




**What do sign languages reveal about human language?**

Zed Sevcikova Sehyr  
[zsevcikova@mail.sdsu.edu](mailto:zsevcikova@mail.sdsu.edu)



## Aims

- Sign language structure (briefly)
- Raise questions about language universals and the nature of human language
- Highlight importance of sign language research
- Review some key concepts and studies in sign language research

## Overview

1. Sign language as a system: the structure of sign languages (phonology, morphology)
2. Questions raised by sign language research
  1. Is meaning conveyed independently of form in sign languages?
  2. Are brain networks shaped differently for sign language?
  3. The role of short-term memory for reading and fingerspelling in deaf readers



## PART I: The structure of sign language

## What is language?



- Language ≠ speech
- System of conventional (agreed) symbols shared by members of community
- Changes overtime
- Communicates abstract concepts / emotions
- Culturally transmitted
- Open-ended and combinatoric: express infinite number of meanings by recombination of basic units




## Sign language


- Emerges from a community of deaf people
- Governed by a system of rules: word formation, lexical creation
- Are not derived from spoken languages: sentence structure is independent of the surrounding spoken language(s)
- Other forms of signed systems (e.g. SEE – Signed Exact English) violate constraints found in natural sign languages

### Sign languages and language variation


American Sign Language (ASL)



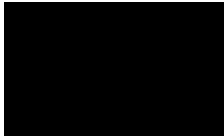
British Sign Language (BSL)



Black ASL (Texas) (regional variation)



Irish Sign Language (gender variation)



### The foundations of language (phonology)

m æ t = mat  
ʃ i: p = sheep

IPA CHART  
IPA SYMBOLS

| VOWELS |   |    |    |  |  | DIPHTHONGS |    |    |  |
|--------|---|----|----|--|--|------------|----|----|--|
| i      | ɪ | ʊ  | u  |  |  | ɔɪ         | eɪ |    |  |
| e      | ə | ɜ: | ɔ: |  |  | ʊə         | ɔɪ | əʊ |  |
| æ      | ʌ | ɑ: | ɒ  |  |  | ɛə         | aɪ | ɒʊ |  |


CONSONANTS

|   |   |   |   |    |    |   |   |
|---|---|---|---|----|----|---|---|
| p | b | t | d | tʃ | dʒ | k | g |
| f | v | θ | ð | s  | z  | ʃ | ʒ |
| m | n | ŋ | h | l  | r  | w | j |


- A sublexical level of structure consisting of patterns of meaningless sounds
- Phonology of a sound-less language?

### Sign language phonology






**Handshape**



**Location**



**Movement**

FATHER FOOTSTEP THINK PLEASE SUMMER UGLY DRY

COFFEE WORK YEAR SORRY

Fox (2007)

### Spoken & signed languages contain:

- A meaningless, discrete, finite, and systematic sub-lexical level of structure (alterations are rule-governed, cross-linguistic similarities)
- Features organized hierarchically; these cluster into categories that correspond to their articulators

### Research on sign language phonology shows that:


1. There are universal properties of phonological organisation in natural languages in both auditory-oral and visual-manual modalities
2. There are substantial areas in which the physical production and perception systems mold the structure of spoken and signed languages

### Word formation (morphology): spoken languages

- Morpheme = smallest unit of meaning, e.g. *cat*, *fire*, *walk*
- Common word formation processes:
  - compounding (*fire + wall*, *cat + walk*)
  - inflecting (*walk -ed*, *walk -er*, *walk -s*, *walk -ing*)
  - borrowing (*hamster* (Ger.), *carpet* (It.), *ballet* (Fr.))


### Word formation in sign languages: inflection

**Negative zero suffix:**




SEE + ZERO = 'not see at all'

**Agentive suffix:**




TEACH + AGENTIVE = 'teacher'



DRIVE + AGENTIVE = 'driver'

### Word formation in sign languages: compounding




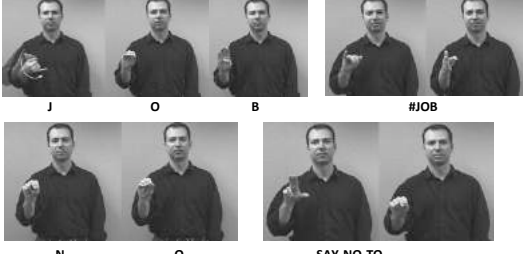
RED FLOW → BLOOD



KNOW STAY → REMEMBER

### Fingerspelled loan signs

- Borrowing from a spoken language via orthography:





J O B #JOB


N O SAY-NO-TO

### Non-manual morphemes

ASL adverbial facial expressions




MM "easily" CS "recently" TH "carelessly" INT "intense" PUFF "a lot" PS "smoothly"




mm RUN "run easily" PUFF WRITE "write easily"

### Depicting constructions

**Handling:** handshape represents how objects were handled



**Entity:** handshape represents an object (part)



*Sevcikova & Cormier (submitted)*

### Signs and gestures can look very similar

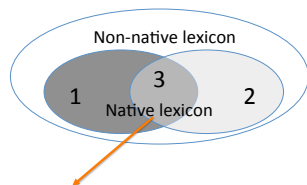
'unscrew a jar lid'



Non-signer BSL signer

non-conventional ← → conventional

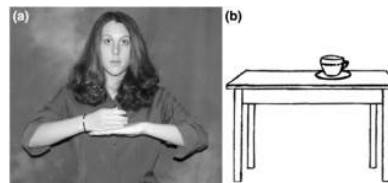
## Sign language lexicon



- (1) Fingerspelled loan signs, e.g. JOB, FIX, SAY-NO-TO
- (2) Depicting signs, e.g. VEHICLE, UPRIGHT-ENTITY
- (3) Lexical signs, e.g. FATHER, COFFEE, SUMMER

*Brentari & Padden (2001)*

## Using space to describe space

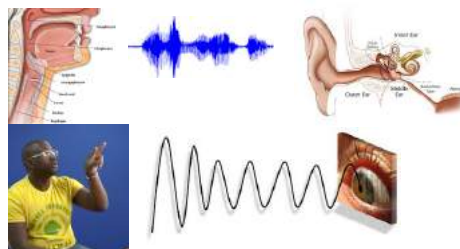


- Signing space is used to indicate the position of referents in real space / with respect to other referents
- Simultaneous expression of information!

## Sequential vs. simultaneous organization

- Temporal constraints on linear production: The tongue is faster than the hands
- Different strengths of auditory and visual systems
- Working memory constraints on language processing:
  - Linguistic information must be maintained in memory when understanding language in real time
  - Information fades quickly such that longer words or phrases are more easily forgotten

## How are aspects of the linguistic structure shaped by the modality of input / output?



## Why do we research sign language?

- What is unique to all human languages?
  - what aspects of the linguistic structure are universal to all languages
- Contribute to existing theories of language
  - theories must account for both signed and spoken language data

One human language or two?



PART II:  
Questions raised by sign language research

### Questions raised by sign language research

- (1) Is meaning conveyed independently of form in sign languages?
- (2) Are brain networks shaped differently for sign language?
- (3) The role of short-term memory for reading and fingerspelling in deaf readers

### Questions raised by sign language research

- (1) Is meaning conveyed independently of form in sign languages?
- (2) Are brain networks shaped differently for sign language?
- (3) The role of short-term memory for reading and fingerspelling in deaf readers

### (1) Form vs. meaning: iconicity

- The form of certain ASL signs reflects their meaning:



Very few words in English actually resemble their meaning (e.g. onomatopoeia?)

### Meaning is independent from form in spoken languages

- Tip-of-the-tongue (TOT) state:
  - you retrieve semantics (you know the word)
  - you fail to retrieve the word (phonological form)



- Speakers retrieve partial information about the word (e.g. word onset)

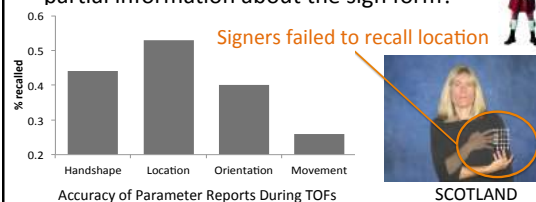
### Are semantic and form representations the same for sign language?

- If so, signers should not experience the equivalent of a Tip-of-the-tongue (TOT)?
- **But they do.** In a diary study, ASL signers reported the feeling of knowing a sign, but not being able to produce it.

Thompson, Emmorey, & Gollan (2005)

### *I know it starts with...*

- TOF elicitation study: Do signers recall partial information about the sign form?



- Sign phonological onsets were most often recalled, rather than iconic features

Thompson, Emmorey, & Gollan (2005)

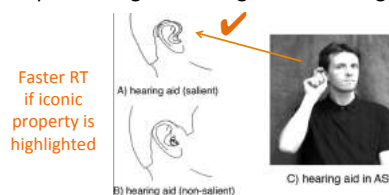
### Is meaning conveyed independently of form in sign languages?

- Yes
- Sign language form can be retrieved independently of meaning (iconicity)
- Sign languages, just like spoken languages, represent meaning independently of form

But! Iconicity is not completely ignored in sign language processing.

### The role of iconicity in sign language: semantic decision

- A picture–sign matching task: meaning of BSL sign?



- Iconic links facilitate lexical retrieval: access to meaning is required

Thompson, Vinson, & Vigliocco (2009)

### The role of iconicity in sign language: phonological decision

- Phonological decision task: is the handshape curved or straight?



- Semantic links interfere with retrieval when access to meaning is not required

Thompson, Vinson, & Vigliocco (2010)

### Form vs. meaning: iconicity

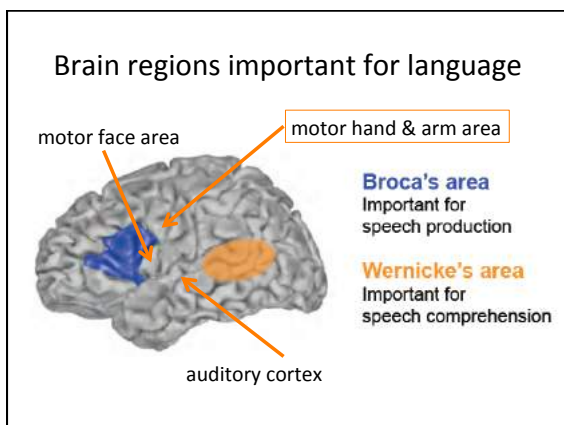
- Signed languages can incorporate (degrees of) iconicity for individual form-meaning mappings while still maintaining arbitrariness
- Research continues to establish the role of iconicity in sign language, e.g. 'iconicity matters' for novice learners (e.g. Baus, Carreiras, & Emmorey, 2012)

### Questions raised by sign language research

- (1) Is meaning conveyed independently of form in sign languages?
- (2) Are brain networks shaped differently for sign language?
- (3) The role of short-term memory for reading and fingerspelling in deaf readers

### (2) Are brain networks shaped differently for sign language?

- Does it matter if language is spoken or signed?
- Does the brain distinguish between sign language and gesture?
- Does the modality of linguistic expression impact the brain bases for spatial language?



### Does it matter if language is spoken or signed?

- Broca's area is equally active for sign & word production (various PET studies)
- Activation in this area is not tied to speech production
- Wernicke's area is active for sign perception
- Not tied to auditory speech processing

Emmorey, Mehta, & Grabowski (2007)

Emmorey et al. (2011), MacSweeney et al. (2002)

### Does it matter if language is spoken or signed?

- Short answer: **No**
- Long answer: same brain regions engage differentially for signed and spoken languages...

### Does the brain distinguish between signs and gesture?

- ASL verbs resemble pantomime:

SCRUB

DRINK

ASL: form is determined by phonological specifications stored in the lexicon (HS, LOC)

Gesture: form is determined by salient properties of objects or how a person handles them

### Does the brain distinguish between signs and gesture?

Left superior parietal lobule (SPL) is activated during pantomimed actions (Choi et al. 2001)

PARIETAL LOBE

If...

- Signs pattern like gestures, greater activation in SPL is found;
- Signs pattern like spoken words, activation in Broca's area is found

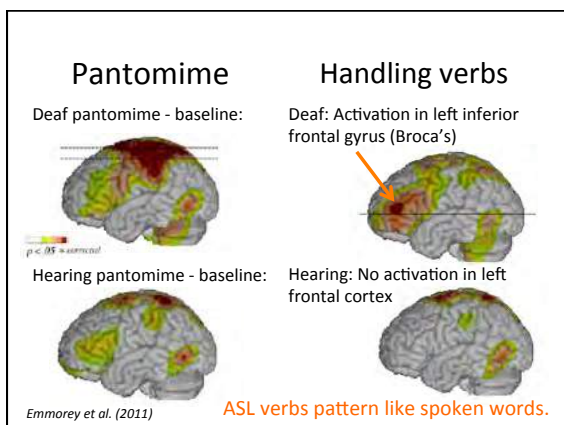
Emmorey et al. (2011)

### Production of ASL verbs vs. pantomime gestures (PET study)

- ASL signers: produce a verb associated with a pictured object (verb generation)
- ASL signers and non-signers: show how you use a pictured object (pantomime generation)

ASL sign contains a handling component

No handling component

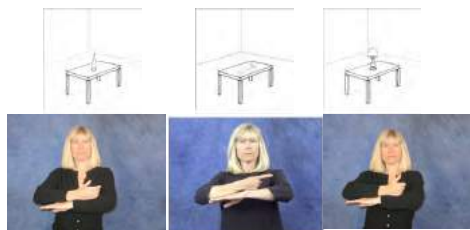


### Does the brain distinguish between signs and gesture?

- Yes
- Signs: left inferior frontal cortex (assists in lexical search and retrieval)
- Pantomime: bilateral superior parietal cortex (assists action planning and motor control)

### Does the modality of linguistic expression impact the brain bases for spatial language?

Task: produce a classifier construction for **the object**



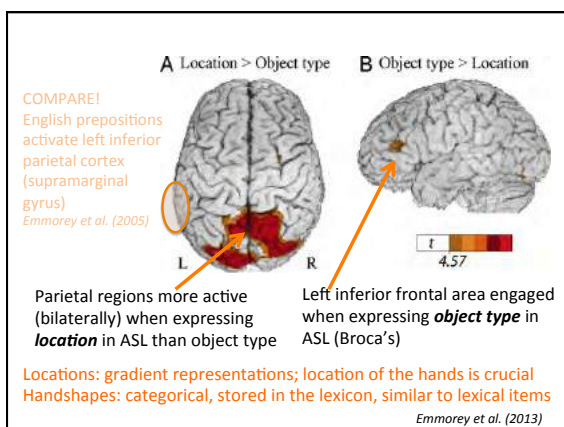
Emmorey et al. (2013)

### Does the modality of linguistic expression impact the brain bases for spatial language?

Task: produce a classifier construction for the object **location**



Emmorey et al. (2013)



### Does the modality of linguistic expression impact the brain bases for spatial language?

- Yes
- In sign language, spatial representations map onto a 'body-centered' representations via visuomotor transformation.
- Locations/movements, unlike handshapes, are not retrieved as morphemes via left hemisphere language regions



### Questions raised by sign language research

- (1) Is meaning conveyed independently of form in sign languages?
- (2) Are brain networks shaped differently for sign language?
- (3) The role of short-term memory for reading and fingerspelling in deaf readers

### Effects of sign language on working memory

- ASL signers store and maintain abstract linguistic representations (visuo-spatial rather than sound-based)
- Ramifications for e.g. lexical retrieval or short-term memory, e.g. during reading

### Short term memory (STM)

- Working memory supports the ability to maintain and manipulate linguistic representations
- What are the mechanisms that support retention and rehearsal within visuo-spatial WM?

### The Phonological Loop

- Temporary storage and rehearsal of information
- Words stored as speech-based representations

Evidence from immediate serial recall: similar words are harder to recall than distinctive words

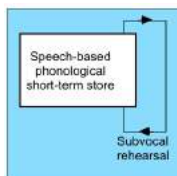
|                   |                      |
|-------------------|----------------------|
| SIMILAR --> HARD? | DISSIMILAR --> EASY? |
| blue              | king                 |
| chew              | farm                 |
| due               | tax                  |
| jew               | bug                  |

### The Phonological Loop

- Temporary storage and rehearsal of information
- Words stored as speech-based representations

Phonological similarity effect for printed words!

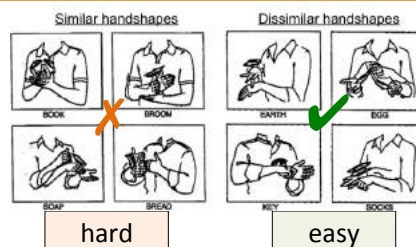
|                  |                     |
|------------------|---------------------|
| SIMILAR --> HARD | DISSIMILAR --> EASY |
| blue             | king                |
| chew             | farm                |
| due              | tax                 |
| jew              | bug                 |



Baddeley (1986)

### Is there a similarity effect for ASL signs?

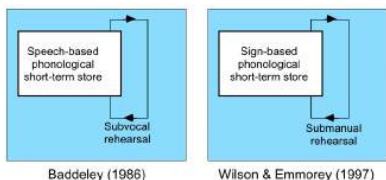
Evidence from immediate serial recall of ASL signs: are similar signs harder to recall than distinctive signs?



Wilson & Emmorey (1997)

### Sign-based phonological loop

- A sign-based mechanism used as a basis for representing linguistic material in STM
- Rehearsal of linguistic information need not be sound based



Baddeley (1986)

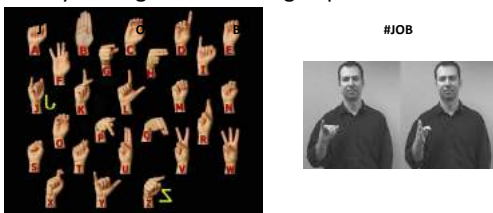
Wilson & Emmorey (1997)

### Short-term memory for printed English words

- For hearing English speakers, printed words are re-coded into a phonological code in short-term memory (STM)
- Evidence for phonological (speech-based) coding for deaf readers has been mixed (e.g. Conrad, 1979)
- Implications for reading skills and literacy in deaf readers

### Short-term memory for fingerspelled words

- Fingerspelling (FS) provides a manual system for representing English orthography
- Many ASL signs contain fingerspelled letters



### Serial recall study with print and FS

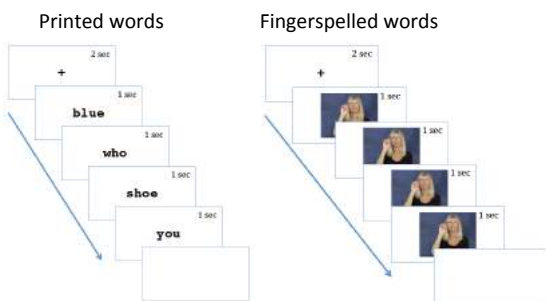
- Do deaf ASL signers re-code **printed words** into a phonological (speech-based) code
- Do deaf ASL signers re-code **fingerspelled words** into a phonological code?

| Similar: | Dissimilar: |
|----------|-------------|
| blue     | king        |
| chew     | farm        |
| due      | tax         |
| jew      | bug         |
| shoe     | some        |
| two      | with        |
| who      | cry         |
| you      | that        |

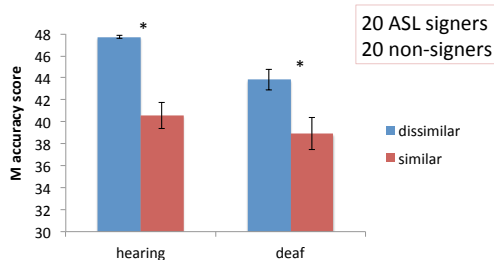
phonological similarity effect?

Sevcikova & Emmorey (in prep)

### Words were presented as print or FS

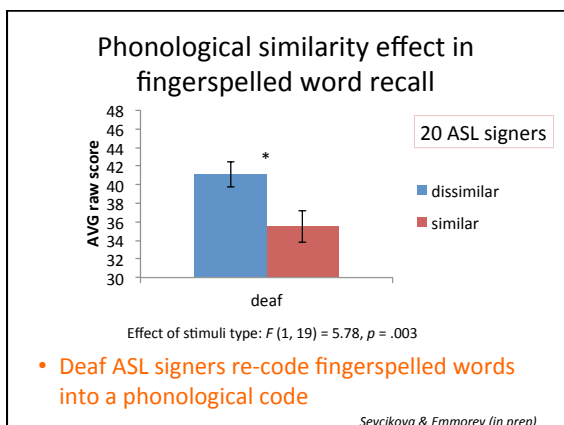


### Phonological similarity effect in printed word recall



- Deaf ASL signers re-code printed words into a phonological code, similarly to hearing non-signers

Sevcikova & Emmorey (in prep)



### Short-term memory (STM) for print and fingerspelling

- Deaf readers maintain and rehearse printed words in STM using a phonological (speech-based) code
- Fingerspelling is re-coded into a phonological (speech-based) code for short-term recall and rehearsal
- Speech-based code may be well-suited for rehearsal of temporal order information in STM

### Conclusions: why study sign language?

- Sign language exhibits the same functional properties as spoken languages
- There are universal principles that govern all human languages (spoken / signed)
- Sign languages provide unique insights into the nature of language itself
  - what properties are shared by all languages
  - what properties are specific to the visual-manual modality

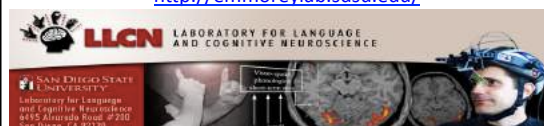
### Come and visit our lab!



Lab Members, Fall 2013

Funding: NIH  
R01 DC010997,  
DC006708

<http://emmoreylab.sdsu.edu/>



### References

See a separate word document