# Sign language linguistics
# Day 1: phonology

Jeremy Kuhn
Insitut Jean Nicod, CNRS, EHESS, ENS

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Jeremy Kuhn, Insitut Jean Nicod
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# Two modalities of language

**Spoken language**



**Sign language**



**Articulators:** Mouth/tongue          Hands/face
**Signal:** Linear, acoustic waveform   Multi-dimensional image
**Perception:** Auditory (ears)         Visual system (eyes)

# Section 1

## Getting started

# Some myths about sign language

▶ **Myth 1:** Sign language is mime.

▶ Sign languages can talk about non-tangible things: ideas, philosophy, mathematics, ...

▶ Words are arbitrary:

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American Sign Language: 'where'

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American Sign Language: 'where'

French Sign Language: 'not'

# Some myths about sign language

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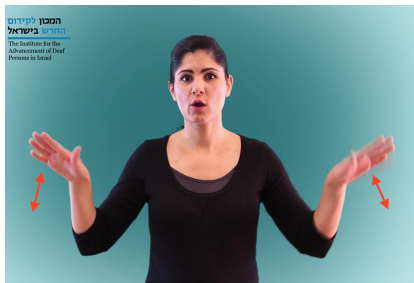American Sign Language: 'where'

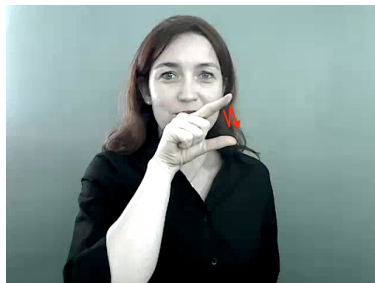French Sign Language: 'not'

Korean Sign Language: 'what'

# Some myths about sign language

- ▶ Now, there *is* iconicity in sign language...
- ▶ ...but what is iconically represented is not predictable.

BIRD



Israeli Sign Language



American Sign Language

# Some myths about sign language

▶ **Myth 2:** There is one sign language.



Dr. Peter Hauser (right) presenting in ASL at TISLR 11, simultaneously being translated into English, British Sign Language (left), and various other sign languages (across the bottom of the stage).

# Some myths about sign language

From airbnb.com:

# Some myths about sign language

▶ **Myth 3**: The grammar of a sign language depends on the grammar of the spoken language.

# Some myths about sign language

▶ **Myth 3:** The grammar of a sign language depends on the grammar of the spoken language.

▶ French:
Jean est arrivé après que Marie est parti.

▶ French Sign Language:
MARIE LEAVE AFTER, JEAN ENTER.

'Jean arrived after Marie left.'

Section 2

# A bit of history

# A brief history of ASL

- *Earlier:* American SL to British SL interpreting.
  - Two different languages!
- *In fact:* ASL is descended from French Sign Language (LSF), not BSL.

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- *Earlier:* American SL to British SL interpreting.
    - Two different languages!
- *In fact:* ASL is descended from French Sign Language (LSF), not BSL.
- Why?

# A brief history of ASL

▶ In the early 1800s, Thomas Gallaudet wanted to establish a school for the Deaf in the US.

▶ First went to England, which used 'oralist' method.

  ▶ Unwilling to share methods. Why? Proprietary secrets.

▶ Then went to France.

  ▶ A strong school for the Deaf, founded in 1755 by the Abbé de l'Epée, taught children using sign language.
  ▶ A Deaf instructor at the school, Laurent Clerc, agreed to return to the US with Gallaudet.

# A brief history of ASL

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  ▶ All instruction is in ASL.
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▶ By the way, there is now a university for the Deaf in the United States.

  ▶ All instruction is in ASL.
  ▶ This is the only university of its kind in the world
  ▶ Its name: Gallaudet University.

# Deaf history, more generally

Notice:

▶ The history of ASL, and thus, of the American Deaf population, is highly dependent on rather arbitrary sociohistorical facts, and in particular, to the opinions of hearing people about how best to educate the deaf.

A more unfortunate story:

▶ In 1880, an international congress met in Milan.
▶ Goal: best educational practices for the deaf.

# The Congress of Milan

▶ At this time, there were two dominant philosophies:

  ▶ Sign language-based : children can learn best in a
    language that they can perceive
  ▶ The oralist method : children should be prevented from
    signing, or they won't learn spoken language.

▶ Through politics and rhetoric, the oralist camp made a
  convincing show at the Congress of Milan.

▶ *The result:* the oralist method was adopted as the
  standard teaching philosophy throughout all of Europe.

# Sign language vs. oralism

Which method *is* actually better?

▶ The oralist hypothesis: learning sign language inhibits spoken language acquisition.

▶ How to test? Language assessments of the two groups.

▶ Confounding factors:

  ▶ Language input at home (which one?), cochlear implants, oralist vs. sign language pedagogy

▶ Davidson et al. (2013):
  'We conclude that natural sign language input does no harm and may mitigate negative effects of early auditory deprivation for spoken language development.'

# The result

▶ The oralist tradition was implemented in many countries of Europe for 100 years. Until 1980!

▶ In France, where sign language had had a strong tradition, LSF was suppressed, yielding fewer native speakers, and a much more fragmented language.

▶ Around 1980, an LSF 'renaissance,' with Deaf signers taking ownership of their language.

# In short...

▶ Sign language is a **natural human language**.

    ▶ Unique grammars

    ▶ Unique histories

▶ We see the same grammatical patterns that we see in spoken language.

    ▶ Syntax, semantics, morphology, .... even phonology!

    ▶ **Conclusion:** the same underlying cognitive system.

▶ But, several places where 'modality matters'.

    ▶ What can you do with signs that you can't with speech?

# Sign language is unique

▶ The **visual-spatial channel** of sign language results in some unique properties:

  1. **Simultaneity**
  2. **Use of space**
  3. **Iconicity**

▶ Looking at two different modalities gives us a richer perspective on the deep properties of language.

# Section 3

# Phonology

# Sign language phonology?

phono    +    logy

# Sign language phonology?

phono    +    logy
'sound'          'study'

# Phonetics vs. phonology

**Phonetics:**
the study of the systems used to physically produce and
perceive sounds

**Phonology:**
the abstract combinatorial system that manipulates
meaningless units

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# Phonetics vs. phonology

**Phonetics:**
the study of the systems used to physically produce and
perceive sounds or signs

▶ This will depend (in part) on the modality.

**Phonology:**
the abstract combinatorial system that manipulates
meaningless units

▶ *Claim:* This depends less on the modality.

# Duality of patterning

*Phonological level:* combination of meaningless units



cat             act             tack

*Syntactic level:* combination of meaningful units

John saw Mary            Mary saw John

# Phonology

1. Categorical perception of continuous signals

$$ba \longleftrightarrow pa$$

2. Combinatorial rules that target classes of sounds

*Japanese:*            {i, u} –> voiceless

# Overview

*Today's goal for sign language:*

1. Identify phonemic inventory.
2. Identify natural classes/features.
3. Describe rules.

Section 4

# Phonemic inventory

# Basics of sign language phonology

Who wants to play a game?

# Basics of sign language phonology

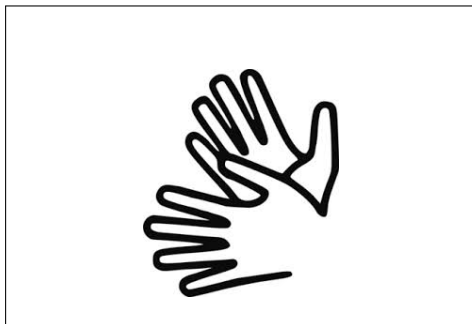Who wants to play a game?



LSF: 'hearing'

# Basics of sign language phonology

Who wants to play a game?

# Basics of sign language phonology

Who wants to play a game?



ASL: 'hotel'

# Basics of sign language phonology

What information did you have to communicate?

# Parameters of SL phonology

**Four parameters:**

- ▶ Handshape
- ▶ Movement
- ▶ Orientation
- ▶ Location

# Parameters of SL phonology

▶ Phonemes are phonological units whose combination generates words/signs

▶ Formational parameters are an easy way to classify those units. Just like spoken language phonemes are organized in vowels and consonants, SL phonemes are organized in parameters

# Parameters of SL phonology

- ▶ Phonemes in spoken languages
    - ▶ / i /, / ε / ... are phonemes in the class of vowels
    - ▶ / g /, / ŋ / ... are phonemes in the class of consonants

- ▶ Phonemes in SL
    - ▶ / F /, / B / ... are phonemes in the class of handshapes
    - ▶ / → /, / ○ / ... are phonemes in the class of movements

# Contrastive phonemes

▶ Are these categories relevant to phonology?

▶ E.g., spoken language:

  ▶ Japanese: no contrast between l and r
  ▶ English: two-way voicing distinction: b vs. p
  ▶ Thai: three-way voicing distinction: b vs. p vs. $p^h$

▶ In English, the b/p distinction is *contrastive*.
  The $p/p^h$ distinction is not.

▶ How do we know?

# Minimal pairs

A **minimal pair** is a pair of phonological forms, differing with respect to a single phoneme, that have different meanings.
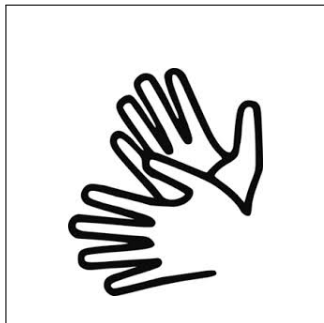
mat        vs.        bat

# Parameters of SL phonology

**Four parameters:**

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- ▶ Movement
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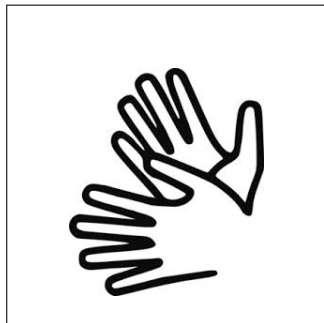
Are these parameters contrastive?

# Minimal pairs in Sign Language



(1)    FULL                    LIS    (2)    FAMILY                    LIS

# FULL vs. FAMILY

They share:

▶ **Place of articulation**:

▶ **Orientation**:

▶ **Handshape**:

They differ in terms of:

# FULL vs. FAMILY

They share:

▶ **Place of articulation**: The non-dominant hand

▶ **Orientation**:

▶ **Handshape**:

They differ in terms of:

# FULL vs. FAMILY

They share:

- ▶ **Place of articulation**: The non-dominant hand

- ▶ **Orientation**: Palm down

- ▶ **Handshape**:

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They differ in terms of:

▶ **Movement**: straight vs. circular

# FULL vs. FAMILY

They share:

▶ **Place of articulation**: The non-dominant hand

▶ **Orientation**: Palm down

▶ **Handshape**: 

They differ in terms of:

▶ **Movement**: straight vs. circular
▶ **Meaning**

# Handshape
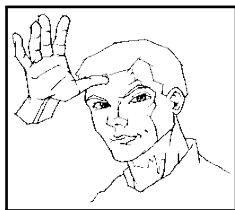
# Minimal pairs: handshape

SORRY $\sim$ PLEASE

RED $\sim$ CUTE $\sim$ SWEET

TWIN $\sim$ RESTAURANT $\sim$ ISRAEL

# Minimal pair: orientation

BALANCE $\sim$ MAYBE

STAR $\sim$ SOCKS

# Minimal pairs: location
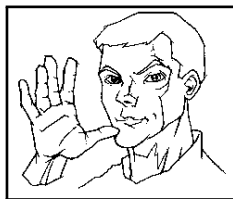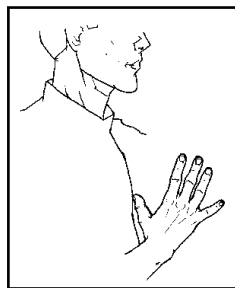


FATHER     $\sim$     MOTHER     $\sim$     FINE

TIME $\sim$ FINLAND

DRY $\sim$ SUMMER $\sim$ UGLY

# Minimal pair: motion

SCHOOL $\sim$ PAPER

COFFEE $\sim$ MAKE

CHOCOLATE $\sim$ CHURCH $\sim$ COMPUTER

# Practice: minimal pairs

LUCKY $\sim$ SMART

SCIENCE $\sim$ CHEMISTRY

BROOKLYN $\sim$ BOSTON $\sim$ BLUE
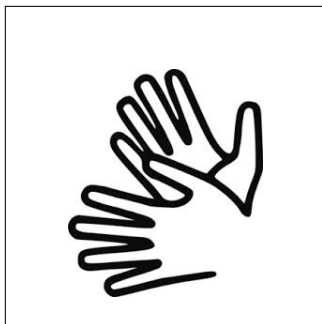
MARRY $\sim$ PROOF

# Consider

Is this a minimal pair?

ASL:
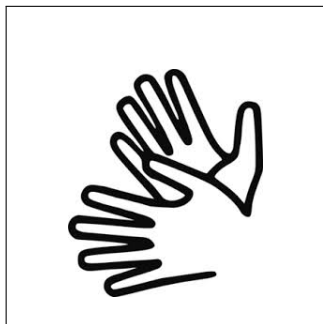


NAME                                    ROME

# Section 5

## Features

# Spoken language features

▶ Phonemes are not just an unorganized set: {a, e, i, u, ...}

▶ Rather:
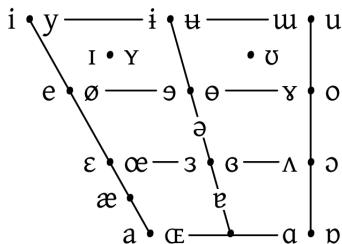


▶ What does this grid mean?

# What are phonological features?

1. Phonetic natural class
    - ▶ F1 = [front]/[back]
    - ▶ F2 = [low]/[high]

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2. Phonological natural class

# What are phonological features?

1. Phonetic natural class
   - ▶ F1 = [front]/[back]
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2. Phonological natural class
   - ▶ Hungarian vowel harmony targets [front]/[back]
   - ▶ Japanese devoicing targets [low]/[high]

# 'Minimal' pairs are relative

What it means to be minimal is relative:

▶ cat vs. bat

▶ pat vs. bat

# A small note: 'parameters' as classes

▶ Earlier, I said: parameters are classes of phonemes

  ▶ 'movement' parameter : same kind category as 'vowels'

▶ It's not surprising that the four parameters are all contrastive.

▶ It's like asking: 'are vowels constrative in this language?'

# Minimal difference vs. minimal pair

# Minimal difference vs. minimal pair



► TRAIN



► TRAIN

# Minimal difference vs. minimal pair



▶ TRAIN



▶ TRAIN

This phenomenon is **allophonic alternation/variation**.

# Cross-linguistic variation

Contrasts in one language might not exist in another.

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1. Movement (forward or back)
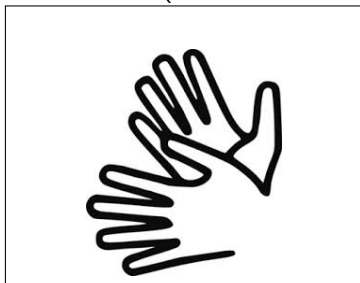


▶ ROLL



▶ SIGN

# Cross-linguistic variation

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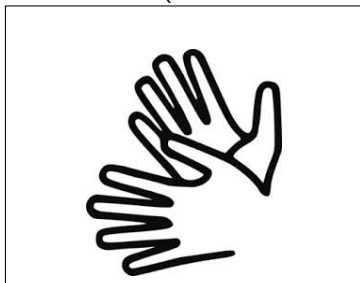


&#9654; ROLL



&#9654; SIGN

&#9654; LIS: this feature is not contrastive (only forward mov't)

# Cross-linguistic variation

Contrasts in one language may exist in another.

2. Handshape: W



▶ WORLD

# Cross-linguistic variation

Contrasts in one language may exist in another.
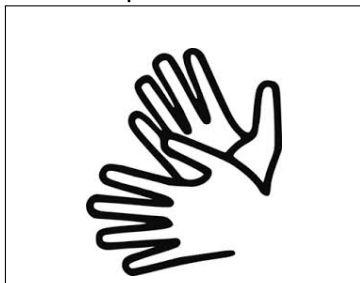
2. Handshape: W



&#9654; WORLD

&#9654; LIS: this handshape does not exist

# From Description to Theory

**At the descriptive level we have**

▶ Minimal pairs generate contrast

▶ Allophonic alternation filters some differences

**At the theoretical level**

▶ There is a mental representation level in which these things happen. This is the **Phonological Level**.

# Loan words

▶ Loan words: one window to the Phonological level

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English loan words in Korean

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English loan words in Korean

▶ English: [vaɪrəs], 'virus'

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$$\boxed{\text{Underlying representation}} \rightarrow \boxed{\text{Surface form}}$$

# Loan words

ASL loan words in LIS
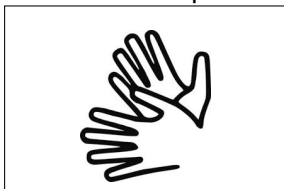
▶ ASL: 'workshop'
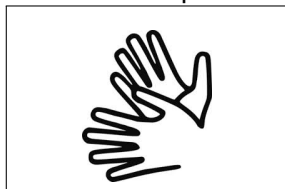


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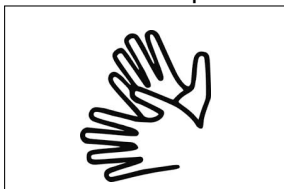
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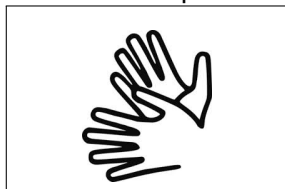


Underlying representation $\rightarrow$ Surface form

# Section 6

# Assimilation

# Assimilation in English (Review)

▶ **Assimilation** is the phonological process where one sound becomes *similar to* an adjacent segment.

▶ *Example:* nasal place assimilation in English

    ▶ interminable     $/n/ \rightarrow [n]$
        intangible
        intolerant

    ▶ impossible      $/n/ \rightarrow [m]$
        implausibe
        impolite

    ▶ inconceivable    $/n/ \rightarrow [ŋ]$
        incongruous
        incomplete

# Assimilation in English

An optional process of nasal assimilation:

▶ ɪn + kʌmplit → ɪŋkʌmplit

▶ More schematized:

| n | + | k | = | ŋ | k |
|---|---|---|---|---|---|
| [+nasal] | | [−voice] | | [+nasal] | [−voice] |
| [+coronal] | | [+velar] | | [+velar] | [+velar] |

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| [+coronal] | | [+velar] | | [+velar] | [+velar] |

▶ **Generalization:** the /n/ of 'in-' changes its place to match the following consonant.

$$/n/ \rightarrow [+\text{velar}] \ / \ \underline{\quad} \ [+\text{velar}]$$

# Assimilation in sign language

▶ Handshape assimilation in sign language:

▶ RED  +  CHOP   =    TOMATO

# Assimilation in sign language

▶ Handshape assimilation in sign language:
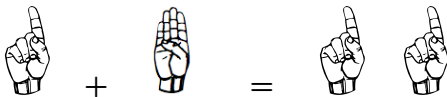
▶ RED  +  CHOP   =   TOMATO

# Assimilation in sign language

▶ Handshape assimilation in sign language:

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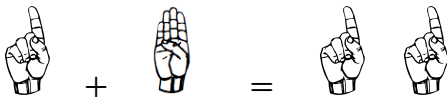


▶ Assimilation of the entire handshape.

# Handshape assimilation

▶ Partial assimilation:                          (features are approximate)

THINK        +        SELF        =        'think for yourself'

        +                =

# Handshape assimilation

▶ Partial assimilation:                          (features are approximate)

THINK         +         SELF         =         'think for yourself'

 +  =  

[+index]          [−index]          [+index]          [−index]
[−thumb]          [+thumb]          [+thumb]          [+thumb]

# Handshape assimilation

▶ Partial assimilation:                              (features are approximate)

THINK        +        SELF        =        'think for yourself'

 +  =  

[+index]        [−index]                [+index]        [−index]
[−thumb]        [+thumb]                [+thumb]        [+thumb]

# Handshape assimilation

▶ Partial assimilation: <span>(features are approximate)</span>



| THINK | + | SELF | = | 'think for yourself' | |
|---|---|---|---|---|---|
| [+index] | | [−index] | | [+index] | [−index] |
| [−thumb] | | [+thumb] | | [+thumb] | [+thumb] |

▶ A new handshape is produced!
▶ Just like [n] + [k] produced [ŋ].

# Handshape assimilation
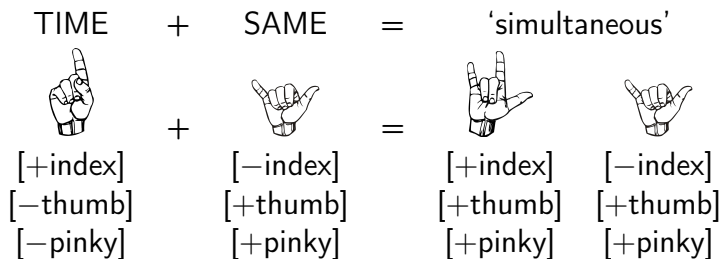
▶ Partial assimilation:

| TIME | + | SAME | = | 'simultaneous' | |
|------|---|------|---|----------------|---|



| [+index] | [−index] | [+index] | [−index] |
|----------|----------|----------|----------|
| [−thumb] | [+thumb] | [+thumb] | [+thumb] |
| [−pinky] | [+pinky] | [+pinky] | [+pinky] |

# Handshape assimilation

▶ Partial assimilation:

TIME       +       SAME       =       'simultaneous'



| [+index] | [−index] | [+index] | [−index] |
| [−thumb] | [+thumb] | [+thumb] | [+thumb] |
| [−pinky] | [+pinky] | [+pinky] | [+pinky] |

# Handshape assimilation

▶ Partial assimilation:

| TIME | + | SAME | = | 'simultaneous' | |
|------|---|------|---|----------------|--|



| [+index] | [−index] | [+index] | [−index] |
|----------|----------|----------|----------|
| [−thumb] | [+thumb] | [+thumb] | [+thumb] |
| [−pinky] | [+pinky] | [+pinky] | [+pinky] |
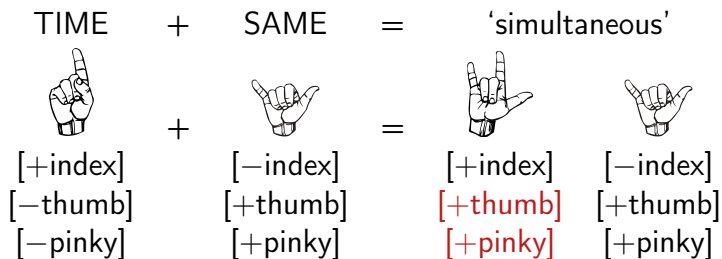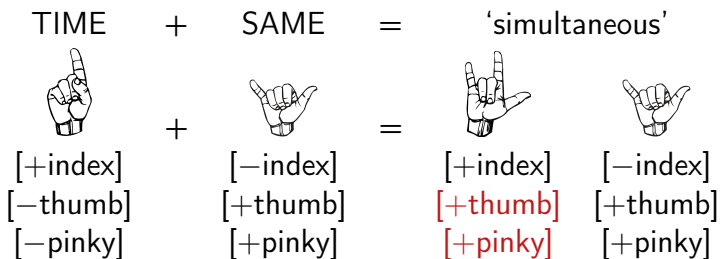
▶ Any other phonological processes going on here?

# Handshape assimilation

▶ Partial assimilation:

TIME      +      SAME      =      'simultaneous'



| [+index] | [−index] | [+index] | [−index] |
|----------|----------|----------|----------|
| [−thumb] | [+thumb] | [+thumb] | [+thumb] |
| [−pinky] | [+pinky] | [+pinky] | [+pinky] |
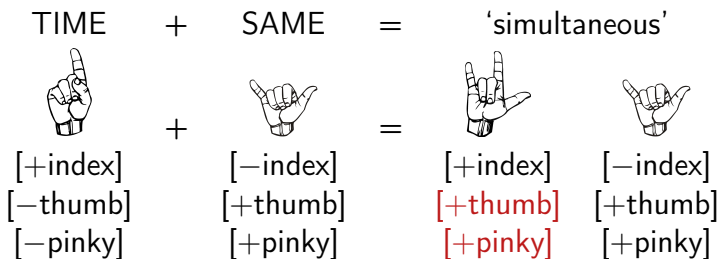
▶ Any other phonological processes going on here?
  ▶ Possible phonetic motivation?

# Handshape assimilation

▶ Like with English velars, assimilation may be optional:

▶ *Example:*
    BELIEVE (= THINK + MARRY) has two forms.

▶ We can represent the pattern as an optional rule:

Section 7

## Exercise

# 'Exercise 1: Phonology'

▶ Compare the two groups of signs: what phonological feature distinguishes them from each other?

▶ Look at the handshape of the non-dominant hand (the left hand) in each group of signs. In 'handshape.pdf', indicate all the handshapes that are attested in the non-dominant hand for each group.

▶ Compare the set of handshapes in each group.
  ▶ Qualitatively, what's the difference between them?
  ▶ Can we say that one set is a subset of the other?

Section 8

## Prosodic constraints: reduction or epenthesis?

# A phonological rule: LIS

HEAD/KNOW

Compounds/derived forms:

HEAD^EMPTY, 'stupid'

HEAD^TURNING, 'dizziness'

HEAD^POUND, 'smart'

IX-3 HEAD^DONE, 's/he knew'

Jeremy Kuhn, Insitut Jean Nicod

# What's going on?

▶ Descriptively, what's going on here?

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    ▶ HEAD            :    sign for HEAD touches head twice

    ▶ HEADˆEMPTY  :    sign for HEAD touches head once

          ...in fact, might just preserve starting location

# What's going on?

▶ Descriptively, what's going on here?

    ▶ HEAD             :     sign for HEAD touches head twice
    ▶ HEAD^EMPTY   :     sign for HEAD touches head once
           ...in fact, might just preserve starting location

▶ How can we explain it?

# Reduction hypothesis

### Hypothesis 1: Compounding induces reduction

▶ HEAD has a repeated movement in its underlying form.

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▶ HEAD has a repeated movement in its underlying form.

▶ The movement is lost because of a phonological reduction process that affects compounds.

*Analogies in spoken language:*

▶ Compounds often have phonological readjustments in spoken languages

    ▶ black bird

    ▶ blackbird

# The epenthesis hypothesis

**Hypothesis 2: Compounds let underlying form surface**

▶ The underlying form is the one that appears in the compound.

▶ I.e., in the underlying form the sign has zero movement.

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# The epenthesis hypothesis

**Hypothesis 2: Compounds let underlying form surface**

▶ The underlying form is the one that appears in the compound.

▶ I.e., in the underlying form the sign has zero movement.

▶ In the plain form, the sign has a repeated movement that is the result of insertion/epenthesis.

▶ In the compound form, insertion is not necessary.

# The epenthesis hypothesis

*Analogies in spoken language:*

Minimal word constraints (English):

- biː       bɪt       *bɪ
  'bee'     'bit'     'bih'

- deɪ       dɛt       *dɛ
  'day'     'debt'     'deh'

- kuː       kʊk       *kʊ
  'coo'     'cook'     'cooh'

A similar constraint for LIS:

- 'You must have some kind of movement.'

# Two hypotheses

▶ Two hypotheses:
  1. *Reduction* of the first member of compounds
  2. UR without movement; *epenthesis* in citation form

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▶ Notice: *in either case*, a phonological level is needed.

▶ Differences in predictions?

# Predictions

Hypothesis 1 (reduction):

▶ If there is a reduction rule, it should apply across the board to the first member of compounds.

Hypothesis 2 (epenthesis):

▶ Words can never appear without movement.

▶ But since compounds allow the underlying form to surface, there should be two classes of compounds; those that show zero movement, and those that don't.

# Compounds

A productive test case: \_\_\_^DONE (=perfect aspect)

Signs that never have movement in compounded form:

▶ HEAD, BEAT, CULTIVATE, RAIN, SWEEP

Signs that allow movement in compounded form:

▶ SEW, REPAIR, CLEAN, CRITICIZE, OPEN, WORK, PAY

# Predictions

Hypothesis 1 (reduction):

▶ If there is a reduction rule, it should apply across the board to the first member of compounds.

Hypothesis 2 (epenthesis):

▶ Words can never appear without movement.

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# Predictions

Hypothesis 1 (reduction): ✗

▶ If there is a reduction rule, it should apply across the board to the first member of compounds.

Hypothesis 2 (epenthesis): ✓

▶ Words can never appear without movement.

▶ But since compounds allow the underlying form to surface, there should be two classes of compounds; those that show zero movement, and those that don't.

Section 9

# Historical relations across sign languages

# Language families in sign langauge

How are the sign languages of the world related to each other?

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▶ Historical record.

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    ▶ *Problem:* Generally very poor records.

▶ Lexical and phonological relatedness.

    ▶ The 'comparative method' of historical linguistics.

    ▶ Phonotactic similarity

# Spoken language: the comparative method

The comparative method for spoken language:

| Italian | French | Spanish | English | Norway | Dutch | German |
|---------|--------|---------|---------|--------|-------|--------|
| torta   | tarte  | pastel  | pie     | taart  | pai   | torte  |
| albero  | arbre  | árbol   | tree    | treet  | boom  | baum   |
| casa    | maison | casa    | house   | hus    | huis  | haus   |
| cuore   | cœur   | corazón | heart   | hjerte | hart  | herz   |

# Spoken language: phonotactic similarity

**Identify the language**

https://www.youtube.com/watch?v=9xl5oi4tEVw

Icelandic        Serbian        Polish        Yoruba        Swedish

https://www.youtube.com/watch?v=jeSxC2RNSkk
Hindi        Scottish Gaelic        Tamil        German        Irish

# Sign language similarity

▶ Why not do the same for sign language?

▶ **Recent work by:**
Carlo Geraci, Natasha Abner, Jessica Lettieri, Shi Yu

# Comparative method

Geraci et al., part 1:

▶ **Woodward List.** Sign language adaptation of the Swadesh list (no body parts, etc. ...): 100 concepts.

▶ **Method.** Comparing pairs of languages.

▶ **Criterion.** If 3/4 parameters are identical then the signs are similar enough.

　　▶ Handshape, Location, Movement, Orientation

# Phonotactic similarity

▶ **Woodward list**

▶ **Feature-based** representation to annotate signs

   ▶ 55 handshape values
   ▶ 36 location values
   ▶ 8 orientation values
   ▶ 8 movement values
   ▶ 2 values: how many hands?
   ▶ 2 values: compound sign or not?
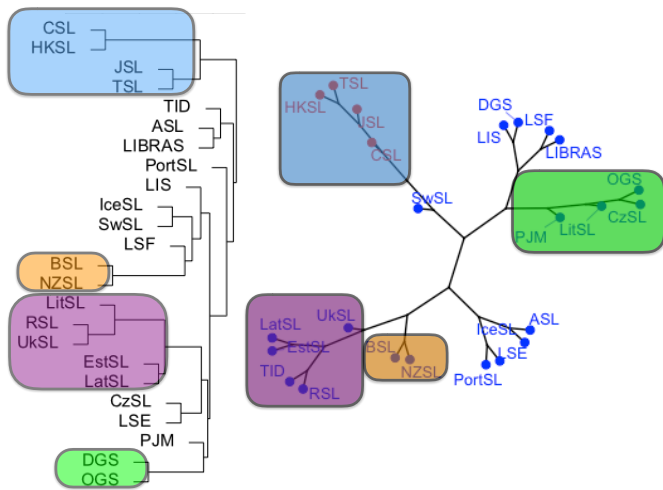
▶ **Cluster analyses** by item and by feature

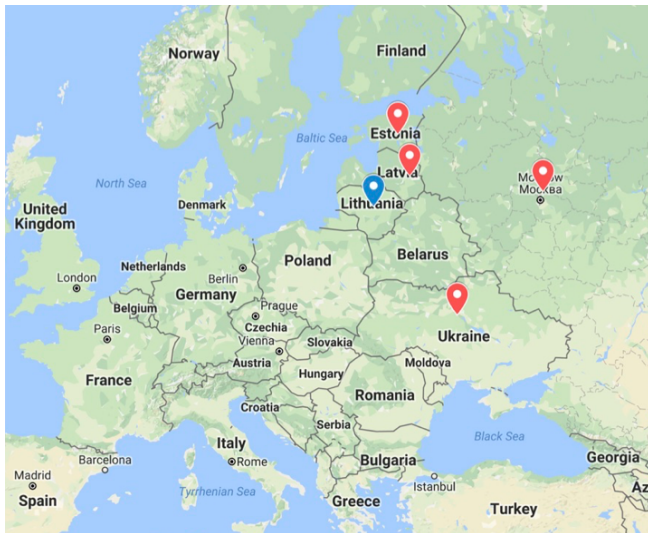# Results: Comparative method
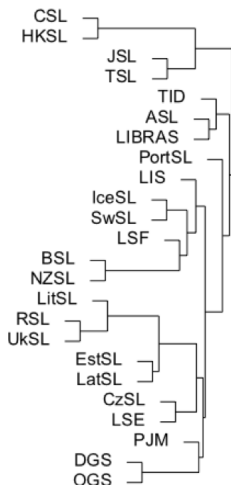
# Results: Phonotactic methods
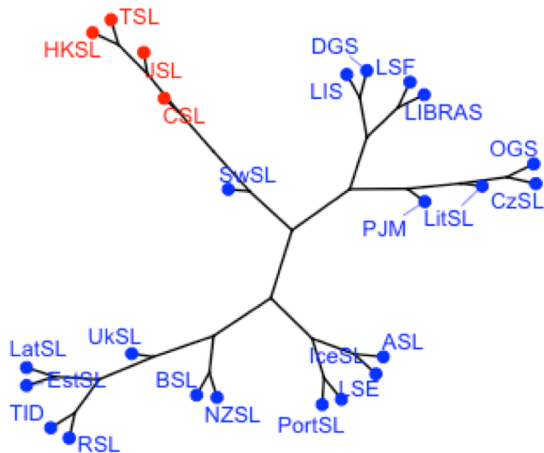
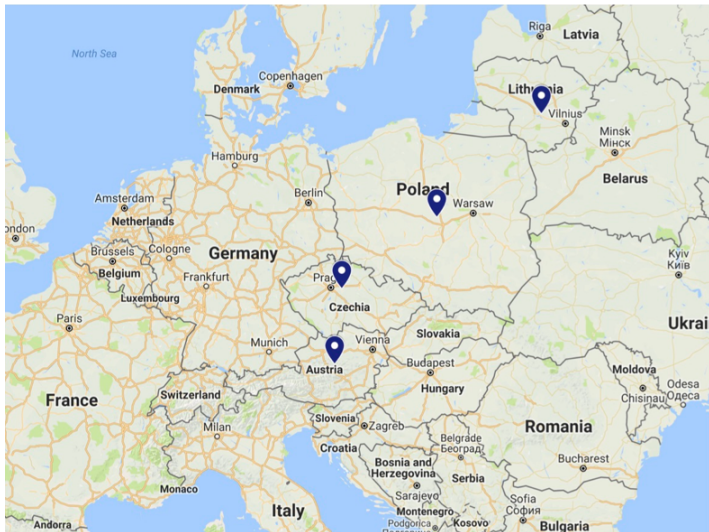# Results



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# Possible explanation for differences

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# Section 10

# Summary

# Summary

Sign languages have phonology

- ▶ Gradient signals are processed categorically.
  - ▶ Cross-linguistic variation regarding phonemic inventory
- ▶ Phonemes are sets of phonetically-grounded features.
- ▶ These features are targeted by phonological rules.
  - ▶ Assimilation (including modality-specific assimilation)
  - ▶ Epenthesis
- ▶ Lexical similarity and phonotactic constraints can be used to reconstruct historical relationships.