WHAT HANDSHAPE TELLS US ABOUT ACTIVE VERSUS INACTIVE ARTICULATORS

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Goals of this talk

1. Translate models of spoken language articulatory phonology to handshape
2. Provide an explicit method of phonetic implementation for handshape
3. Use this model to make predictions about variation in handshape
adapted from (Browman and Goldstein, 1992, pp 28)
Sign language phonology
Handshape portion from the Prosodic Model

(Brentari, 1998)
Selected fingers

- are described as the most salient fingers for a given handshape,
- are often (but not always!) extended, with other fingers (more) flexed,
- are used by many models of sign language phonology.
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There is independent evidence for their existence:

- restrictions on handshapes in signs,
- selected fingers contact the body,
- selected fingers are preserved in compounds.
Handshape portion from the Prosodic Model

(Brentari, 1998)
Handshape tract variables
Degrees of freedom

- Fixed
  - 1 DOF
  - 2 DOF

6 DOF Wrist

Fixed

Carpometacarpal (CMC)

Trapezio-metacarpal (TM)

Meta-carpo-phalangeal (MCP)

Inter-phalangeal (IP)

Distal-interphalangeal (DIP)

Proximal-interphalangeal (PIP)

Erol et al. (2005)
## The articulatory model of handshape

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<tr>
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<td>Selected fingers</td>
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<td>all</td>
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Predictions
General hypotheses

1. Because gestures are dynamic, signing does not consist of static, sequential handshapes, but rather articulator gestures which blend into each other.
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2. The hand configuration of a specific segment will vary in predictable ways based on the surrounding context.
Specific hypotheses

1. The nonselected (nonactive) fingers are more frequently the targets of coarticulatory pressure (vs. selected (active) fingers).
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1. The nonselected (nonactive) fingers are more frequently the targets of coarticulatory pressure (vs. selected (active) fingers).

2. The selected fingers are the sources of coarticulatory pressure.
Case study: BUILDING
B-U-I-L-D-I-N-G; half speed
B-U-I-L-D-I-N-G; half speed
Gestural score for B-U-I-L-D-I-N-G
Gestural score for B-U-I-L-D-I-N-G

- **B-**
- **U-**
- **I-**
- **L-**
- **D-**
- **I-**
- **N-**
- **G-**

**Extension**

**time (msec)**

0 500 1000
Gestural score for B-U-I-L-D-I-N-G
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**Time (msec):**
- 0
- 500
- 1000

**Extension:**
- Pinky
- Ring
- Middle
- Index
- Thumb

**Scores:**
- B
- U
- I
- L
- D
- I
- N
- G
Gestural score for B-U-I-L-D-I-N-G

![Gestural score graph](image)
Gestural score for B-U-I-L-D-I-N-G
Pinky extension coarticulation
Data collection

- 4 native signers, 1 early learner (4 coded so far) produced
- 600 words
- repeating each word twice
- being recorded by 2 or 3 video cameras
- recording at 60 FPS
- for a total of 21,453 letters
Pinky extension

A still image of each letter was annotated for pinky extension, defined as:

- The tip of the pinky was above the plane perpendicular to the palmar plane, at the base of the pinky finger (the MCP joint).
- The proximal interphalangeal joint (PIP) was more than half extended.
What affects the -L- handshape?

- B -  - U -  - I -  - L -  - D -  - I -  - N -  - G -
What affects the -L- handshape?

current handshape

- B-, -C-, -F-, -I-, -J-, or -Y-;
- A-, -S-, -E-, or -O-; other
What affects the -L- handshape?

**current handshape groups**

- **Extended (and selected) pinky:**
  -B-, -C-, -F-, -I-, -J-, or -Y-

- **Flexed and selected pinky:**
  -A-, -S-, -E-, or -O-

- **other**
What affects the -L- handshape?

word type
name; noun;
non-English

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-B-, -C-, -F-, -I-, -J-, or -Y-;
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**Local transition time**

**Zscore of log(time)**

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previous handshape
- B-, -C-, or -F-;
- I-, -J-, or -Y-;
other;
word boundary

current handshape
- B-, -C-, -F-, -I-, -J-, or -Y-;
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word type
name; noun;
non-English

other;
What affects the -L- handshape?

- previous handshape: -B-, -C-, or -F-; -I-, -J-, or -Y-; other; word boundary
- local transition time
- zscore of log(time)
- word type: name; noun; non-English
- following handshape: -B-, -C-, or -F-; -I-, -J-, or -Y-; other; word boundary
- current handshape: -B-, -C-, -F-, -I-, -J-, or -Y-; -A-, -S-, -E-, or -O-; other
What affects the -L- handshape?

previous/following handshape groups

Extended pinky (alone):
-Ⅰ-, -J-, or -Y-

Extended pinky (with other fingers):
-Ⅱ-, -C-, or -F-

other

Extended pinky (alone):
-Ⅰ-, -J-, or -Y-

Extended pinky (with other fingers):
-Ⅱ-, -C-, or -F-

other

word boundary
What affects the -L- handshape?

- Local transition time
- Z-score of log(time)
- Previous handshape: -B-, -C-, or -F-; -I-, -J-, or -Y-; other;
- Word boundary
- Current handshape: -B-, -C-, -F-, -I-, -J-, or -Y-; -A-, -S-, -E-, or -O-; other;
- Following handshape: -B-, -C-, or -F-; -I-, -J-, or -Y-; other;
- Word boundary
- Interaction
- Word type: name; noun; non-English
What affects the -L- handshape?

- Local transition time
- Zscore of log(time)
- Word type: name; noun; non-English

Interaction

Previous handshape:
- B-, C-, or F-;
- I-, J-, or Y-;
- Other;
- Word boundary

Current handshape:
- B-, C-, F-, I-, J-, or Y-;
- A-, S-, E-, or O-; other;
- Word boundary

Following handshape:
- B-, C-, or F-;
- I-, J-, or Y-;
- Other;
- Word boundary
Model predictions around -I-, -J-, or -Y-

![Graph showing model predictions for different letter combinations and conditioning letter position. The x-axis represents the conditioning letter position, and the y-axis represents the probability of pinky extension. The graph compares different letter combinations, with each column showing predictions for a specific letter or combination of letters.]
Model predictions around -i-, -J-, or -Y-
Model predictions around -i-, -j-, or -y-
Model predictions around -I-, -J-, or -Y-

(probability of pinky extension vs. conditioning letter position)
What's special about -A-, -S-, -E-, and -O-?

**Flexed and nonselected pinky:**
- -L- with and without pinky extension

**Flexed and selected pinky:**
- -A- and -S- have nearly no pinky extension
- -E- and -O- both are close to the edge of our coding scheme for pinky extension.
Conclusions

1. Articulatory models of speech production are generalizable to sign languages.
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I must also acknowledge the contributions of many who contributed in ways big and small:

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References II
