Outline

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  O-I-L

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

  A-C-T-I-V-I-T-Y
A basic description of fingerspelling

- Fingerspelling is a type of loanword system that makes up anywhere from 12–35% of ASL discourse (Padden, 1991; Padden and Gunsauls, 2003).
- Simplistically, fingerspelling is a set of static (except for -j- and -z-) handshake-orientation combinations strung together sequentially, where each maps to one letter in an English word.
- Many note that this description is not quite accurate (Wilcox (1992); Akamatsu (1982) &c.).
What fingerspelling looks like; full speed

data.mp4
What fingerspelling looks like; half speed

data.mp4
Broad questions

1. How do handshapes in fingerspelling vary across environments, and what is the best explanation for this variation?

2. Is it possible to divide fingerspelling cleanly into discrete segments?

Specifically, what can pinky extension in fingerspelling tell us?

Fingerspelling is an especially good phenomenon to look at handshape variation as well as segmentation because it is quick and sequential, unlike handshape in signing.
Coarticulation in sign languages

There has been much work on coarticulation in speech, however sign languages, and fingerspelling especially has been explored less:

- Cheek (2001) looks at coarticulation of pinky extension on lexical signs as a proxy for handshape generally.
- Jerde et al. (2003) mentions that there is coarticulation with respect to the pinky.
- Tyrone et al. (2010) describes some parkinsonian signers who blend letters together.
Recording specifications

- 4 native signers, 1 early leaner (2 (native) coded so far) produced 300 words
  - 100 names
  - 100 nouns
  - 100 non-English words
- repeating each word twice
- being recorded by 2 or 3 video cameras
- recording at 60 FPS
- for a total of 8,115 apogees
**Apogee detection**

We used a combination of human coders, algorithmic averaging, forced alignment, and verification to code timing data.

**Apogees**

- are the point where the hand reached a target handshape and orientation, or
- the point of minimum instantaneous velocity of all of the articulators, but
- crucially are not defined as the canonical form.

(Keane et al., 2011)
Pinky extension annotation

Feature annotation

- We extracted still images from the data that has been coded.
- We hand coded pinky extension for all apogees.
- There are total of 4,741 word medial apogees annotated.

Two goals

- A simple task with only a minimal amount of training necessary
- A metric that would apply regardless of how canonical a given handshape was
Pinky extension

- 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.

Pinky extension

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Handshape variation

Expected (bcfijy):
- -ext: 0
- +ext: 500
- 1000
- 1500
- 2000
- 2500
- 3000
- 3500

Unexpected (others):
- -ext: 1000
- +ext: 3000

Handshape variant
Handshape variation

Expected (bfijy)

- ext: 0
+ ext: 500

Unexpected (others)

- ext: 3500
+ ext: 3000
Conditioning variables

**B-U-I-L-D-I-N-G; full speed**

building.mp4
B-U-I-L-D-I-N-G; half speed
What affects the -L- handshape?

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

- word type
  - name, noun, non-English

- signer
  - s1, s2
What affects the -L- handshape?

- word type
  - name, noun, non-English

- signer
  - s1, s2

- previous handshape
What affects the -L- handshape?

word type
name, noun, non-English

signer
s1, s2

previous handshape

previous transition time
What affects the -L- handshape?

- word type
  - name, noun, non-English
- signer
  - s1, s2
- previous handshape
- following handshape
- previous transition time
What affects the -L- handshape?

- word type
  - name, noun, non-English

- signer
  - s1, s2

- previous handshape → following handshape

- previous transition time → following transition time

- conditioning variables
  - previous handshape
  - previous transition time
  - following handshape
  - following transition time

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

word type
name, noun, non-English

signer
s1, s2

previous handshape

following handshape

previous transition time

following transition time

Conditioning variables
What affects the -D- handshape?

- word type
  - name, noun, non-English
- signer
  - s1, s2
- previous handshape
- following handshape
- previous transition time
- following transition time
Specific questions – coarticulation

1. Does the extension of the pinky finger spread to neighboring apogees?
3. Do all handshapes with an extended pinky condition coarticulation equally?
4. Is this coarticulation gradient?
Pinky extension by surrounding handshape

![Diagram showing pinky extension by surrounding handshape](image-url)
Using a multilevel logistic regression, we determined that the following have a significant effect on pinky extension:

- handshape of the previous apogee
- handshape of the following apogee
- word type
- interaction of following handshape and following transition time
Near -I-, -J-, and -Y-; mean transition times

![Graph showing mean transition times for various handshapes.](image-url)
Near -I-, -J-, and -Y-; mean transition times

![Graph showing the mean transition times for different conditioning handshape positions for the letters h, l, and u.](image)
In other words the following are correlated with higher probability that an apogee will have pinky extension:

- following or preceding apogee is an -i-, -j-, or -y-
- both the following transition was shorter, and the following apogee is a -i-, -j-, or -y-
- the wordtype was English (name or noun)
Conclusions

1. There is coarticulation with respect to pinky extension.
2. Both the previous and following apogee handshape condition coarticulation.
3. The handshapes for -I-, -J-, and -Y- condition pinky extension in neighboring apogees more than -B-, -C-, and -F-.
4. Gradient?
As noted by others:

- Fingerspelling has only brief periods of handshape stability, followed by much longer periods of transition.
- Transitions are not able to be easily categorized discreetly.
- Signers (probably!) do not perceive individual apogees.

The relatively large amounts of pinky extension coarticulation additionally shows that it is difficult to segment apogees discreetly based on time.
Why not?

-O-  -I-  -L-  vs.  -O-  -I-  -L-
Selected vs. nonselected fingers

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.

Handshape portion from the Prosodic Model

```
hand
   /\               /\       \
selected fingers   nonselected fingers
   |                |
   \               \       \
   joints          fingers\_1
   |                |
   base            thumb    nonbase
   |                |
   quantity        fingers\_0
                    |
                    point of ref.
```
full speed

oil.mp4
half speed

oil.mp4
Articulator trajectories

-O-
-I-
-L-
Articulator trajectories

![Graph showing articulator trajectories for -O-, -I-, and -L- gestures over time.](Image)
Articulator trajectories
Articulator trajectories
Articulator trajectories
full speed

building.mp4
half speed

building.mp4
Articulator trajectories
Articulator trajectories

- Articulator trajectories shown with images of hands in different positions.
- A line graph shows the movement of different fingers (thumb, index, middle, ring, pinky) over time (msec).
- The graph includes markers for specific letter positions (B, U, I, L, D, I, N, G).
- The graph illustrates the extension of fingers over time, with peaks and troughs indicating movement or position changes.
Articulator trajectories
Articulator trajectories
Articulator trajectories
Articulator trajectories

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

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Articulator trajectories
Articulator trajectories

![Diagram showing articulator trajectories over time]
Articulator trajectories
Articulator trajectories
Articulator trajectories
full speed

activity.mp4
half speed

activity.mp4
Articulator trajectories
Articulator trajectories

The diagram illustrates the articulator trajectories for the letters 'A', 'C', 'T', 'I', 'V', 'IT', and 'Y'. The trajectories are shown for different articulators such as the thumb, index, middle, ring, and pinky fingers. The x-axis represents time in milliseconds, and the y-axis represents the extension of the fingers.
Articulator trajectories
Articulator trajectories
Articulator trajectories
Articulator trajectories

A

C

T

I

V

IT

Y

-0-200-400-600-800-1000-1200

0 1

extension

A C T I V IT Y

thumb

index

middle

ring

pinky

time (msec)
Articulator trajectories
Articulator trajectories

- A -

- C -

- T -

- I -

- V -

- IT -

- Y -

---

**Extension**

- Thumb
- Middle Finger
- Ring Finger
- Pinky

---

**Time (msec)**

0 200 400 600 800 1000 1200

---

**Articulator Trajectories**

- "A"
- "C"
- "T"
- "I"
- "V"
- "IT"
- "Y"
Articulator trajectories

![Diagram of articulator trajectories](Image)

- **A-**
- **C-**
- **T-**
- **I-**
- **V-**
- **IT-**
- **Y-**

**Time (msec)**

0 200 400 600 800 1000 1200

**Extension**

- Thumb
- Middle Index
- Ring
- Pinky

- **A**
- **C**
- **T**
- **I**
- **V**
- **IT**
- **Y**
Articulator trajectories
Articulator trajectories
Articulator trajectories

- A -
- C -
- T -
- I -
- V -
- IT -
- Y -

[Graph depicting articulator trajectories over time]
Articulator trajectories

The figure shows the articulator trajectories for the letters A, C, T, I, V, IT, and Y. Each letter is represented by a series of images showing the movement of fingers over time, with corresponding graphs indicating the extension of fingers at different moments. The graphs are labeled for the thumb, index finger, middle finger, and ring finger, showing the changes in extension over time in milliseconds.
The same as speech, the phonetic production of fingerspelling does not have discrete segments.

1. It is very hard to draw boundaries between apogees there is no way to categorize each frame as associated with a specific apogee.
2. Some gestures (e.g., pinky extension) can extend over a number of apogees.
3. The selected finger configuration seems to need to be maintained, while the nonselected fingers are allowed to vary.
4. If two apogees have different selected fingers their gestures can overlap (completely!).
Future Directions

- We need pinky extension annotation between the apogees for a better sense of gradience.
- We need more precise timing measurements to look at systematicity of holds and transitions.
- We need more precise articulator movement measurements.
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References


References


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