VARIATION IN FINGERSPELLING
TIME, PINKY EXTENSION, AND WHAT IT MEANS TO BE ACTIVE

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Language Variation and Change & Language, Cognition, and Computation workshops

Goals of this talk

1. Describe the temporal properties of ASL fingerspelling
2. Show variation in the temporal properties of fingerspelling
3. Translate models of spoken language articulatory phonology to handshape
4. Provide an explicit method of phonetic implementation for handshape
5. Use this model to make predictions about variation in handshape

Timing properties

There has been relatively little phonetic work on ASL generally, and fingerspelling specifically.

Most studies of the temporal properties of fingerspelling have been limited because they

- measured rate as duration of word/number of letters
- analyzed data from manually coded English settings
- measured a small number of words with limited formational properties

What we know

Reported fingerspelling rates have considerable variation (Quinto-Pozos, 2010; Bornstein, 1965; Hanson, 1981; Wilcox, 1992; Geer, 2010) :

- a lower bound of ~125msec per letter
- an upper bound of ~300msec per letter
    - ~100msec for holds
    - ~300msec for transitions

Reich and Bick (1977) are the only to use a segment based analysis which showed word medial letters are fingerspelled quicker than initials or finals. Although this was on manually coded English.

Questions about fingerspelling timing

1. How long are segments on average?
2. Do they vary by position?
3. Do they vary by (letter) identity?
4. Do they vary by signer?
5. Do they vary based on English phonology?

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 14,169 apogees

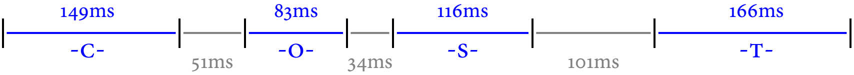
C-O-S-T

Holds and transitions

Holds the time periods where the entire hand configuration is stable

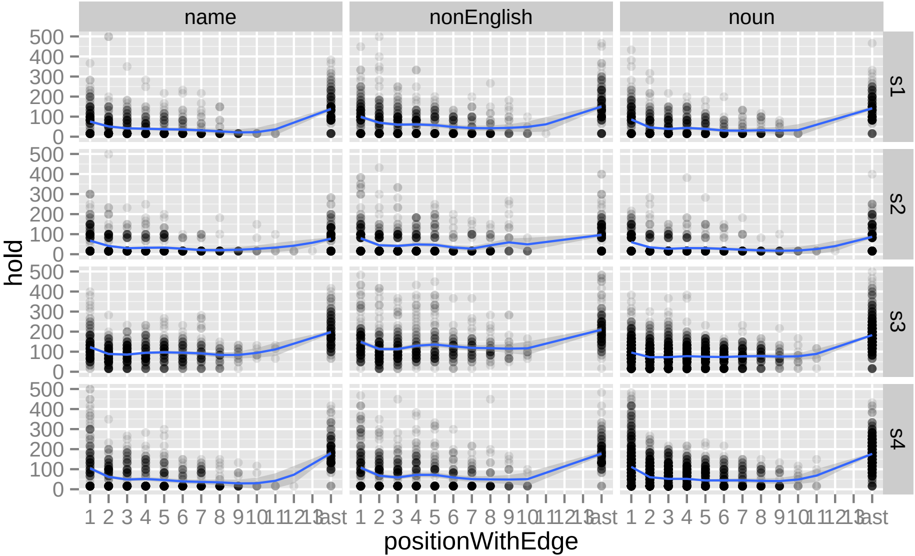
Transitions the time periods between holds

Holds and transitions

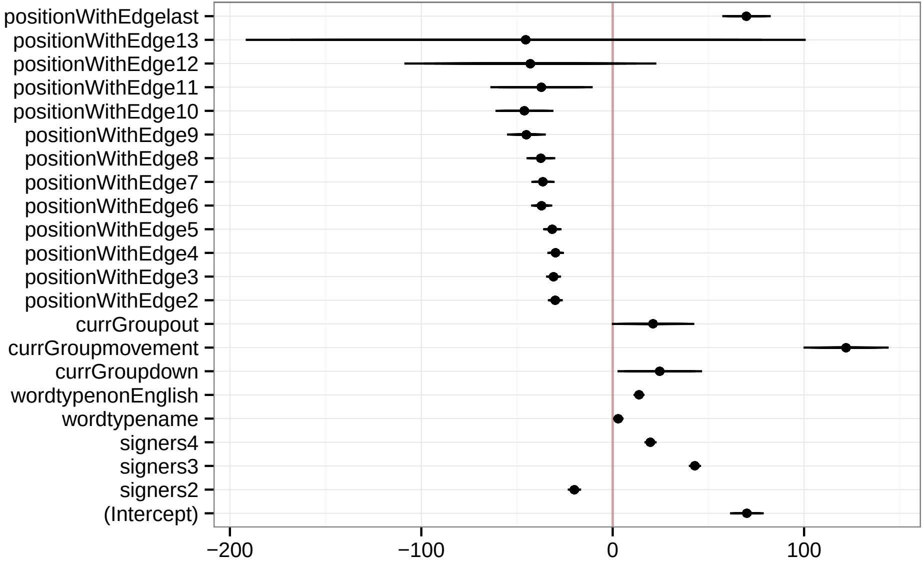


C-O-S-T again

Descriptive data



All letters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positionWithEdge13
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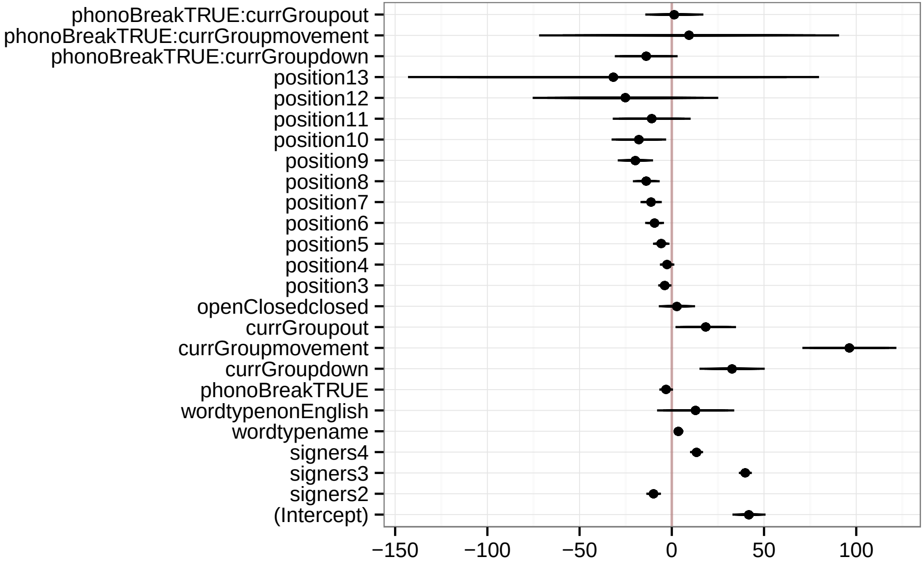
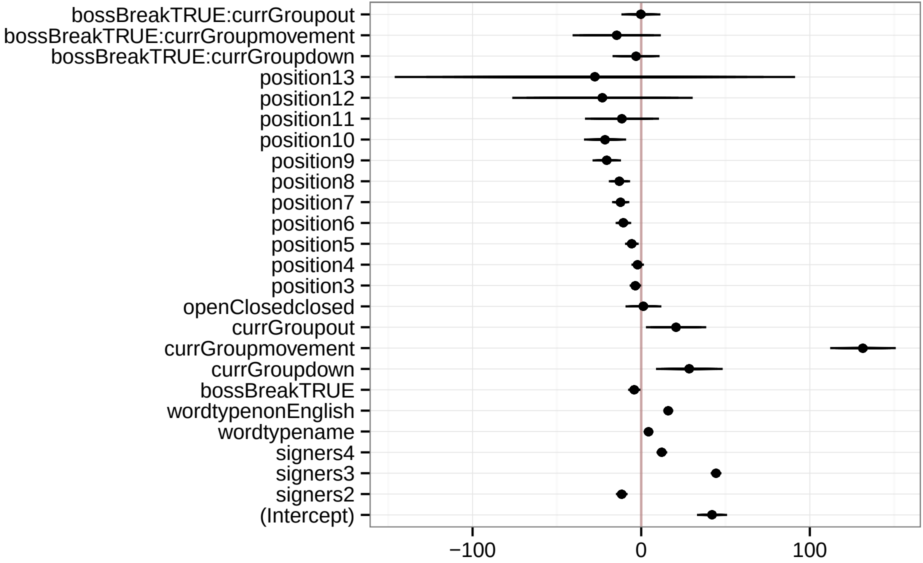
positionWithEdge6
positionWithEdge5
positionWithEdge4
positionWithEdge3
positionWithEdge2
currGroupout
currGroupmovement
currGroupdown
wordtypenonEnglish
wordtypename
signers4
signers3
signers2
(Intercept)
−200
−100
0
100

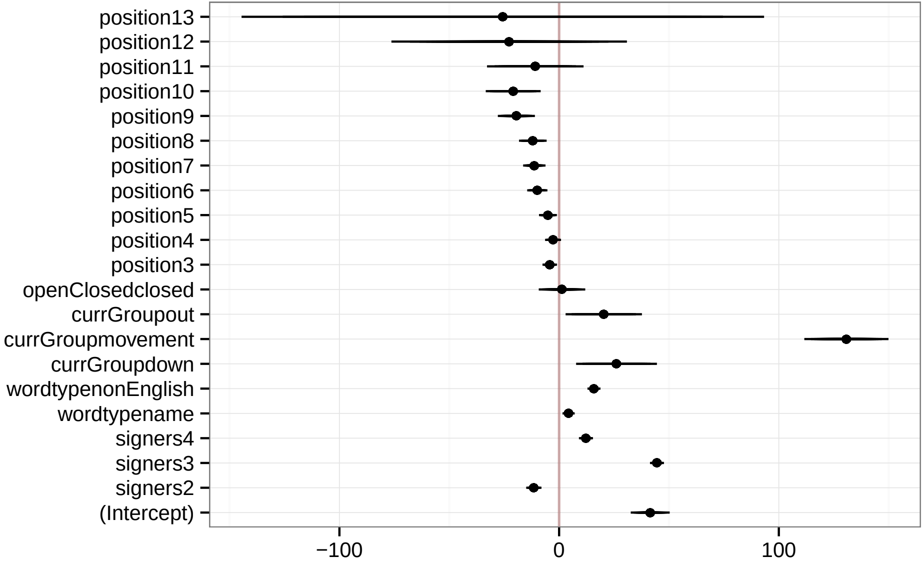
Medial: Phonological break



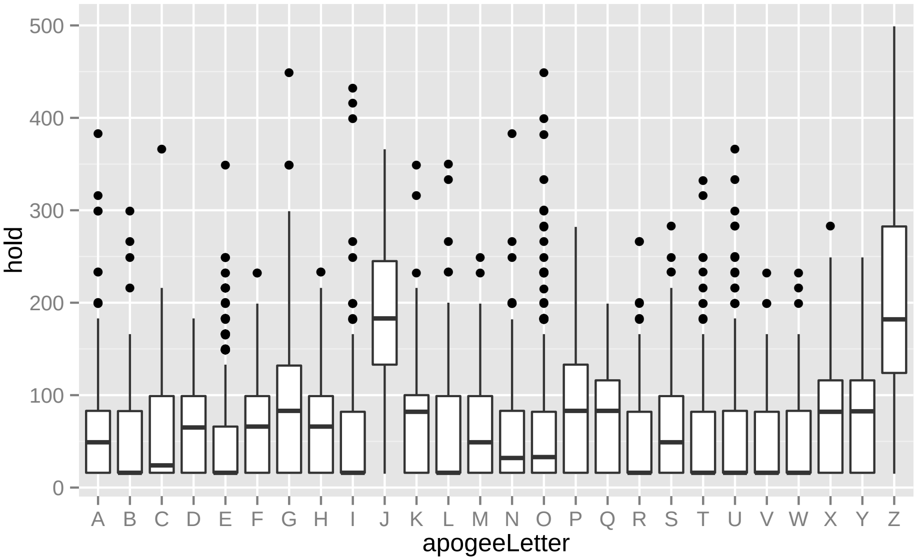
Medial: BOSS break



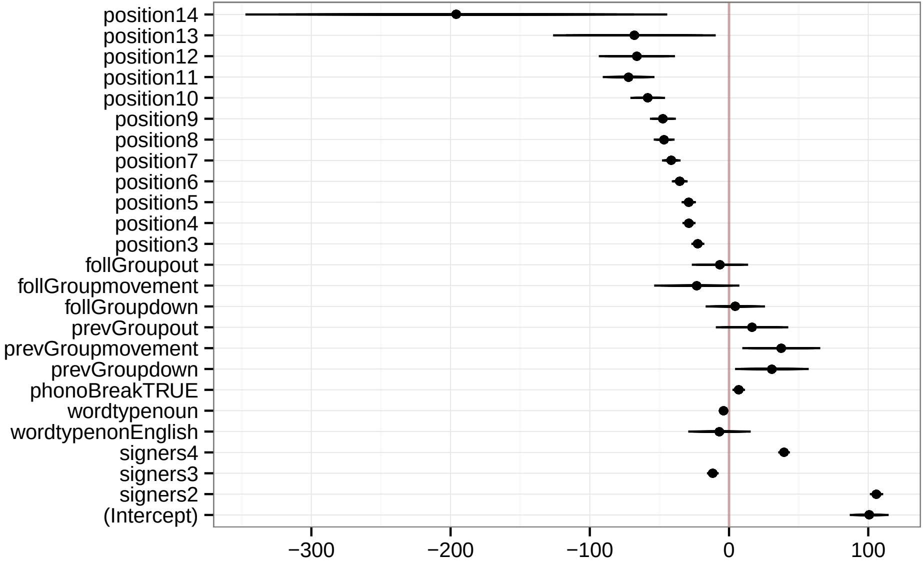
Medial: No Breaks



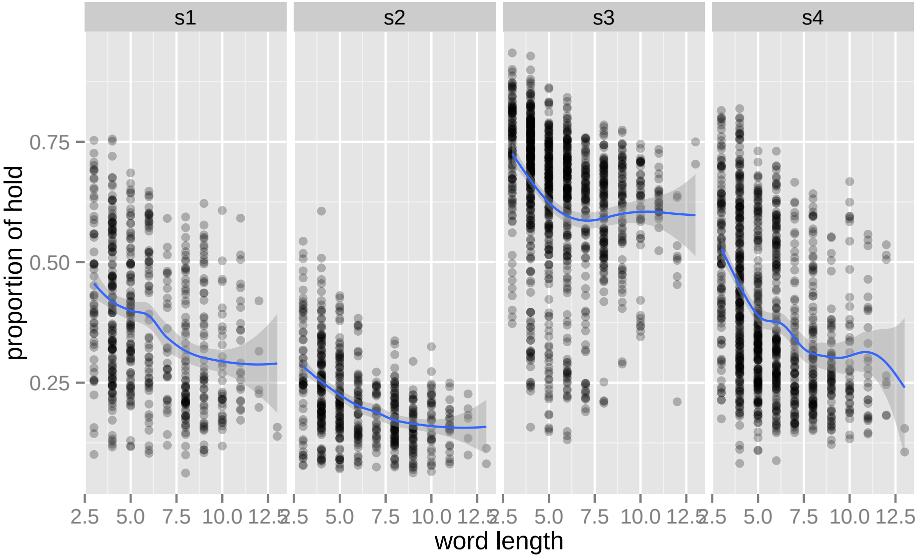
Letter Based Variation



All Transitions



Hold/Transitions ratio



Results

- holds are ~40msec
- transitions are ~100msec
- first and last letters are significantly longer
- for the medial letters, they tend to be held for less time in later positions in words
- letters with movement and orientation changes are held longer
- signers vary greatly
- English phonology doesn't seem to have an effect on holds

Discussion

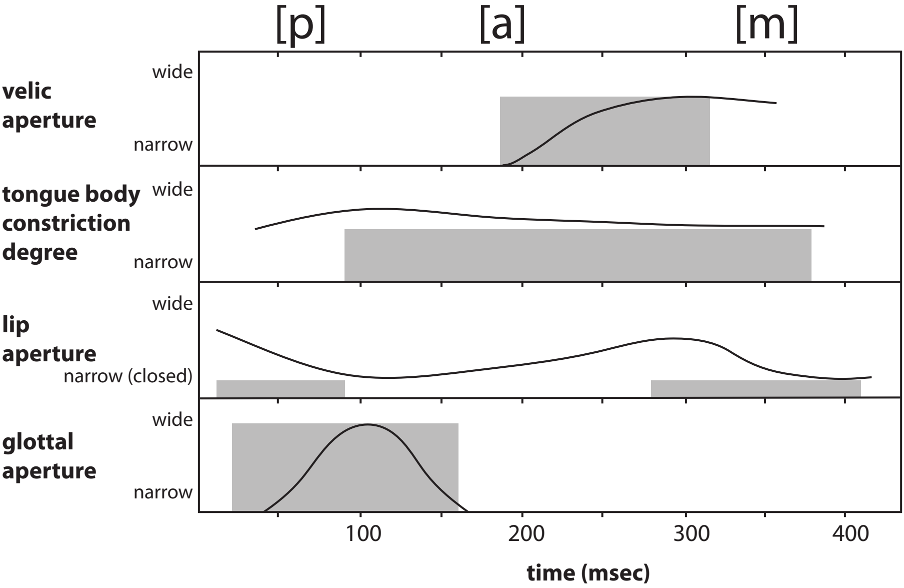
Timing information is important for

- Language learning and acquisition norms
- Perception studies
- Input into models of fingerspelling production

Why ASL fingerspelling for handshape variation?

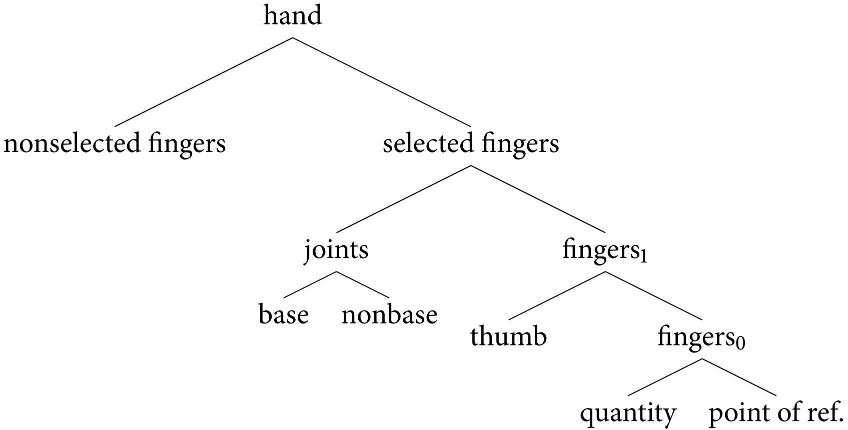
Fingerspelling is a loanword system for borrowing written English words into ASL. It involves quick and sequential handshape changes, unlike signing. This results in an ideal data set to look at variation in handshape because there are

- a large number of individual tokens
- a huge variety of contexts
- involves most of the handshapes in ASL



adapted from (Browman and Goldstein, 1992, pp28)

Handshape portion from the Prosodic Model



(Brentari, 1998)

Selected fingers

- are described as the most salient fingers for a given handshape,
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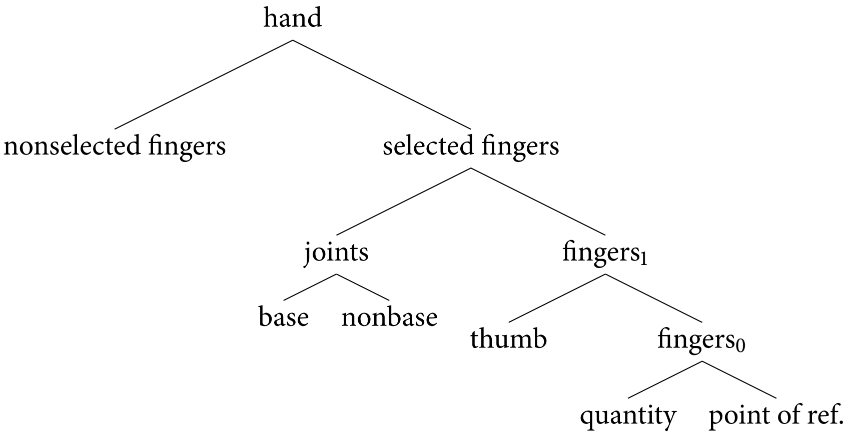
There is independent evidence for their existence:

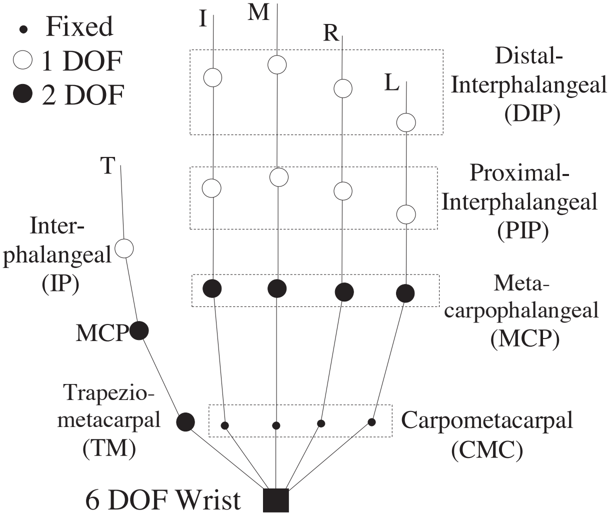
- restrictions on handshapes in signs,
- selected fingers contact the body,
- selected fingers are preserved in compounds.

Handshape portion from the Prosodic Model



(Brentari, 1998)

Degrees of freedom



Erol et al. (2005)

The articulatory model of handshape

group	joint	tract variable	values
selected fingers	MCP	SF-MCP	-15–90°
	PIP	SF-PIP	0–90°
	MCP	SF-ABDUCTION	[±ABDUCTED]

Broadly compatible with phonological models Sandler (1989); Brentari (1998) among others; as well as phonetic models like Johnson and Liddell (2011a,b); Liddell and Johnson (2011a,b).

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nonselected fingers	all	NSF	[±FLEXED]

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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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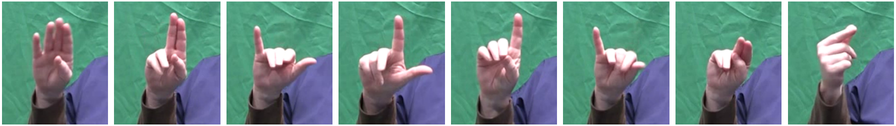
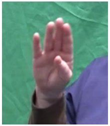
1. The nonselected (nonactive) fingers are more frequently the targets of coarticulatory pressure (vs. selected (active) fingers).
2. The selected fingers are the sources of coarticulatory pressure.
3. Finger configuration that is due to (phonetic) coarticulatory pressure will differ from configuration due to phonological specification (ie, gradient in extension, time, etc. vs. categorical in nature).

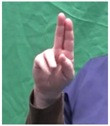
B-U-I-L-D-I-N-G; half speed

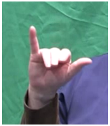


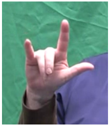
-B- -U- -I- *-L- *-D- -I- -N- -G-

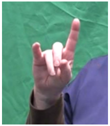
B-U-I-L-D-I-N-G; half speed


-B-


-U-


-I-


-L-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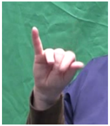
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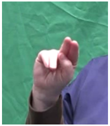
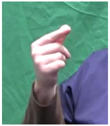
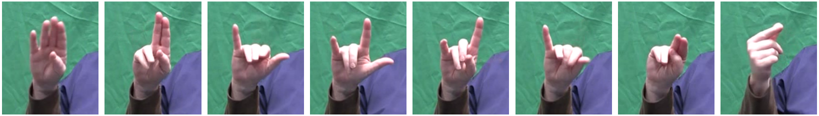
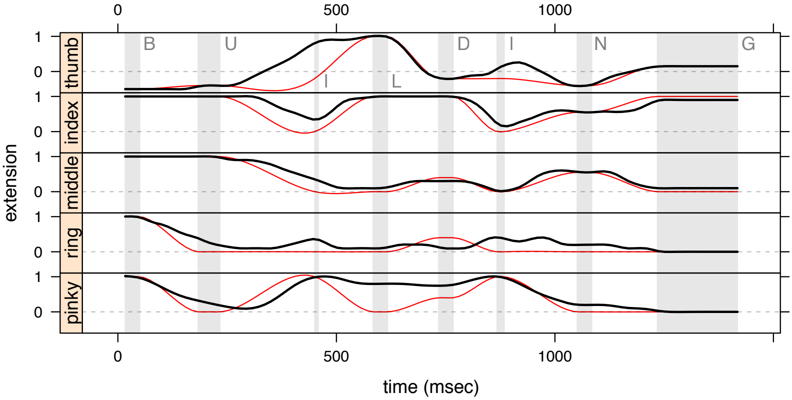

-N-


-G-

Gestural score for B-U-I-L-D-I-N-G



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



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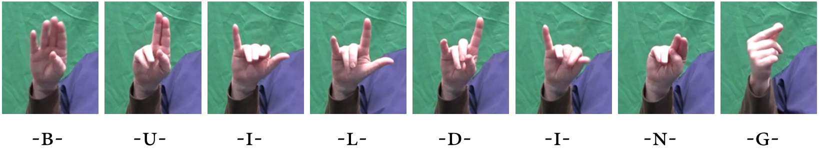
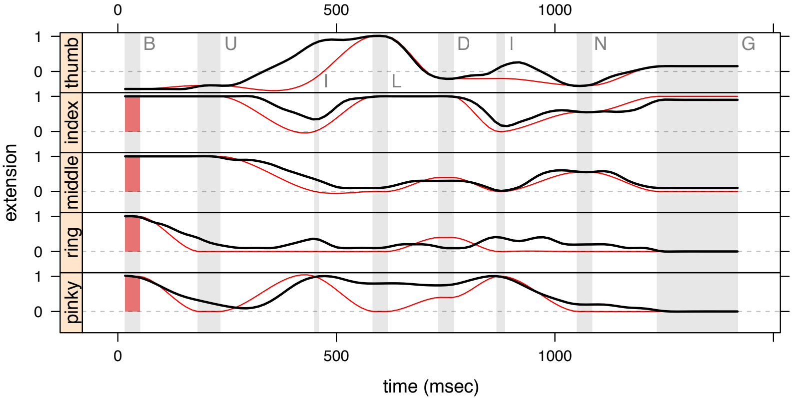
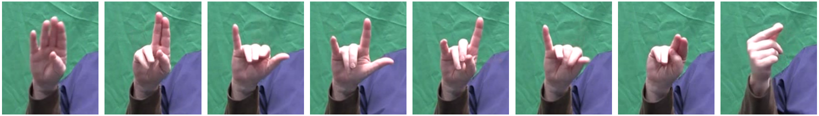
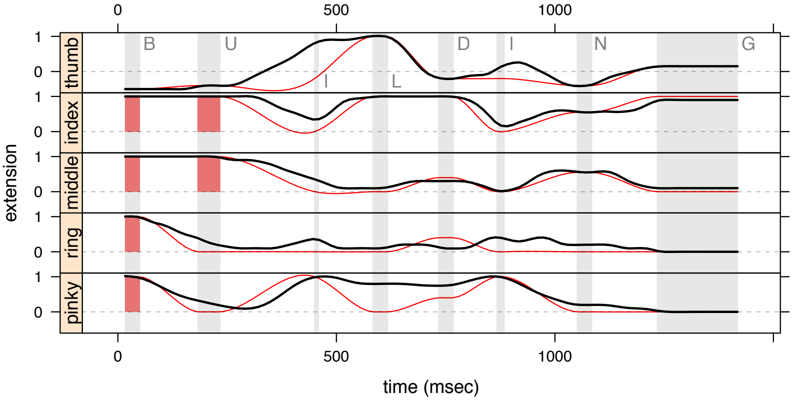




Gestural score for B-U-I-L-D-I-N-G



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



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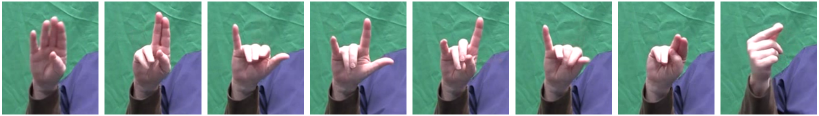
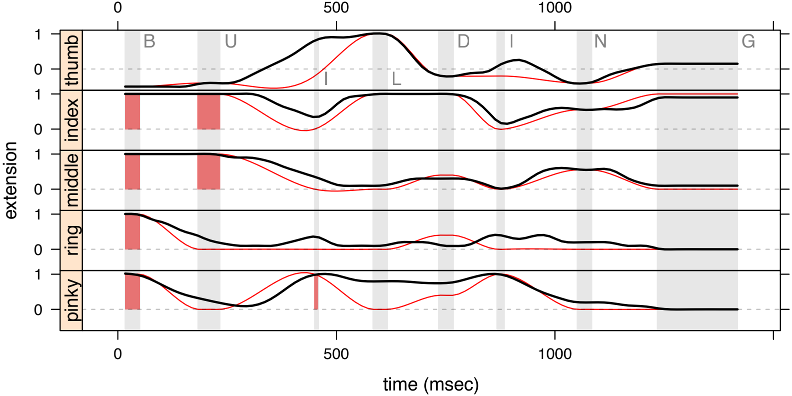


-B- -U- -I- -L- -D- -I- -N- -G-



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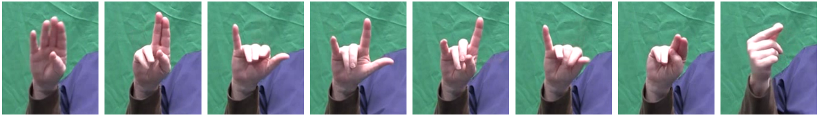
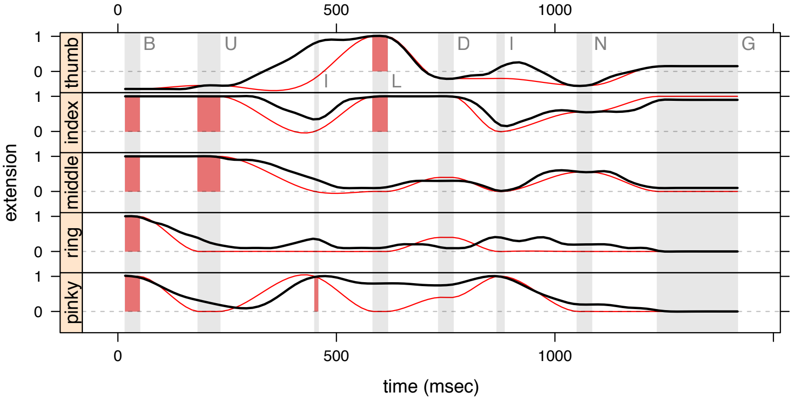


-B- -U- -I- -L- -D- -I- -N- -G-



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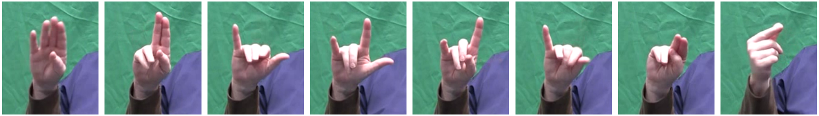

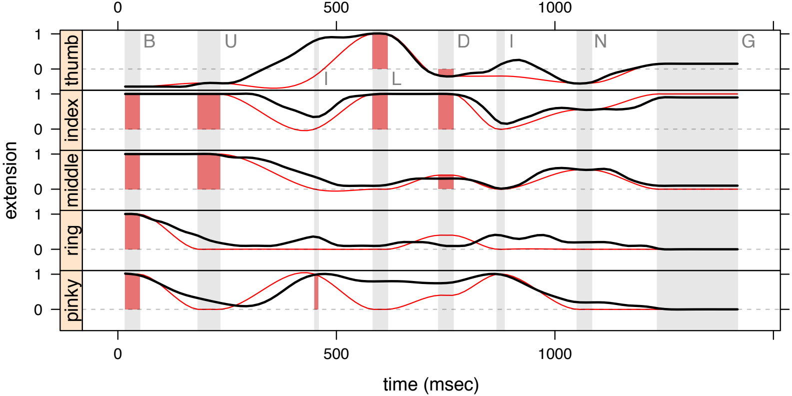

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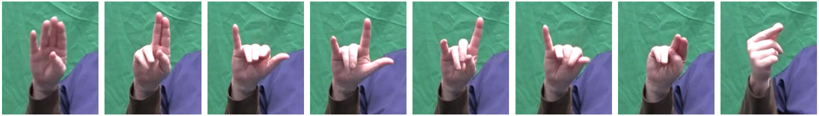
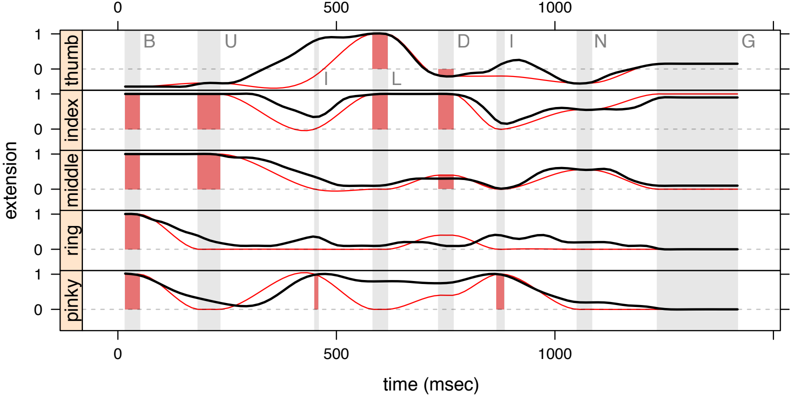


-B- -U- -I- -L- -D- -I- -N- -G-



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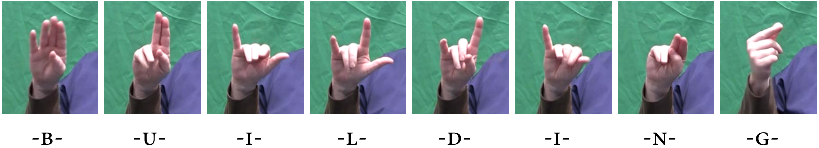

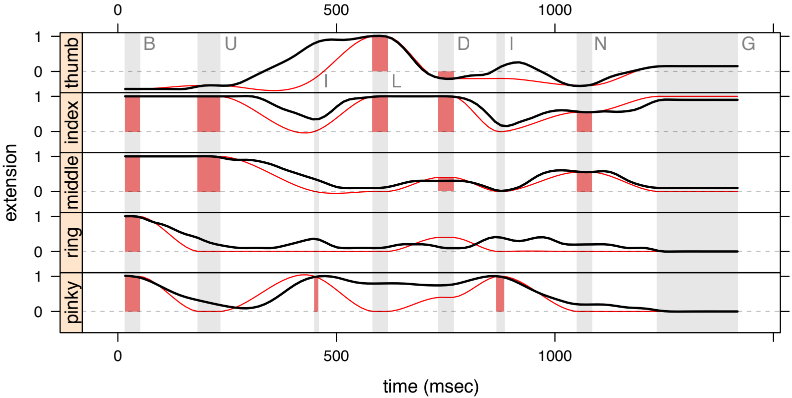

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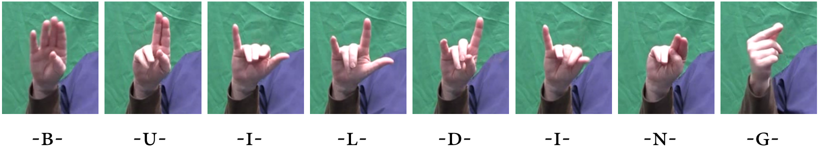

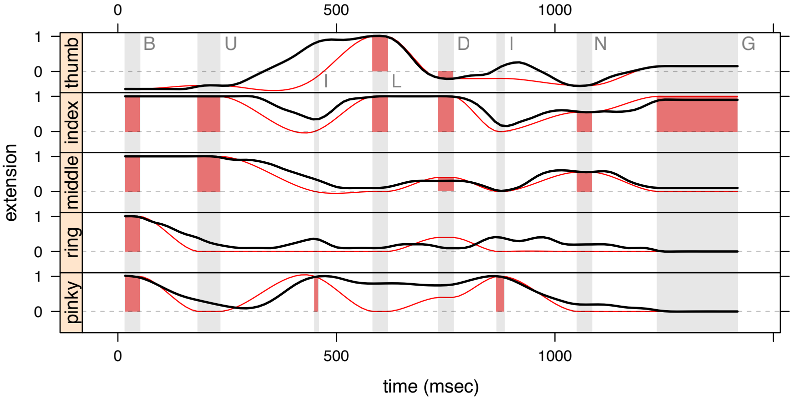

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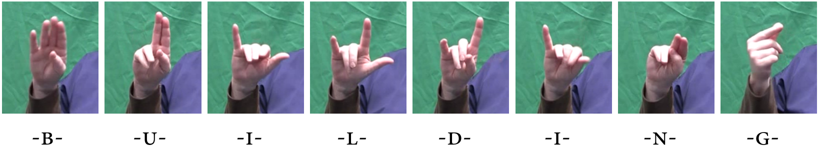
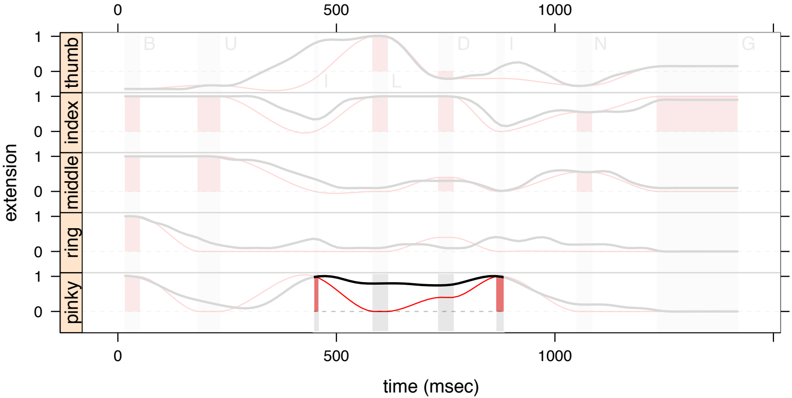
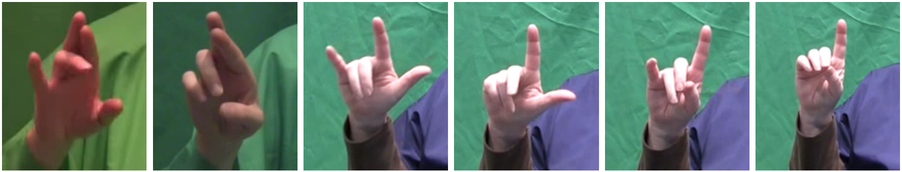




Pinky extension

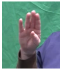
A still image of each apogee was annotated for pinky extension, defined as:

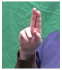
- The tip of the pinky was above the plane perpendicular to the palmar plane, at the base of the pinky finger (the MCP joint).
- The proximal interphalangeal joint (PIP) was more than half extended.

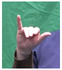


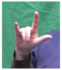
-R- [+ext] -R- [−ext] -L- [+ext] -L- [−ext] -D- [+ext] -D- [−ext]

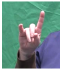
What affects the -L- handshape?

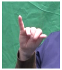

-B-

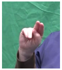

-U-

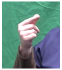

-I-

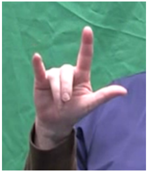

-L-


-D-

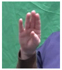
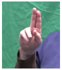
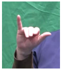
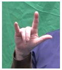
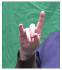
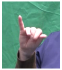
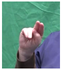
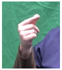

-I-

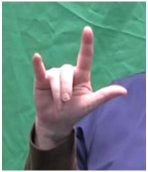

-N-


-G-



What affects the -L- handshape?


-B-

-U-

-I-

-L-

-D-

-I-

-N-

-G-



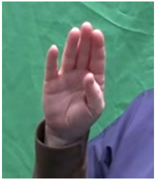
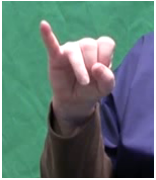
↑

apogee handshape

-B-, -C-, -F-, -I-, -J-, or -Y-;

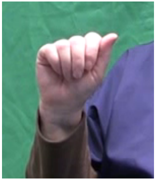
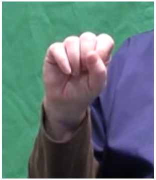
-A-, -S-, -E-, or -O-; other

apogee handshape groups

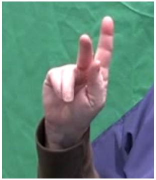
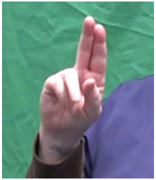
Extended (and selected) pinky:

-B-, -C-, -F-, -I-, -J-, or -Y-

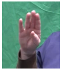
Flexed and selected pinky:

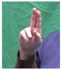
-A-, -S-, -E-, or -O-

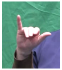



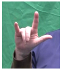
other

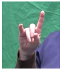
What affects the -L- handshape?

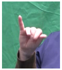

-B-

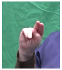

-U-

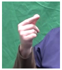

-I-


-L-

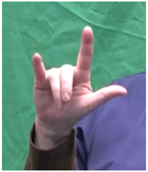

-D-


-I-


-N-


-G-

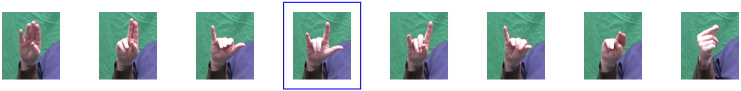
word type
name; noun;
non-English



↑

apogee handshape
-B-, -C-, -F-, -I-, -J-, or -Y-;
-A-, -S-, -E-, or -O-; other

What affects the -L- handshape?



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

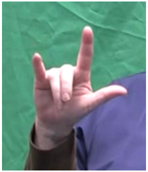
local transition time

zscore of log(time)

word type

name; noun;

non-English



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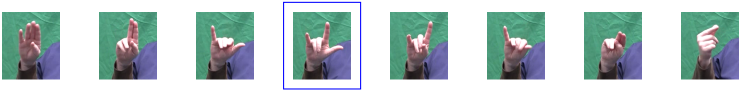

-B- -U- -I- -L- -D- -I- -N- -G-

local transition time

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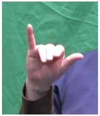


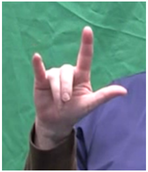
previous handshape

-B-, -C-, or -F-;

-I-, -J-, or -Y-;

other;

word boundary

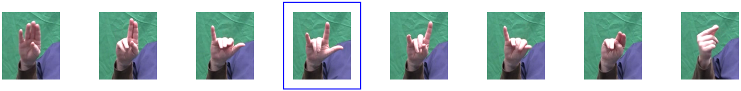


apogee handshape

-B-, -C-, -F-, -I-, -J-, or -Y-;

-A-, -S-, -E-, or -O-; other

What affects the -L- handshape?



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

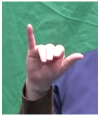
local transition time

zscore of log(time)

word type

name; noun;

non-English



previous handshape

-B-, -C-, or -F-;

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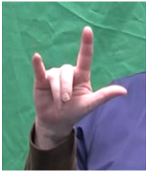
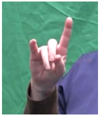
other;

word boundary





following handshape

-B-, -C-, or -F-;

-I-, -J-, or -Y-;

other;

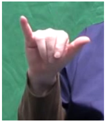
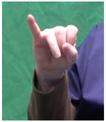
word boundary

apogee handshape

-B-, -C-, -F-, -I-, -J-, or -Y-;

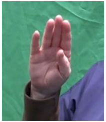
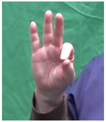
-A-, -S-, -E-, or -O-; other

previous/following handshape groups

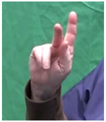
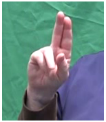
Extended pinky (alone):

-I-, -J-, or -Y-

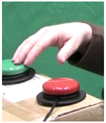
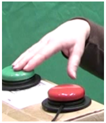



Extended pinky (with other fingers):

-B-, -C-, or -F-

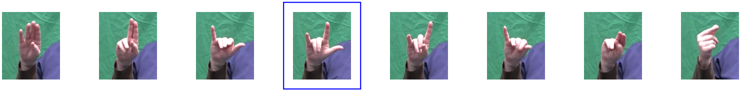



other

word boundary

What affects the -L- handshape?



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

local transition time

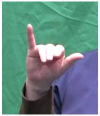
zscore of log(time)

interaction → ← *interaction*

word type

name; noun;

non-English



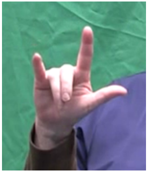
previous handshape

-B-, -C-, or -F-;

-I-, -J-, or -Y-;

other;

word boundary



apogee handshape

-B-, -C-, -F-, -I-, -J-, or -Y-;

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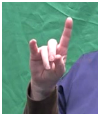


following handshape

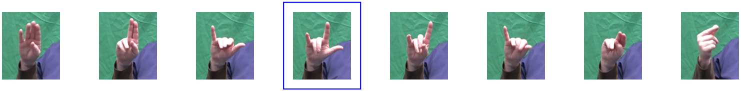
-B-, -C-, or -F-;

-I-, -J-, or -Y-;

other;

word boundary

What affects the -L- handshape?

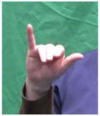


-B- -U- -I- -L- -D- -I- -N- -G-

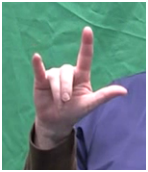
local transition time
zscore of log(time)

interaction → ← *interaction*

word type
name; noun;
non-English



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



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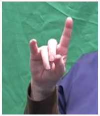
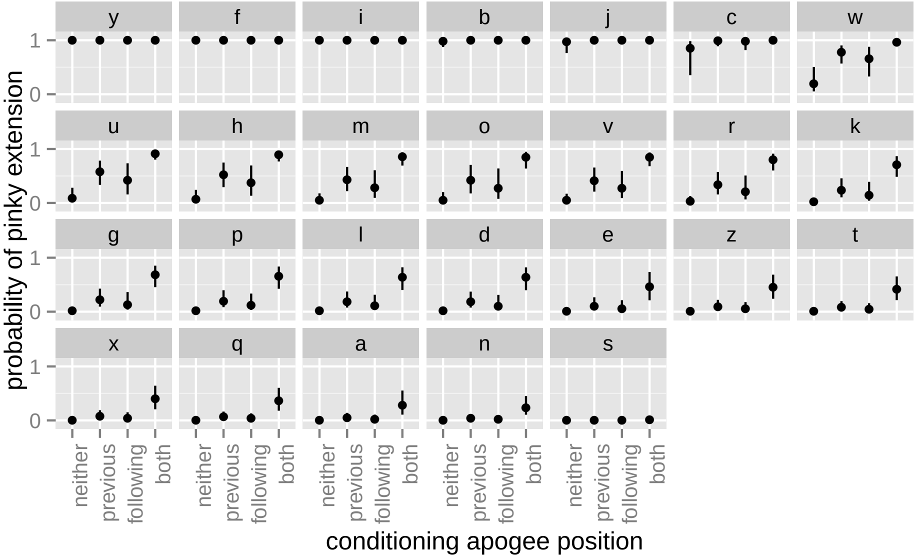
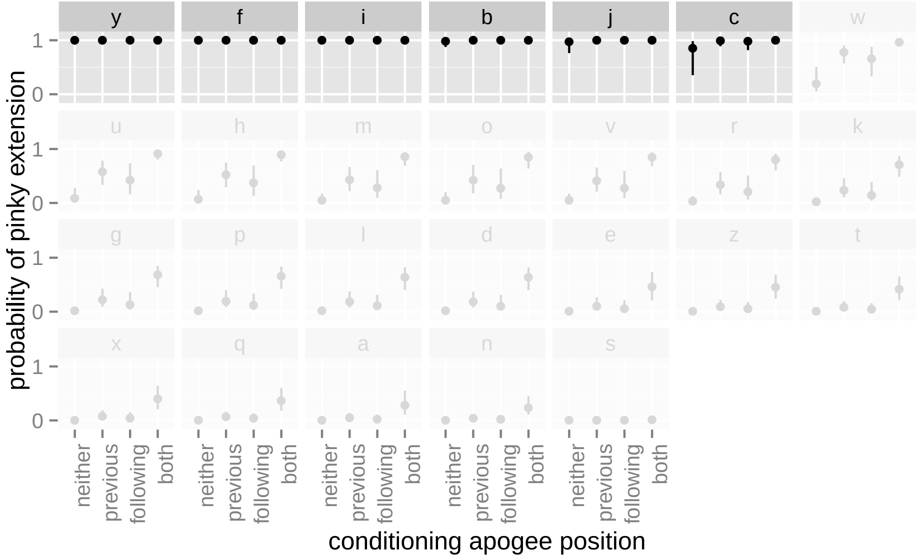


following handshape
-B-, -C-, or -F-;
-I-, -J-, or -Y-;
other;
word boundary

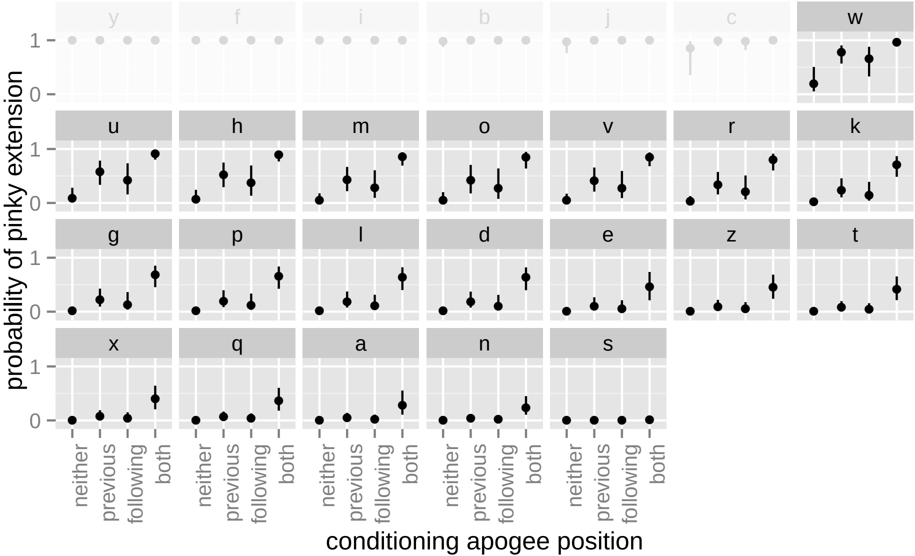
Model predictions around -I-, -J-, or -Y-



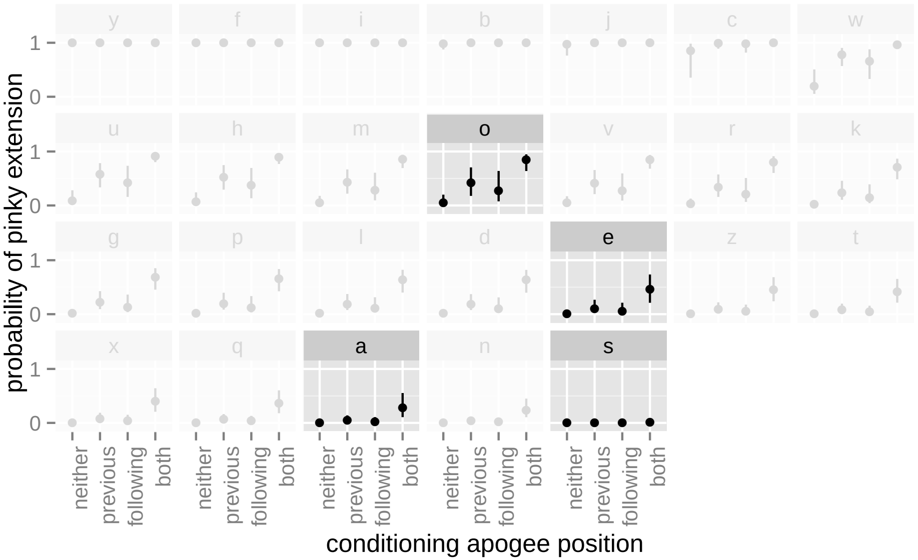
Model predictions around -I-, -J-, or -Y-



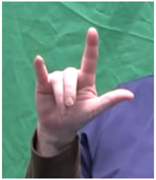
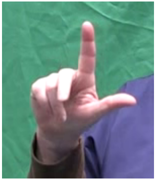
Model predictions around -I-, -J-, or -Y-



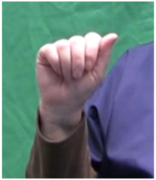
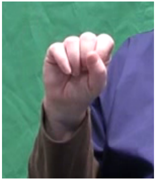
Model predictions around -I-, -J-, or -Y-



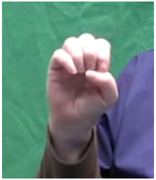
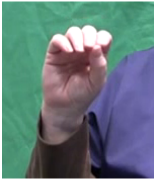
What's special about -A-, -S-, -E-, and -O-?

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

Flexed and selected pinky:
-A- and -S- have nearly no pinky extension

Flexed and selected pinky:
-E- and -O- both are close to the edge
of our coding scheme for pinky extension.

Conclusions

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Conclusions

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   3.1 The nonselected (nonactive) fingers are more frequently the targets of coarticulatory pressure (vs. selected (active) fingers).
   3.2 The selected fingers are the sources of coarticulatory pressure.
   3.3 Finger configuration that is due to (phonetic) coarticulatory pressure will differ from configuration due to phonological specification (ie, gradient in extension, time, etc. vs. categorical in nature).

I must also acknowledge the contributions of many who contributed in ways big and small:

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