. Participants had to detect rare deviants at speaker 1 (attend centre) or speaker 8 (attend periphery). **b**, Gradients of the percentage of detection responses (mean ± standard error) to deviants at the central speakers 1–4 and peripheral speakers 8–5 when the participant's task was to press a button to deviants at speaker 1 (attend centre) and speaker 8 (attend periphery), respectively. Responses to deviants at locations 1 and 8 were classified as correct responses, whereas responses to the remaining locations were considered false alarms. Response rates to deviants in the unattended speaker array were negligible and are not shown. Sighted and blind participants did not differ in their gradients of detection performance in the 'attend centre' condition, but blind participants showed a more sharply tuned gradient of attention than sighted subjects in the 'attend periphery' condition.

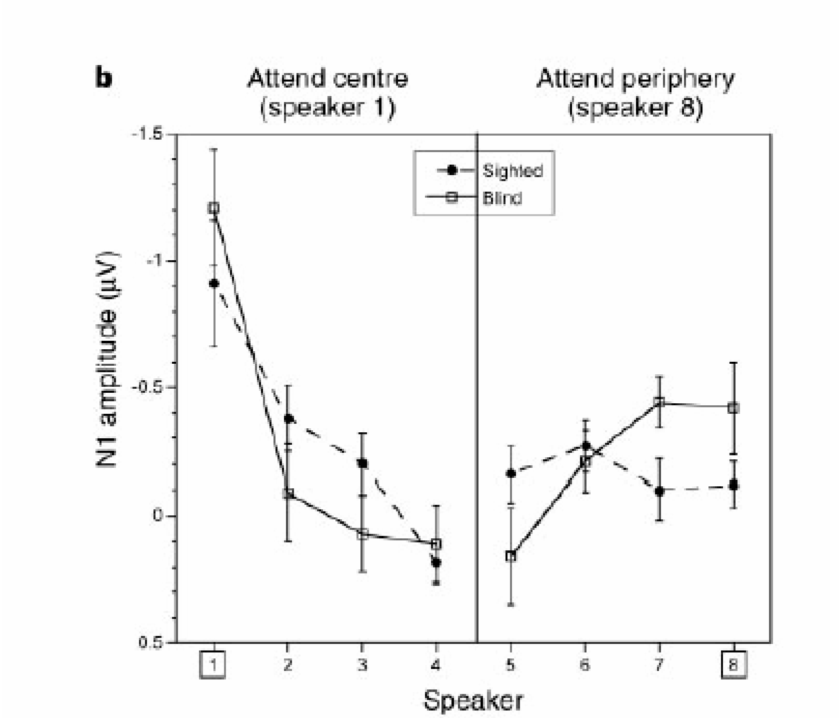
- Attend Center
  - Slightly better target detection for sighted in position 1
  - Spatial tuning no different in 2 populations
- Attend Periphery
  - Similar performance on target detection at 8
  - Blind show significantly fewer false alarms for targets originating from adjacent speakers
- *What do these data suggest about how altered visual experience impacts auditory localization ability?*

Standards: Attended vs. Unattended Locations



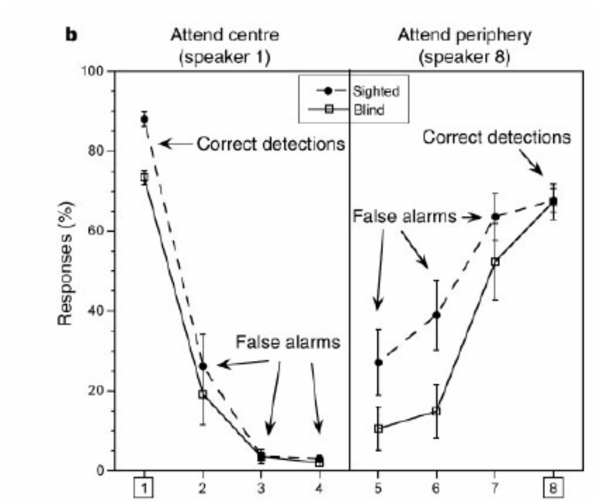
- Standards coming from central speakers 1-4
  - Speaker 1: N1 larger when task involved targets at speaker 1
  - Speaker 4: No N1 Task Effect
- Standards coming from peripheral speakers 5-8
  - Speaker 8: N1 larger when task involved targets at speaker 8
  - Speaker 5
    - N1 Task Effect in Sighted
    - No N1 Task Effect in Blind
- See next slide for N1 measurements

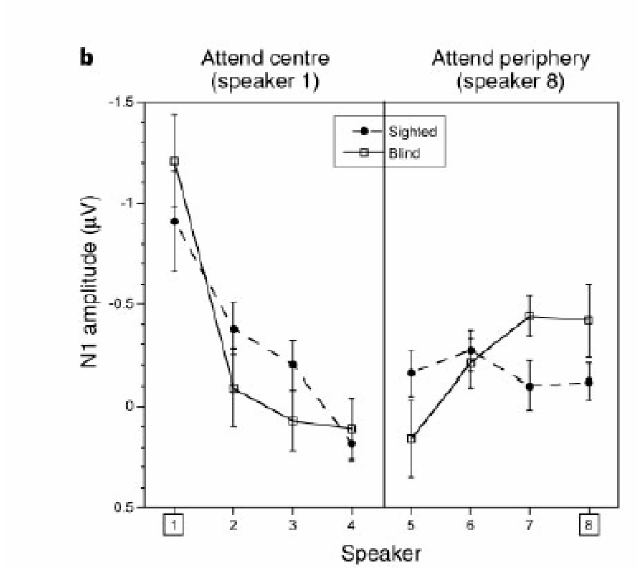
N1 to Standards & Spatial Tuning



- Attend Center
  - N1 largest at attended location
  - N1 smallest at place farthest from attended location (speaker 4)
  - Gradual dropoff
- Attend Periphery
  - Blind:
    - Larger N1 than sighted at speaker 8
    - Slight dropoff from 8 to 5
  - Sighted: flat curve
- Spotlight of Attention
  - Who has a

Spotlight of Attention





- How do behavioral data (top) map onto N1 amplitude data (bottom)?
- Are good correct detection scores associated with big or small N1 amplitude?
  - Why?
- Are low false alarm rates associated with big or small N1 amplitude?
  - Why?
- Who has a more focused attentional spotlight in the periphery?
- What about the center?

Nd: Attended minus Unattended

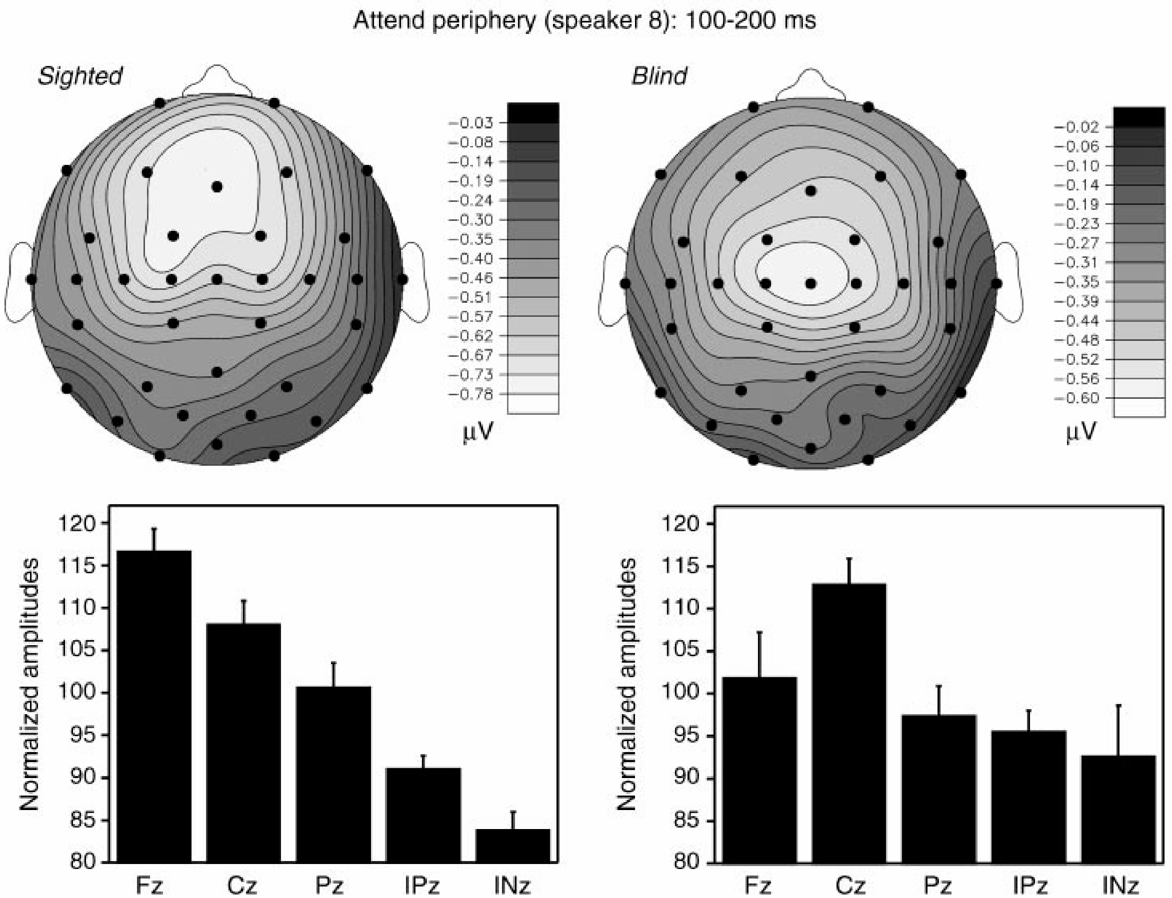


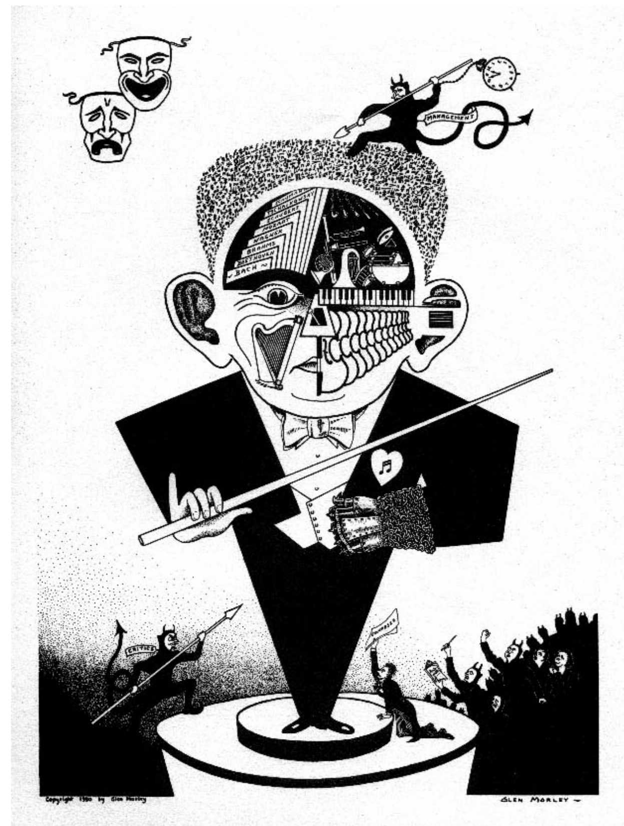
Figure 3 Topographic voltage maps of the N1 attention effect (attended minus unattended amplitudes) and the normalized anterior–posterior scalp distributions for the attended peripheral speaker. Left, sighted subjects; right, blind subjects. Lighter shading in the topographic maps indicates the greater amplitude of the N1 to attended relative to unattended standards. Bar graphs show standardized amplitudes of the N1 attention effect (mean, 100; s.d., 15) at frontal (Fz), central (Cz), parietal (Pz), parieto-occipital (IPz) and inferior-occipital (INz) electrode sites. The anterior–posterior distribution of the N1 attention effect differed between groups with a frontal maximum in the sighted subjects and a central maximum in the blind subjects.

Roder et al. (1999)

- Blind individuals have similar auditory localization ability for centrally located sounds
- More precise localization for *peripheral* sounds – area of space where sighted individuals have the most difficulty
- Posterior shift in scalp topography of auditory attention effect suggests different brain areas mediate localization in the blind
- Perhaps: recruitment of posterior multimodal brain areas that represent visual space in sighted individuals

Conductors

- Besides sensory deprivation, experience can also alter brain organization
- Orchestra conductors have to both listen to overall sound and be able to focus on particular individuals
- Does this experience affect their ability to localize sounds in the environment
  - Relative to other musicians, e.g. pianists
  - Relative to non-musicians



Nager et al. (2003)

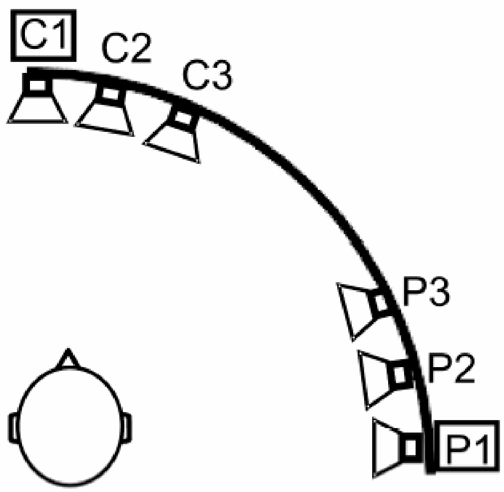


Fig. 1. Schematic drawing of experimental set-up.

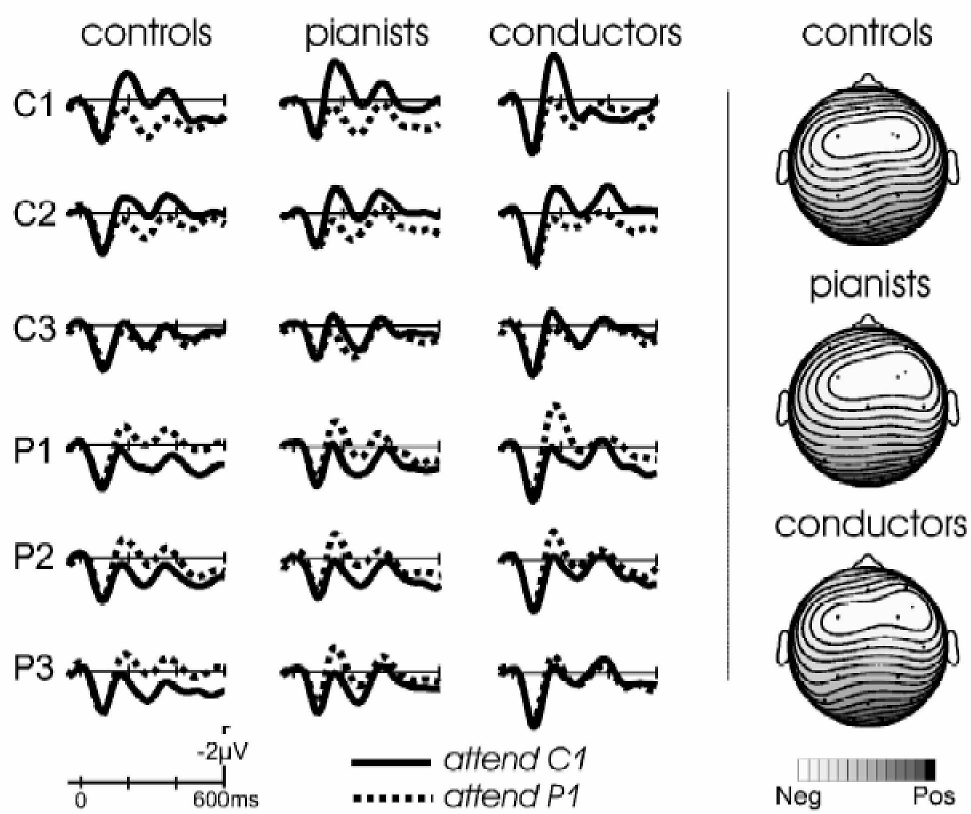
- Set-up reminiscent of Roder et al. (1999)
- 84% (standards) pink noise 500-5000 Hz
- 16% (deviants) pink noise 500-15000 Hz
- Attend Center
  – Press button if deviant comes from C1 speaker
  – Ignore all other stimuli
- Attend Periphery
  – Press button if deviant comes from P1 speaker
  – Ignore all other stimuli

Those amazing components…

- What component did Roder and colleagues examine in a similar paradigm?
  - Functional significance?
- What difference component do you get if you subtract (N1) ERPs elicited by stimuli when its location is unattended from attended?
  - Functional significance?
- When auditory stimuli are ignored, what component is derived by subtracting the standard noises from the deviant noises?
  - Is it larger when the difference between the two sorts of stimuli is *easy* to detect or *hard* to detect?
- What ERP component are the auditory deviant stimuli likely to elicit when they are the targets?

ERPs to Standard Tones

W. Nager et al. / Cognitive Brain Research 17 (2003) 83–93 87



2. Grand average potentials (Fz-site) for the different subject groups. Shown are ERPs to standard tones for each of the six loudspeakers, when either center-most speaker (C1) was attended (solid line) or when the most peripheral speaker (P1) was attended (dotted line). Clearly, all three subject groups w a gradual decline of the attention effect for the three central speakers. By contrast, in the periphery only the conductors show an attentional gradient also Ref. [13]).

- Is there an attention effect on the N1?
- Is there a gradation from C1 to C3?
  - Is it present in all the groups?
- Is there a gradation from P1 to P3?
  - Is it present in all the groups?
  - Are conductors more like sighted people or like blind people?
- Do the topo maps of the Nd look similar in the 3 groups or different?
  - Are conductors more like sighted people or like blind people?
- What does this imply about the impact of sensory deprivation versus enriched sensory experience on auditory localization ability?

ERPs to Target Stimuli

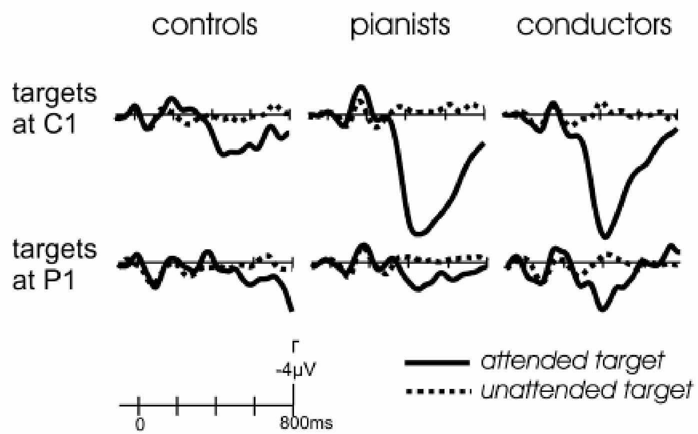


Fig. 3. Grand average potentials (Pz-site) for the different subject groups. Shown are ERPs to target tones for the two relevant speakers (C1 and P1).

- What component do the attended targets elicit?
- Why is it bigger for targets at C1 than P1?
- What is the most obvious difference between the groups?
- Muente interprets this as due to more confident decisions
  - Is that consistent with any accounts of this component?
  - Does it seem to make sense?

Ignored Stimuli

- Though it hasn't actually been derived here, what component is isolated by this comparison?
- Which group has the biggest and which the smallest effect?
  - Why do you think that's the case?
- Which group has a qualitatively different effect starting about 250 or 300 ms after tone onset?
  - Is this similar to any other ERP effects (similar sort of paradigm) we've seen this quarter?

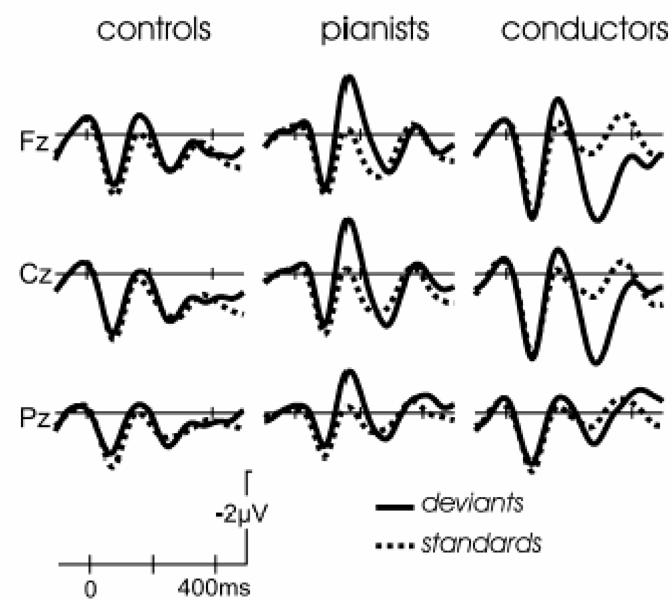


Fig. 4. Grand average potentials to deviant and standard stimuli coming from the periphery (averaged across speakers P1/2/3) when the centermost speaker was attended. Very different responses to deviant stimuli are found for the three subject groups: non-musicians show only a very rudimentary difference between deviants and standards (frontal MMN), the pianists display a very large mismatch MMN, while for the conductors a negativity immediately followed by a prominent frontocentral positive is found for the deviants.

MMN & P3a

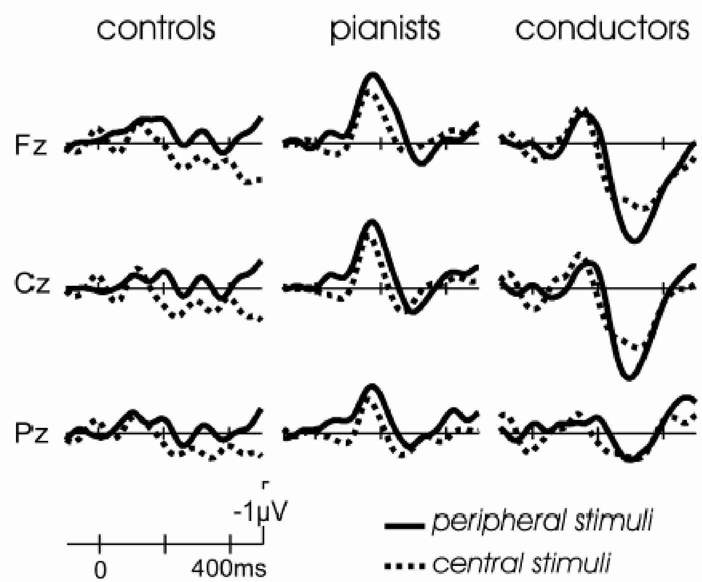


Fig. 5. Deviant minus standard difference waves for the peripheral stimuli (when the centermost-speaker was attended) and the central stimuli (when the most peripheral speaker was attended). A very different morphology of the difference waves is found for the three subject groups (see text).

- Barely discernable MMN in controls
- Big MMN in pianists
- MMN in conductors followed by P3a
  - P3a elicited by novel stimuli in oddball paradigm (e.g. dog bark vs. high/low tones)
  - Signals involuntary shift of attention
  - May reflect conductors automatic orienting to contextually salient sounds

Nager et al. Discussion

- Conductors better than pianists at attentively focusing relevant auditory information in space
  - Dropoff in Nd effect at irrelevant locations in the periphery
  - Same brain regions used as pianists, though
- Conductors better at “pre-attentive registration of deviant stimuli outside the attentional focus.”
  - P3a to ignored deviants observed only in conductors

Sign Languages

- Full-fledged languages, created by hearing-impaired people (*not* by Linguists):
  - Dialects, jokes, poems, etc.
  - Do not resemble the spoken language of the same area (ASL resembles Bantu and Navaho)
  - Pinker: Nicaraguan Sign Language
  - Another evidence of the origins of language (gestures)
- Most gestures in ASL are with right-hand, or else both hands (left hemisphere dominance)
- Signers with brain damage to similar regions show aphasia as well

Spoken and Sign Languages

- Neural mechanisms are similar
- fMRI studies show similar activations for both hearing and deaf
- But in signers, homologous activation on the right hemisphere is unanswered yet

LANGUAGE DEVELOPMENT
American Sign Language

Sign constructed from a limited set of gestural components (same way that the spoken word is constructed from a finite number of distinctive sounds or phonemes).

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American Sign Language

Sign constructed from a limited set of gestural components (same way that the spoken word is constructed from a finite number of distinctive sounds or phonemes).

Components of ASL:

1. Position of hands
2. Configuration of hands/fingers
3. Motions of hands/fingers

SEQUENCE OF LANGUAGE DEVELOPMENT

Universal Milestones in Language Devel.

Milestone	Approx. Age
Cooing	2-3 mos.
Babbling	5 mos.
First Words	10-14 mos.
Ten Words	12 mos.
Two-word sentence	21-24 mos.
Two-hundred words	24 mos.

LANGUAGE DEVELOPMENT
American Sign Language

Deaf children acquire ASL much like hearing children acquire their oral language.

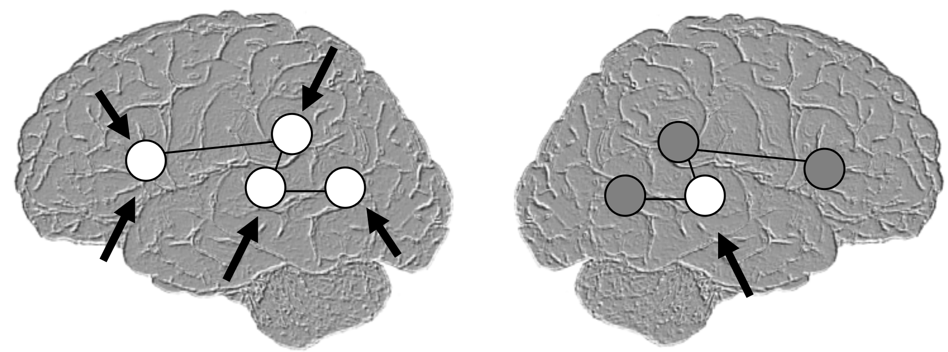
When deaf children are raised with deaf parents:

Babbling – 7-11 mos.

Pointing – 8-9 mos.

Word/Sign – 12 mos.

Research Program Outline



What drives this organization?

Why left dominance for many language functions?

What are the effects of the particular sensory and motor channels?

Fast temporal processing requirements?

Approach

Sign Language

Natural human languages

There are many signed languages throughout the world

They are not merely manual versions of the spoken language in the surrounding community

They are not merely elaborate mime-like systems, but rather have the same sorts of linguistic structuring found in the world's spoken languages

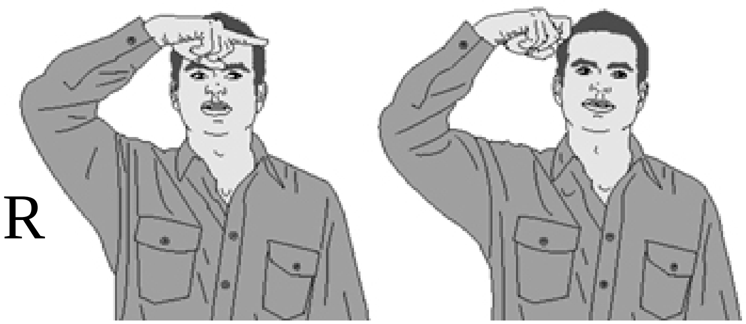
Approach

Sign Language

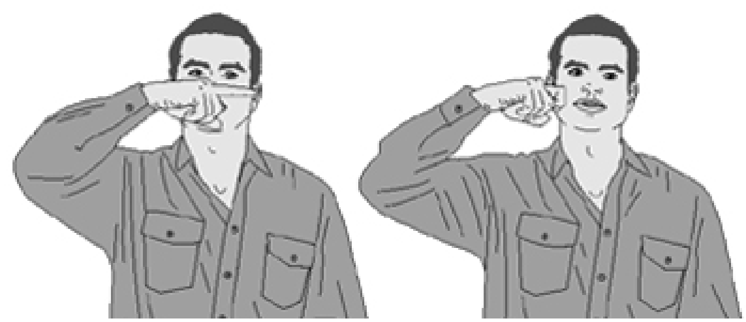
Natural human languages

…with different sensory and motor processing requirements

SUMMER



UGLY



DRY

Approach

Sign language and the brain

A natural experimental manipulation

Linguistic representation systems are held constant, while the sensory and motor modalities through which language is perceived and produced are varied.

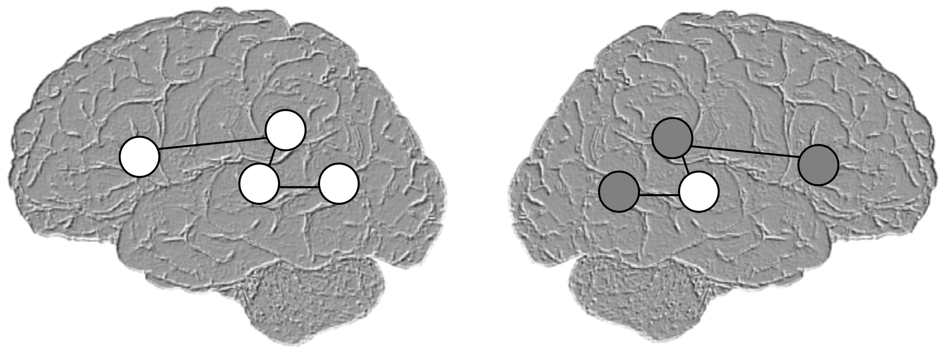
How will this affect the anatomy of language?

Approach

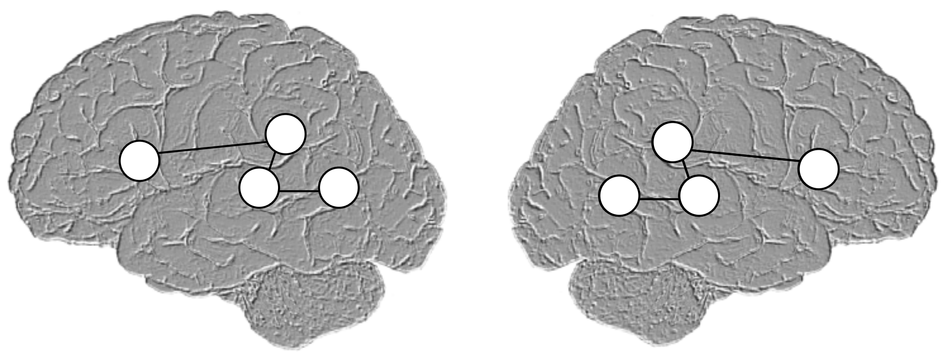
Sign language and the brain

Lateralization Pattern?

Spoken Language



Signed Language



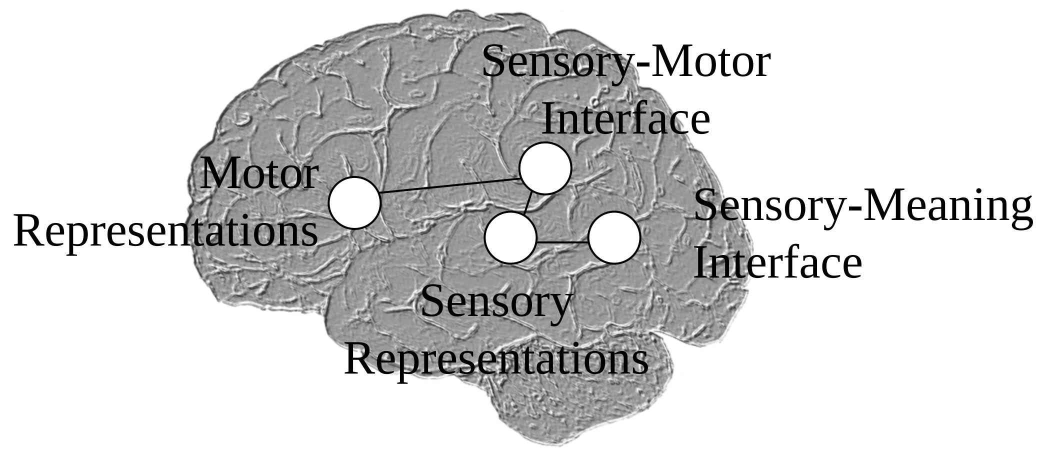
Approach

Sign language and the brain

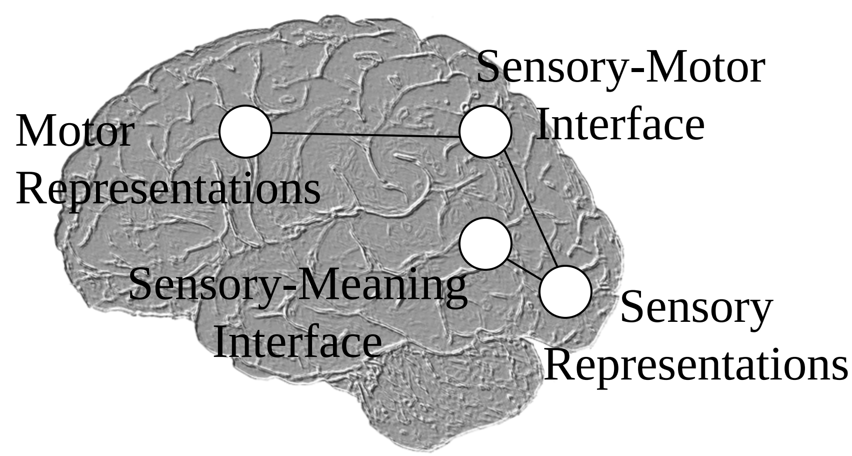
Lateralization Pattern?

Within Hemisphere Organization?

Spoken Language



Signed Language?



Approach

Sign language and the brain

Lateralization Pattern?

Within Hemisphere Organization?

1. Lesion method:
   Left versus right brain damaged
   Deaf signers

2. Functional imaging:
   Native Deaf signers

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

Production

LHD, but not RHD, signers often present with phonemic paraphasia in production

FINE

correct

handshape error

Data: Lateralization Pattern

Language

Sub-lexical

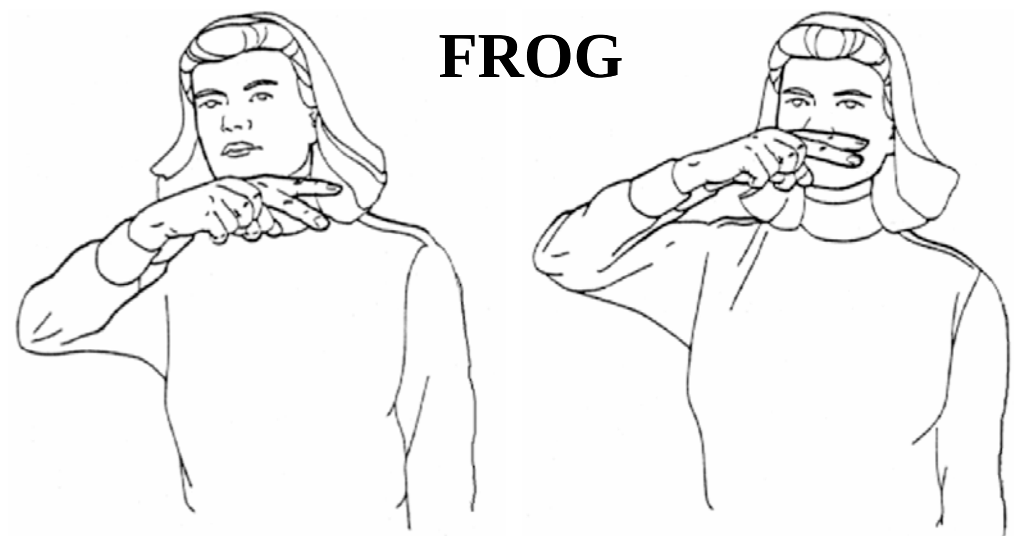
Lexical

Sentence-level

Discourse-level

Production

LHD, but not RHD, signers often present with phonemic paraphasia in production



correct location error

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

Production

Semantic paraphasias are fairly common following LHD but not RHD

Comprehension

Single sign comprehension deficits have been found only following LHD

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

Production

Agrammatic production has been observed following LHD, but not RHD

Comprehension

Sentence-level comprehension deficits are most severe following LHD

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

Group Studies

(Hickok, et al. 1996, *Nature*, 381:699-702)

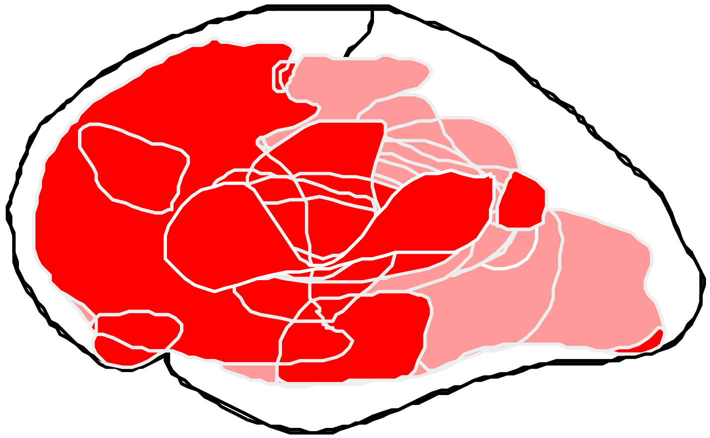
13 LHD Deaf signers
10 RHD Deaf signers

Administered a range of clinical aphasia assessment tests (ASL adapted)

	Age of Sign Exposure	Onset Deafness	Sex	Handed-ness	Age at Testing	Lesion Size/Location	Lesion Etiology
Left Lesioned:							
LHD01	6	5	m	r	81	lg/frontal-parietal	Ischemic Infarct
LHD02	5	5	f	r	66	mod/inf parietal	Ischemic Infarct
LHD03	0	0	f	r	37	lg/frontal	Ischemic Infarct
LHD04	6	1	f	r	51	sm/inf-ant frontal	Aneurism Rupture*
LHD05	13	0	m	r	45	lg/temp-par	Hematoma
LHD06	0	0	m	r	77	mod/frontal-temp-par	Ischemic Infarct
LHD07	0	0	m	r	86	sm/sup frontal-parietal	Ischemic Infarct
LHD08	6	2	f	r	64	mod/medial occ	Ischemic Infarct
LHD09	7	< 1	m	r	29	mod/frontal-par	Hematoma*
LHD10	0	2	f	r	79	mod/inf-post frontal	Ischemic Infarct
LHD11	9	< 1	f	r	73	mod/frontal-par	Ischemic Infarct
LHD12	11	0	f	r	79	lg/frontal-temp-par	Ischemic Infarct
LHD13	4	0	m	r	71	mod/inf frontal-par	Hematoma
Right Lesioned:							
RHD01	12	0	f	r	71	lg/front-temp-par	Ischemic Infarct
RHD02	9	5	m	r	82	mod/temp-par	Ischemic Infarct
RHD03	5	0	m	r	60	lg/front-temp-par	Ischemic Infarct
RHD04	0	0	f	r	61	mod/sup front-par	Tumor*
RHD05	0	n/a	f	r	38	mod/sup par-occ	Hematoma*
RHD06	0	0	m	r	74	lg/front-temp-par	Ischemic Infarct
RHD07	11	2	f	r	78	mod/frontal-par	Ischemic Infarct
RHD08	7	<1	m	r	74	lg/frontal-temp-par	Ischemic Infarct
RHD09	6	3	f	r	83	mod/temp-par	Ischemic Infarct
RHD10	0	0	f	r	78	mod/temp-par-occ	Ischemic Infarct

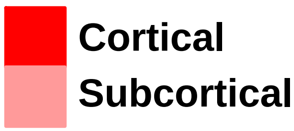
* = surgical intervention

Superimposed Lesions

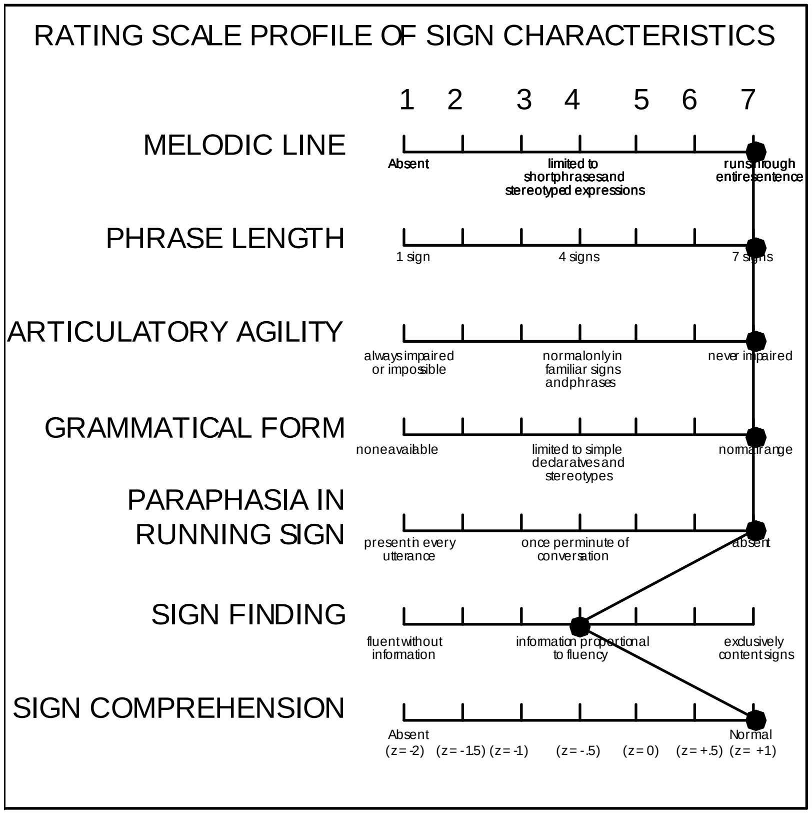


Left Hemisphere Damage (n=13)

Right Hemisphere Damage (n=8)

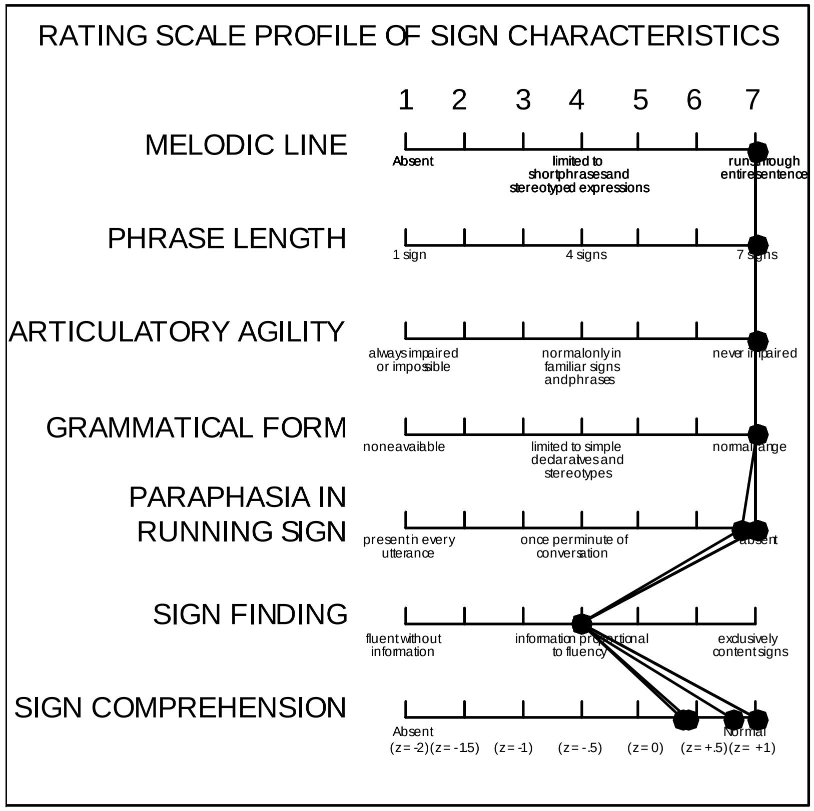


Normal


RATING SCALE PROFILE OF SIGN CHARACTERISTICS
1 2 3 4 5 6 7
MELODIC LINE
Absent
limited to short phrases and stereotyped expressions
runs through entire sentence
PHRASE LENGTH
1 sign
4 signs
7 signs
ARTICULATORY AGILITY
always impaired or impossible
normal only in familiar signs and phrases
never impaired
GRAMMATICAL FORM
none available
limited to simple declaratives and stereotypes
normal range
PARAPHASIA IN RUNNING SIGN
present in every utterance
once per minute of conversation
absent
SIGN FINDING
fluent without information
information proportional to fluency
exclusively content signs
SIGN COMPREHENSION
Absent
Normal
(z = -2) (z = -1.5) (z = -1) (z = -.5) (z = 0) (z = +.5) (z = +1)

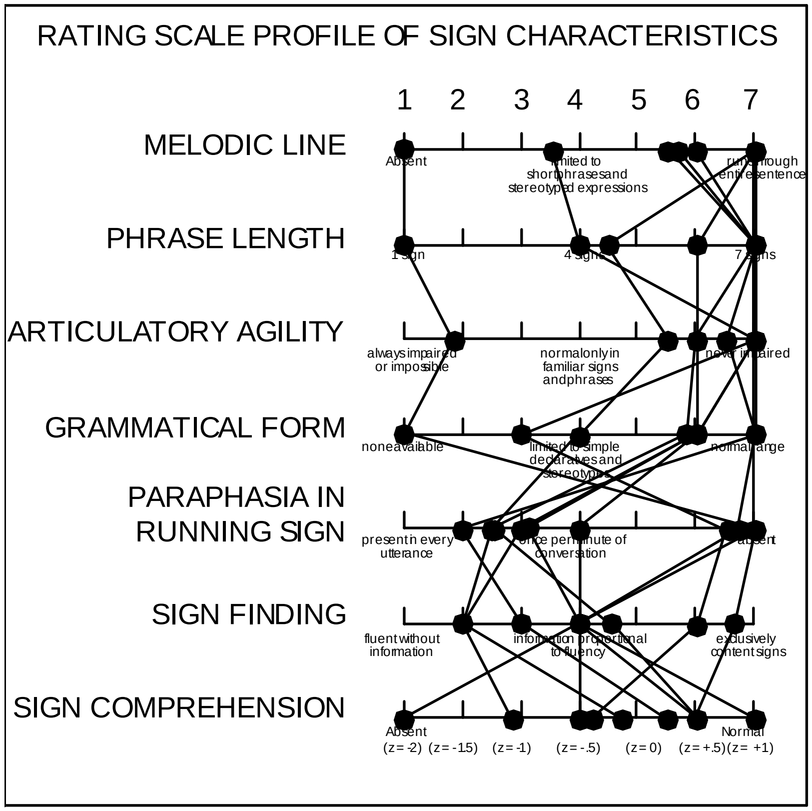
Right Hemisphere Damaged

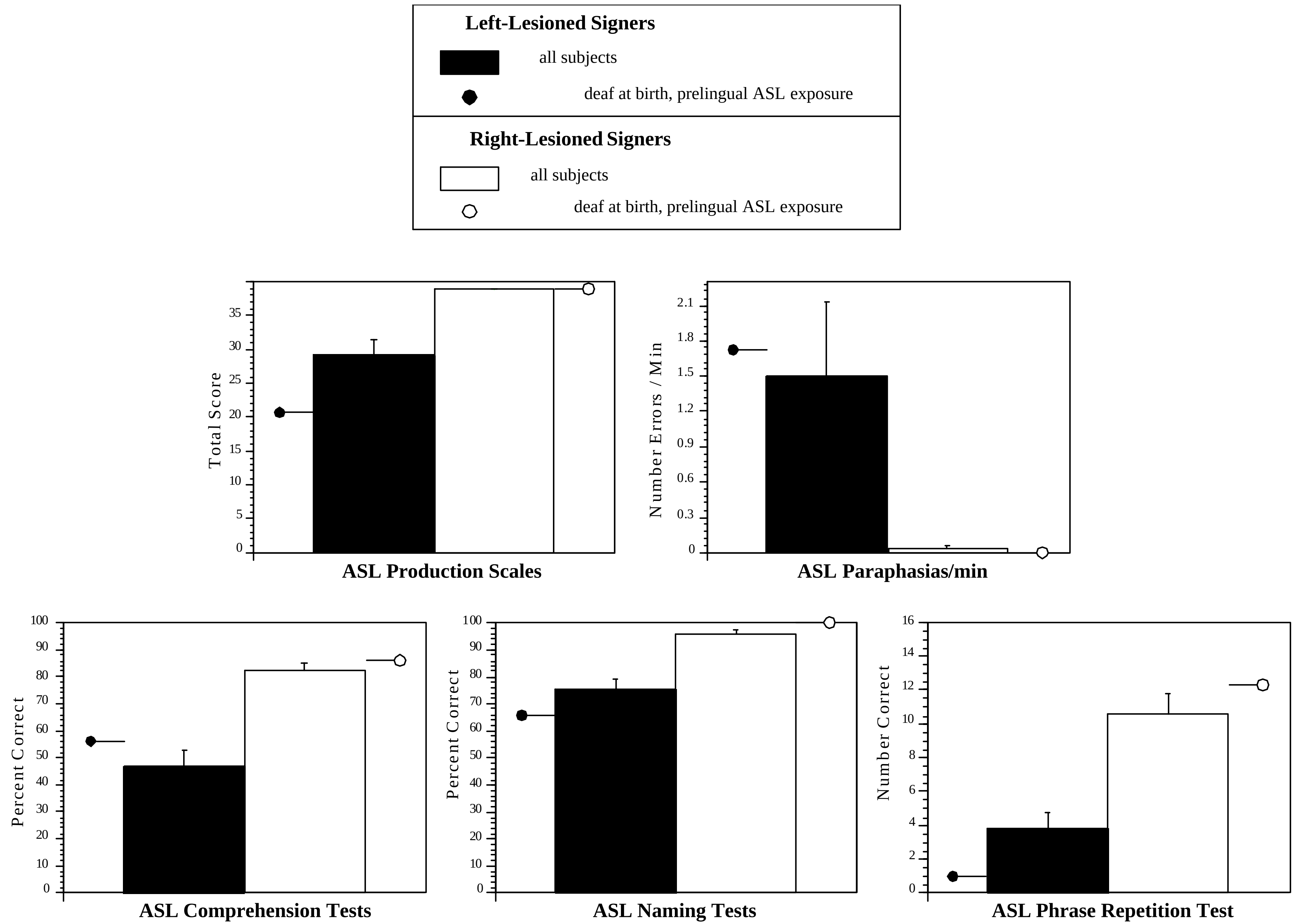
(n=7)



Left Hemisphere Damaged

(n=10)




Left-Lesioned Signers
all subjects
deaf at birth, prelingual ASL exposure
Right-Lesioned Signers
all subjects
deaf at birth, prelingual ASL exposure
Total Score
ASL Production Scales
Number Errors / Min
ASL Paraphasias/min
Percent Correct
ASL Comprehension Tests
Percent Correct
ASL Naming Tests
Number Correct
ASL Phrase Repetition Test

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

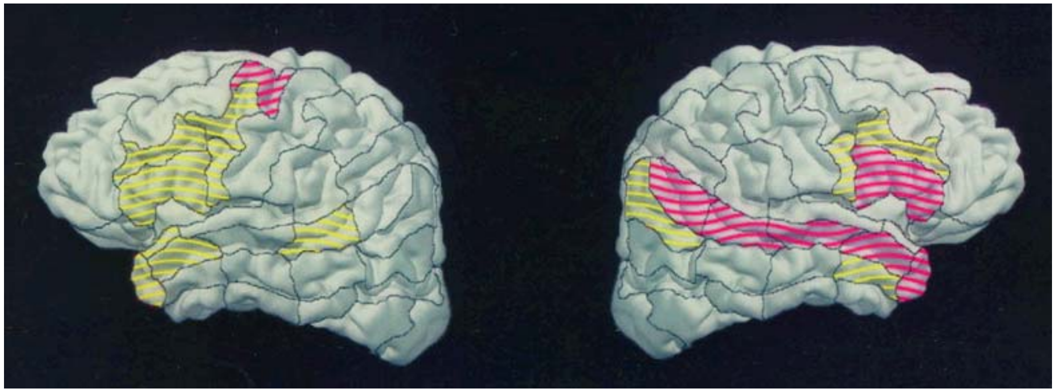
Sentence-level

Discourse-level

fMRI Study of ASL Comprehension

(Neville, et al. 1998, *PNAS*, 95:922-929)

Studied healthy native Deaf signers watching videos of ASL sentences



“*…the specific nature and structure of ASL results in the recruitment of the right hemisphere in the language system*” p. 928

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

Group Studies: Comprehension

11 LHD Deaf signers
8 RHD Deaf signers

Three ASL comprehension measures

1. Single sign-to-picture matching (BDAE)
2. Simple commands (one clause, one step)
3. Complex commands (multi-clause/-step)

Analysis looked at

1. Left vs. right hemisphere damage
2. Temporal lobe lesioned vs. spared

Data: Lateralization Pattern

Language

Sub-lexical

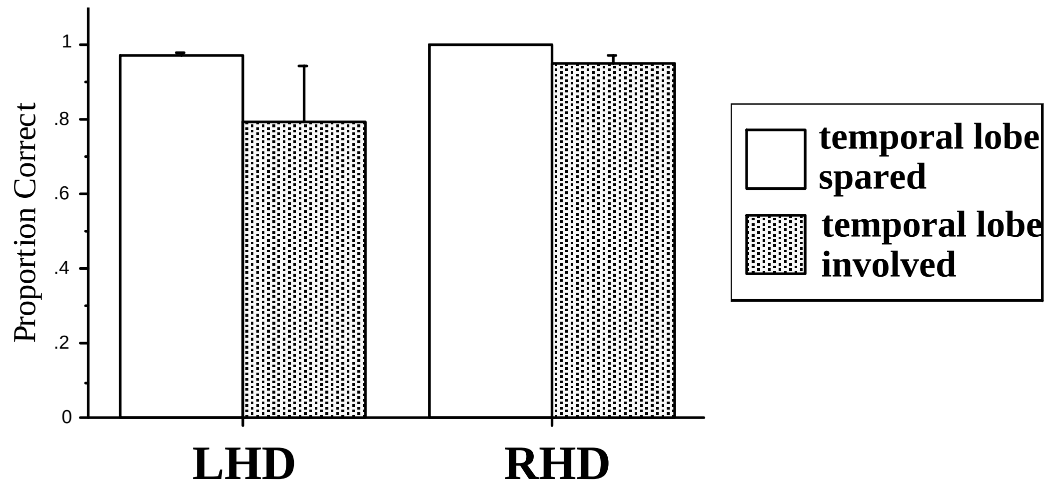
Lexical

Sentence-level

Discourse-level

Group Studies: Comprehension

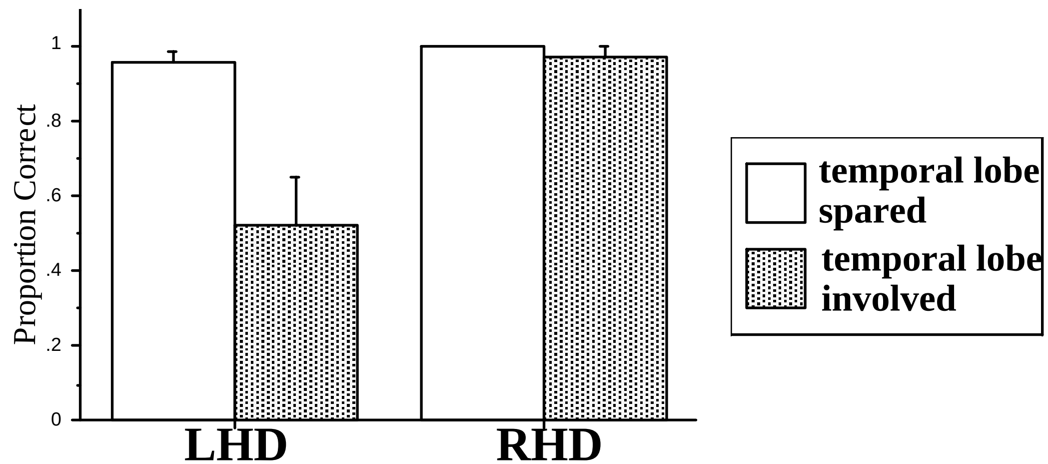
Single signs



Data: Lateralization Pattern

Group Studies: Comprehension

Simple sentences



Language

Sub-lexical

Lexical

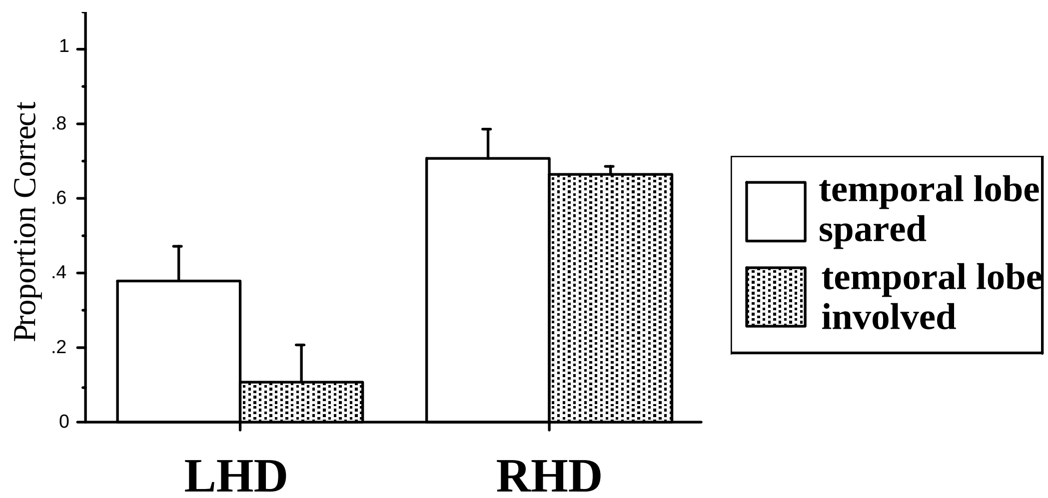
Sentence-level

Discourse-level

Data: Lateralization Pattern

Group Studies: Comprehension

Complex sentences



Language

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Sentence-level

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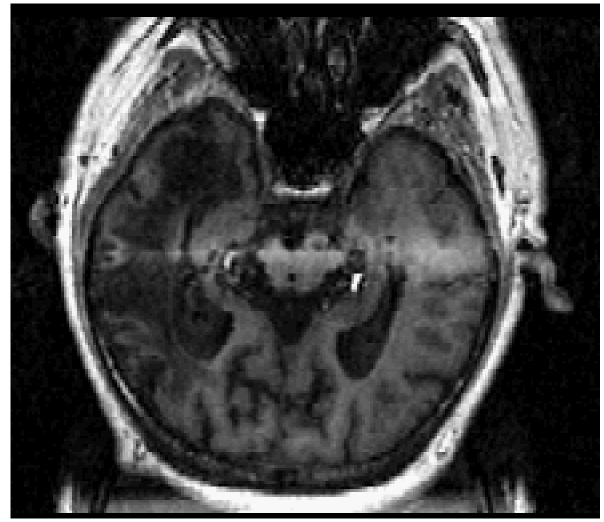
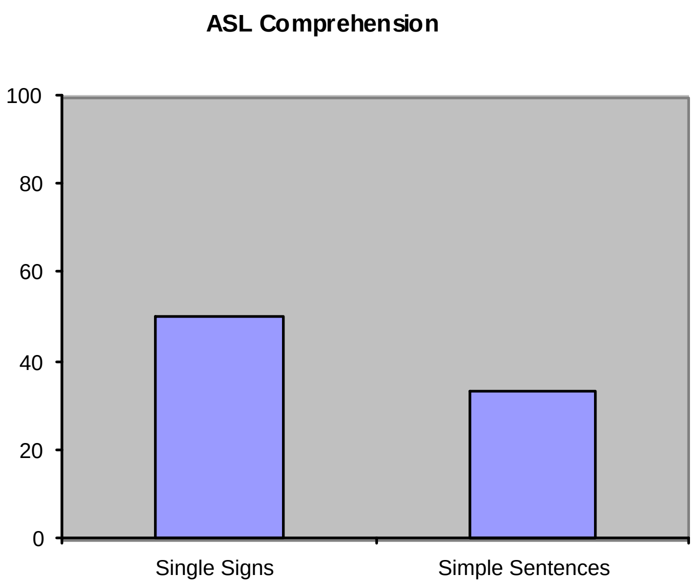
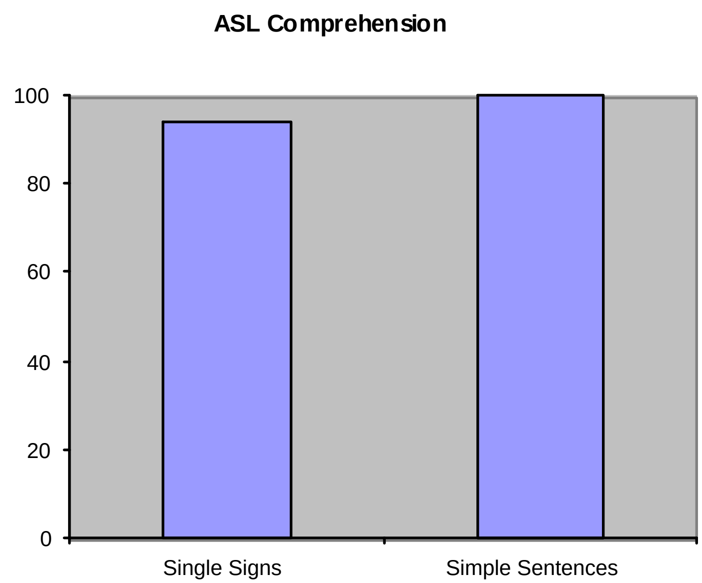



ASL Comprehension
100
80
60
40
20
0
Single Signs
Simple Sentences


ASL Comprehension
100
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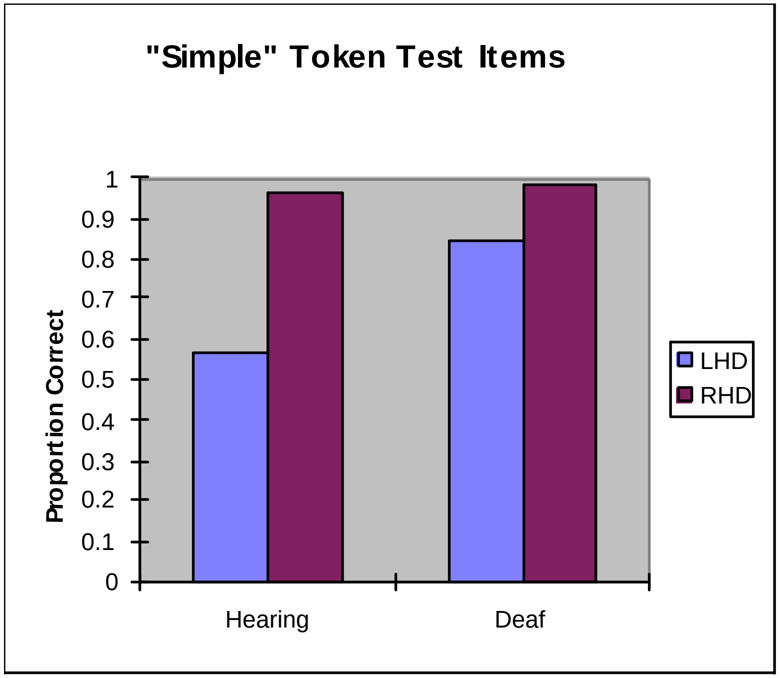
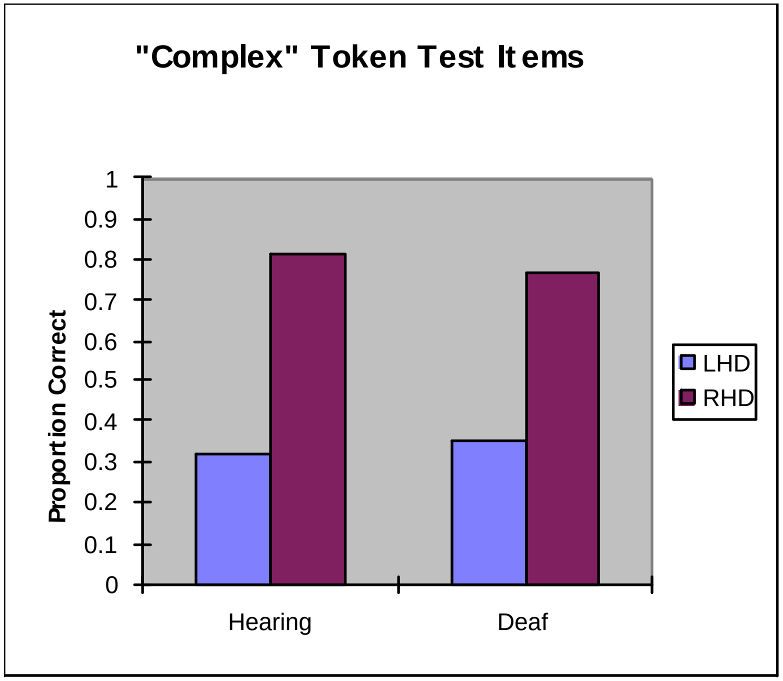
Similar Token Test Performance Levels Among Hearing and Deaf, LHD vs. RHD Subjects





Hearing data from: Swisher, L. P.; Sarno, M. T. (1969). Token Test Scores of Three Matched Patient Groups: Left Brain-Damaged with Aphasia, Right Brain-Damaged Without Aphasia, Non-Brain-damaged. Cortex, 5:264-273

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

Sentence-level

Discourse-level

RHD has been associated with discourse-level deficits in hearing patients

The same appears to hold in the Deaf signing population

Data: Lateralization Pattern

Language

Sub-lexical

Lexical

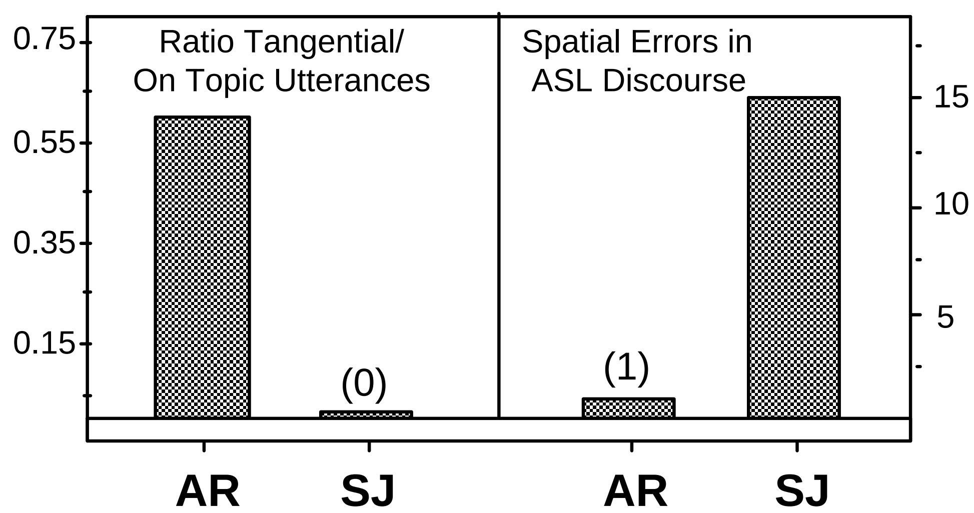
Sentence-level

Discourse-level

Two types of discourse-level deficits
Hickok et al. 1999. Brain Lang. 66:233-48

1. Tangential utterances
2. Spatial referential errors

Discourse Deficits in RHD Deaf Signers



Neville et al. (1997)

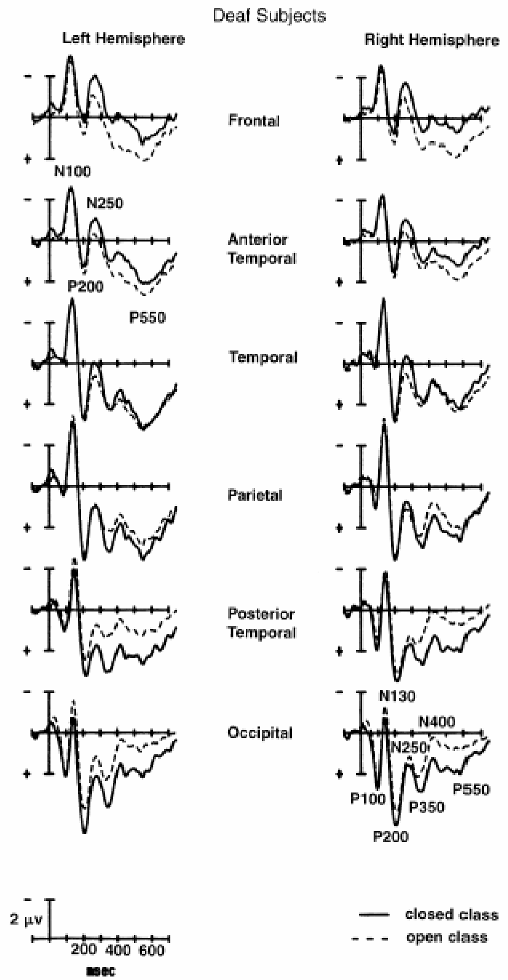


FIG. 1. ERPs to closed/open class signs in the middle of ASL sentences. ERPs averaged across ten deaf subjects. Recordings from frontal, anterior temporal, temporal, parietal, posterior temporal and occipital areas of the left and right hemispheres.

- Multiple populations differing sensory experience and differing language experience watched videos of sentences in ASL
- Half congruous, half incongruous
- ERPs to sentence final words
- ERPs to OC vs. CC words in middle of sentence
  - Noun/Verb/Adjective
  - Pronouns/Conjunctions/Auxiliaries

ASL vs. English

- Overall similarity in ERPs to OC vs. CC
  - Similar neural systems mediate language comprehension irrespective of modality
- ASL
  - N250 larger over anterior sites for CC words
  - N250 larger over posterior sites for OC words
- English
  - N280 larger over anterior sites for CC words
- N400 comparable in ASL and English
- Speculate N250 more related to face processing

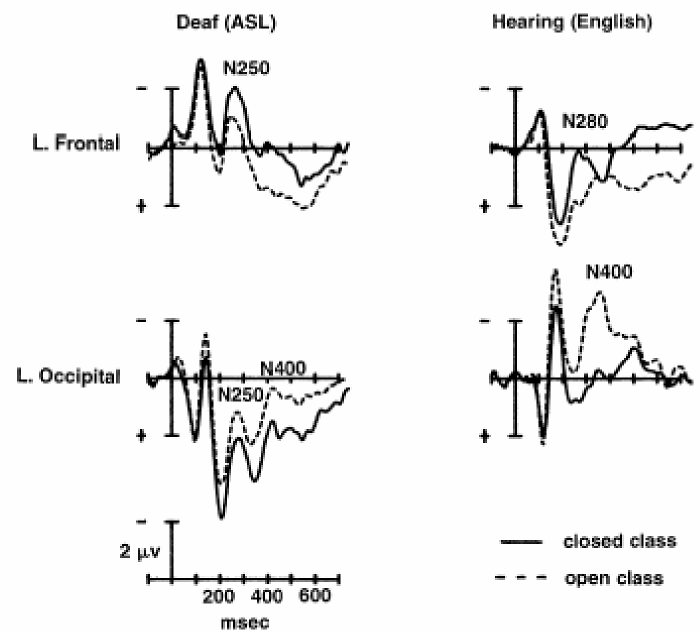


FIG. 2. ERPs to open and closed class signs in ASL sentences averaged across 10 deaf subjects from left frontal and occipital areas. ERPs to open and closed class words in English sentences from 17 normally hearing subjects reported in Neville, Mills, and Lawson, 1992.

ASL: Deaf vs. Hearing Native Signers (CoDAs)

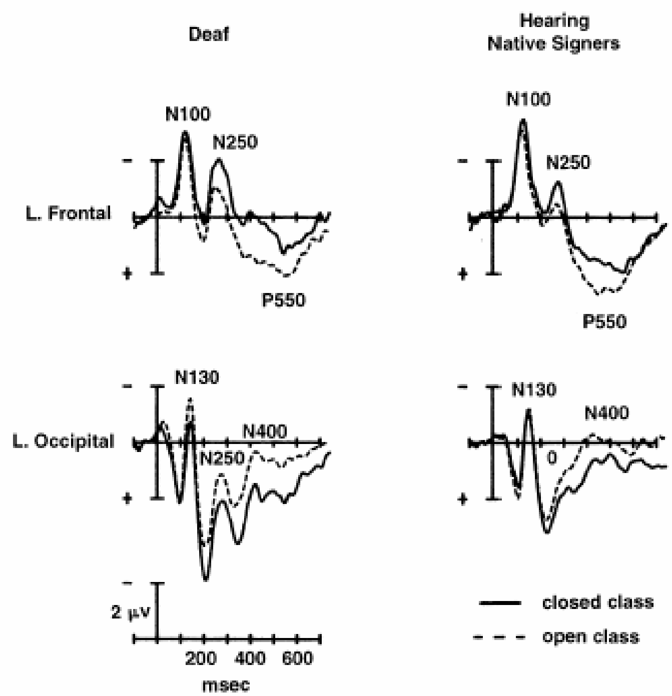


FIG. 3. ERPs to open and closed class signs in ASL sentences averaged across 10 deaf and 10 hearing native signers born to deaf parents. Recordings from left frontal and occipital electrodes.

- Similar pattern over frontal sites
  - N250, P550
  - Later latency in Hearing may reflect bilingual nature of this population
- Similar N400
- Differences due to auditory deprivation in deaf
  - N250 over posterior sites
  - P380
- Increased activity over posterior visual areas in the deaf

Age of Acquisition

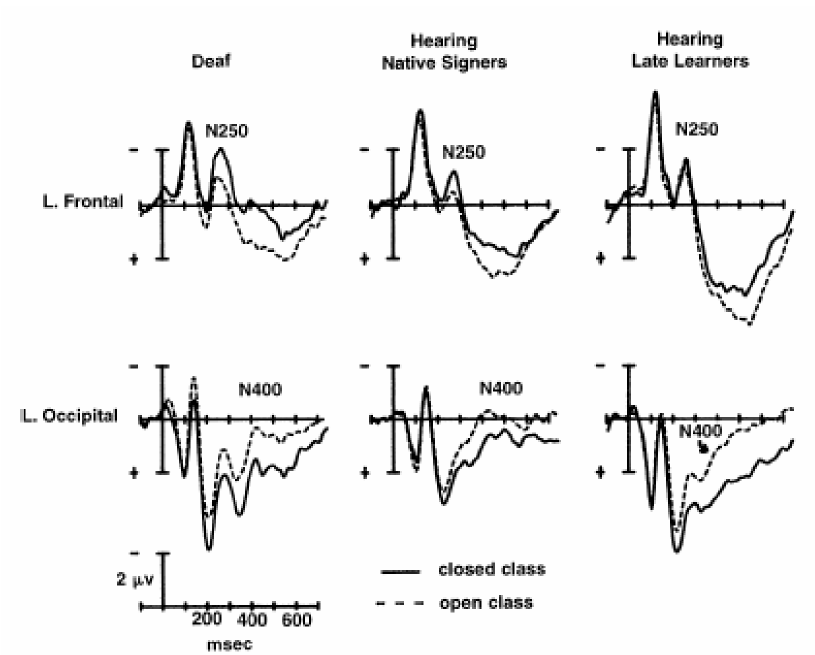


FIG. 4. ERPs to open and closed class signs in ASL sentences from 10 deaf and 10 hearing native signers and from 9 hearing ASL interpreters who learned ASL in the late teenage years ("Hearing Late Learners"). Recordings from left frontal and occipital areas.

- N250 component present in both Hearing groups
- N250 only modulated by word class in native signers
- May reflect proficiency differences due to age of acquisition

Age of Acquisition & Parietal Areas

- Another difference between Hearing Native vs. Late Learners is N250 topography
- Evident at posterior temporal and parietal sites in Hearing Native Signers
- Barely evident over parietal sites in Hearing Late Learners
- Early exposure to ASL leads to recruitment of RH parietal areas important for perception of motion, space & faces

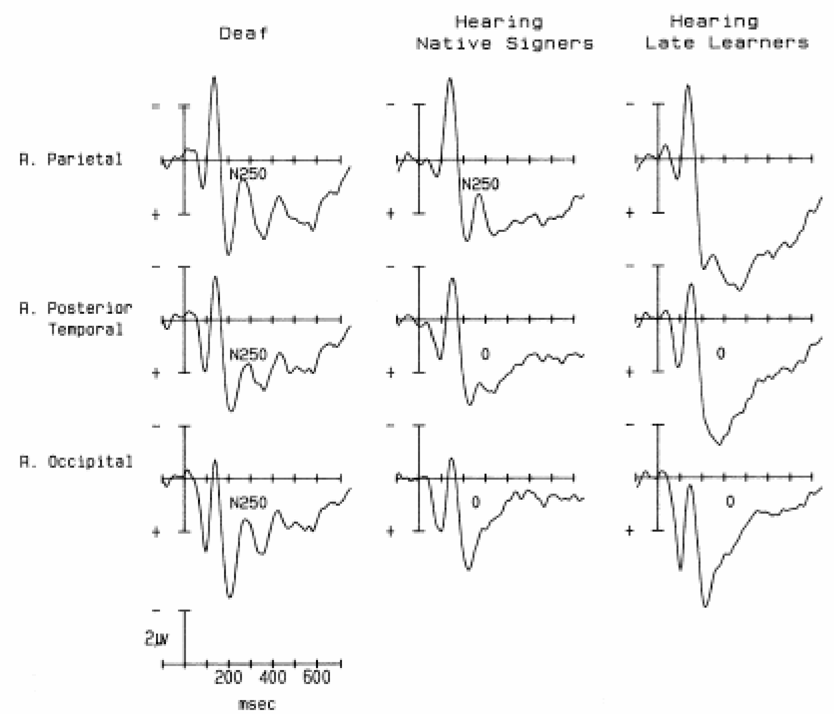


FIG. 5. ERPs to closed class signs in ASL sentences from 10 deaf and 10 hearing native signers and 10 late learners of ASL. Recordings from parietal, posterior temporal and occipital areas of the right hemisphere.

Linguistic Knowledge

- N250 present at frontal sites only in hearing nonsigners
- N250 not modulated by word class in hearing nonsigners
- N400 (suprisingly) modulated by word class
  - Due to repetition of CC but not OC words?
- Any other suggestions for why this happened?

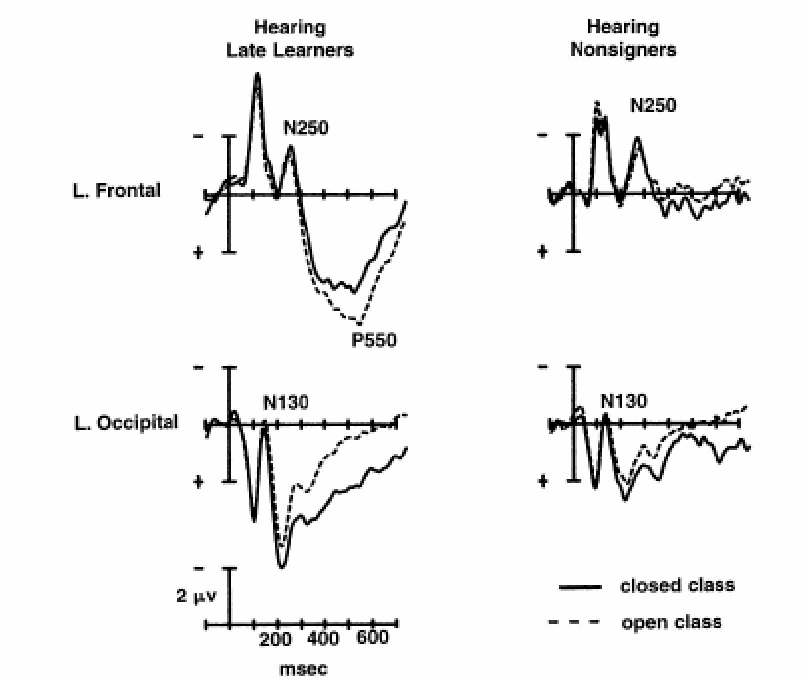


FIG. 6. ERPs to open and closed class signs in ASL sentences averaged across 10 hearing late learners of ASL and 8 hearing subjects who never learned ASL. Recordings from left frontal and occipital areas.

N400 ASL Congruity Effects

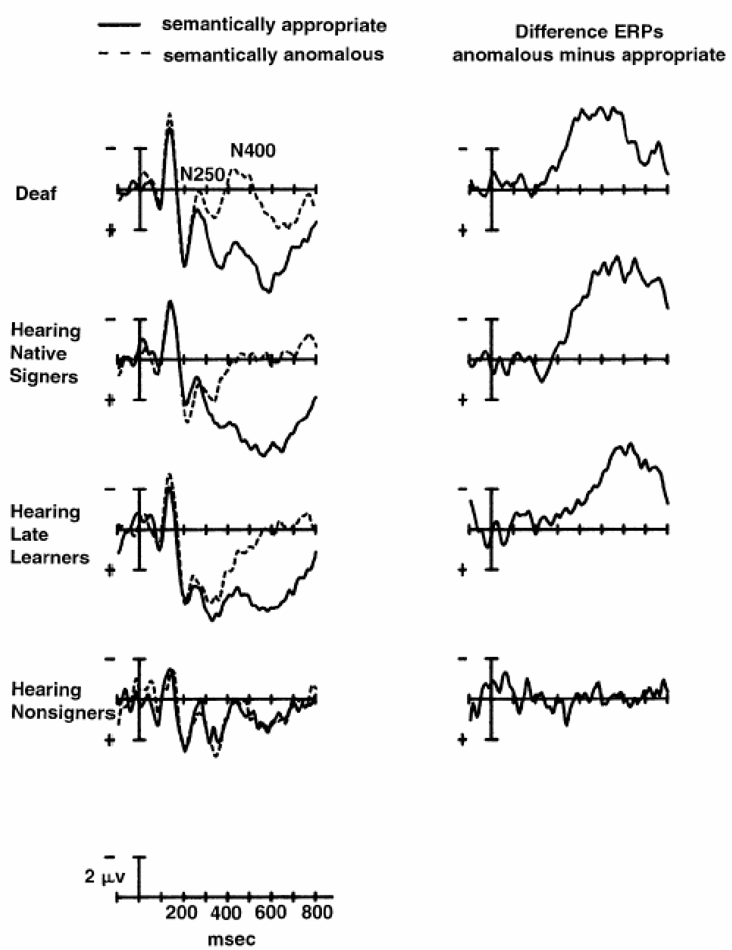


FIG. 7. ERPs from 10 deaf and 10 hearing native signers, 9 hearing late learners of ASL and 8 hearing subjects who did not know ASL. Left: Responses to final signs of ASL sentences that were either semantically appropriate or anomalous. Right: Difference ERPs formed by subtracting ERPs to semantically appropriate signs from semantically anomalous signs. Recordings are from right parietal electrode.

- Deaf
  - N250 & N400 effect
- Hearing Native
  - N400 effect
- Hearing Late Learners
  - N400 effect
- Hearing Nonsigners
  - No N400 effect
- Why is the N400 more similar across groups than the N250?