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

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Goals of this talk

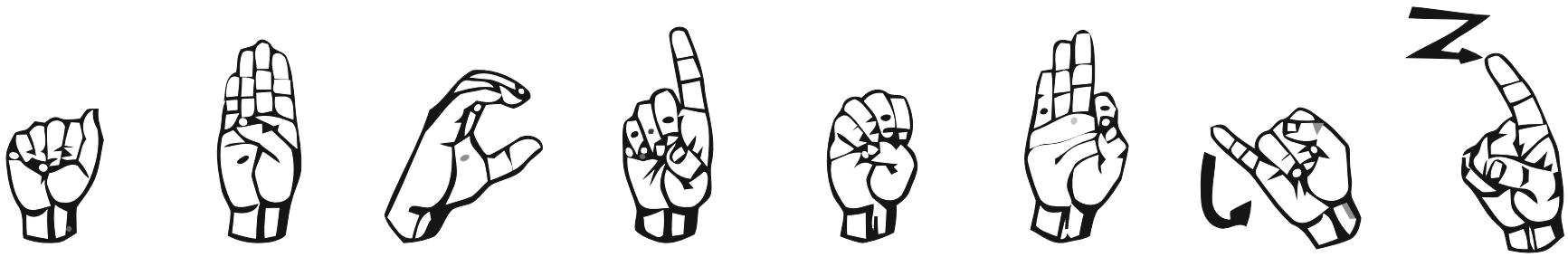
1. Describe the temporal properties of ASL fingerspelling
2. Show variation in the temporal properties of fingerspelling

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

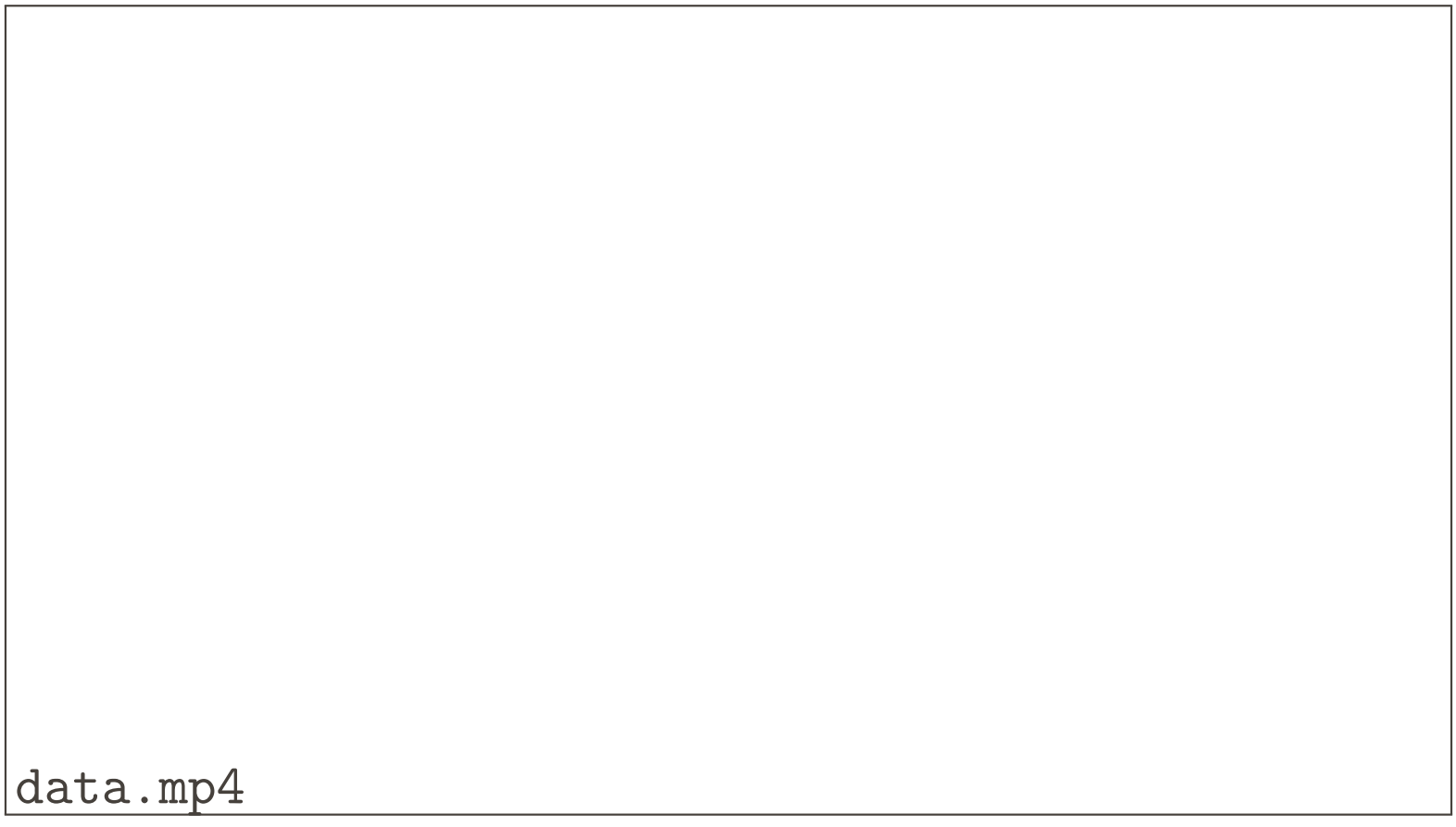
Background

A basic description of fingerspelling

- Simple: a set of static (except for -J- and -Z-) handshapes strung together sequentially, where each maps on to one letter in an English word.
- Many (Wilcox, 1992 and Akamatsu, 1985) note that this description is not quite accurate. Rather signers perceive overall contours, not individual handshapes.
- Fingerspelling makes up anywhere from 12–35% of ASL discourse. (Padden, 1991 and 2003)



What fingerspelling looks like



Why ASL fingerspelling for timing and 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 timing and handshape because there are

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

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 ~125 msec per letter
- an upper bound of ~300 msec per letter
  - ~100 msec for holds
  - ~200 msec 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?

Methods

Data collection

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

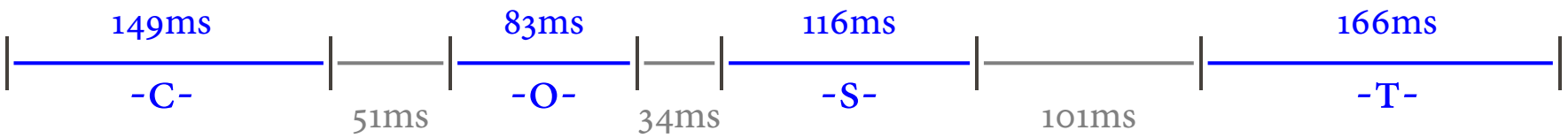
C-O-S-T

Holds and transitions

Holds the time periods where the entire hand configuration is stable

Transitions the time periods between holds

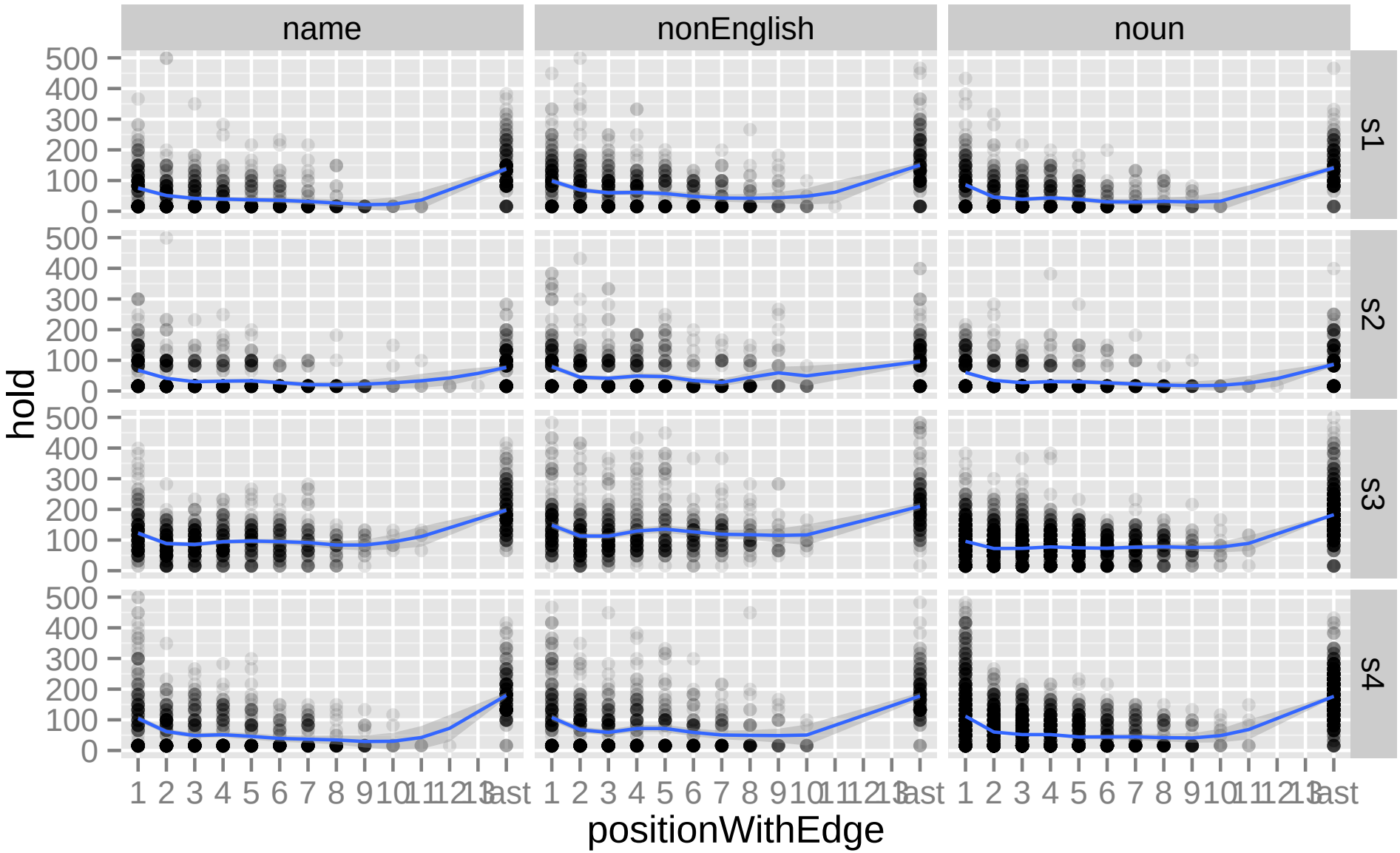
Holds and transitions



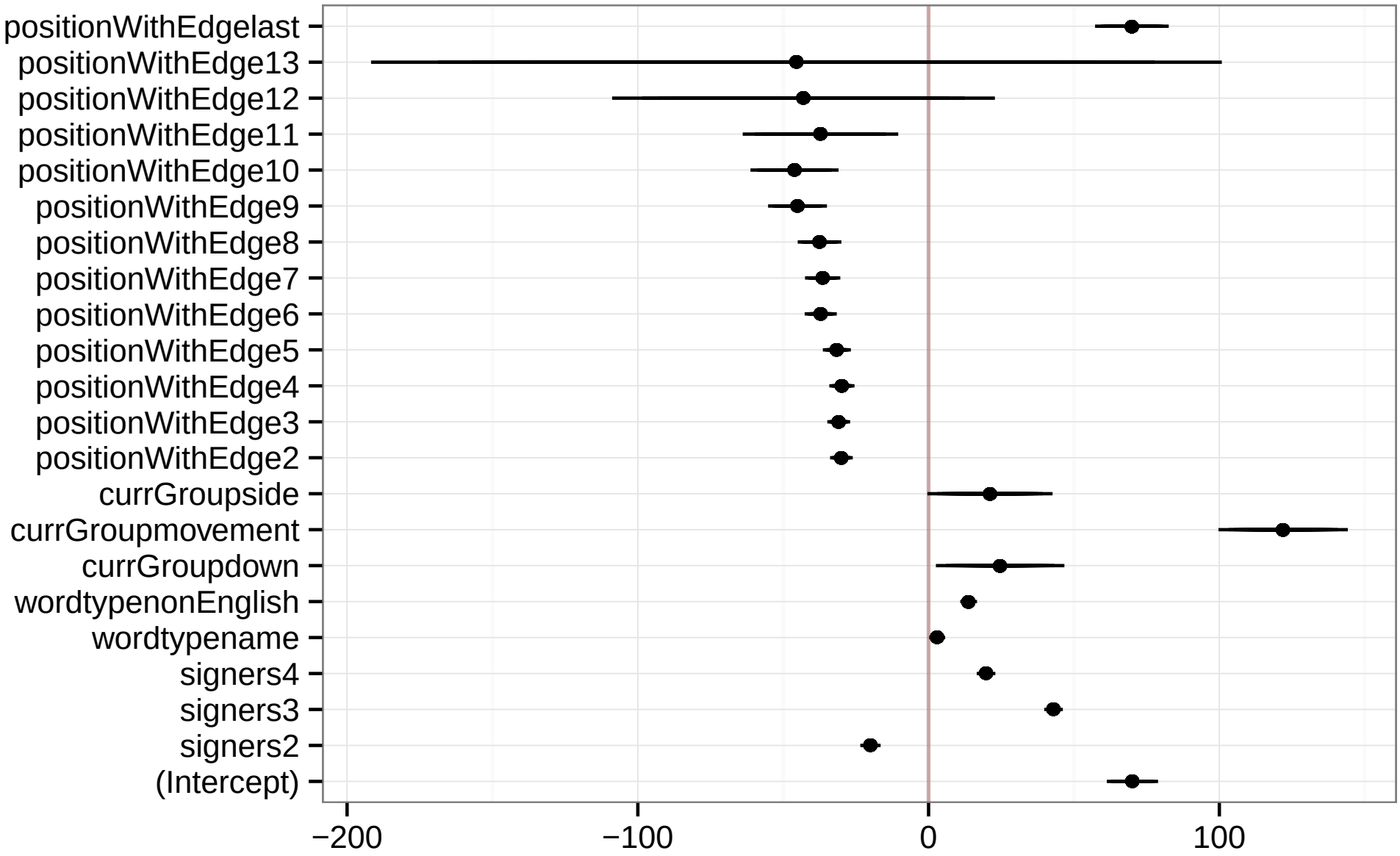
C-O-S-T again

Timing results

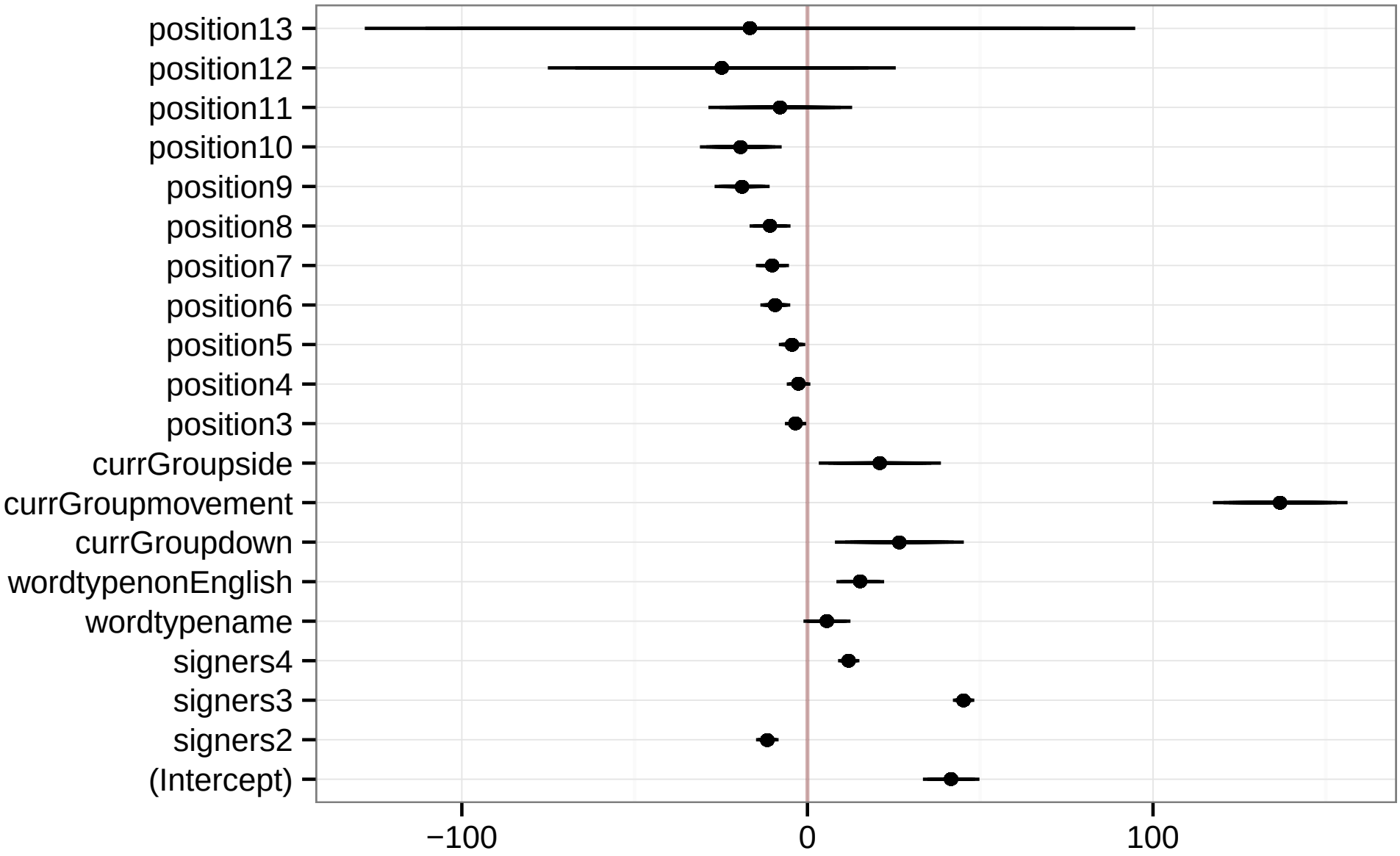
Descriptive data



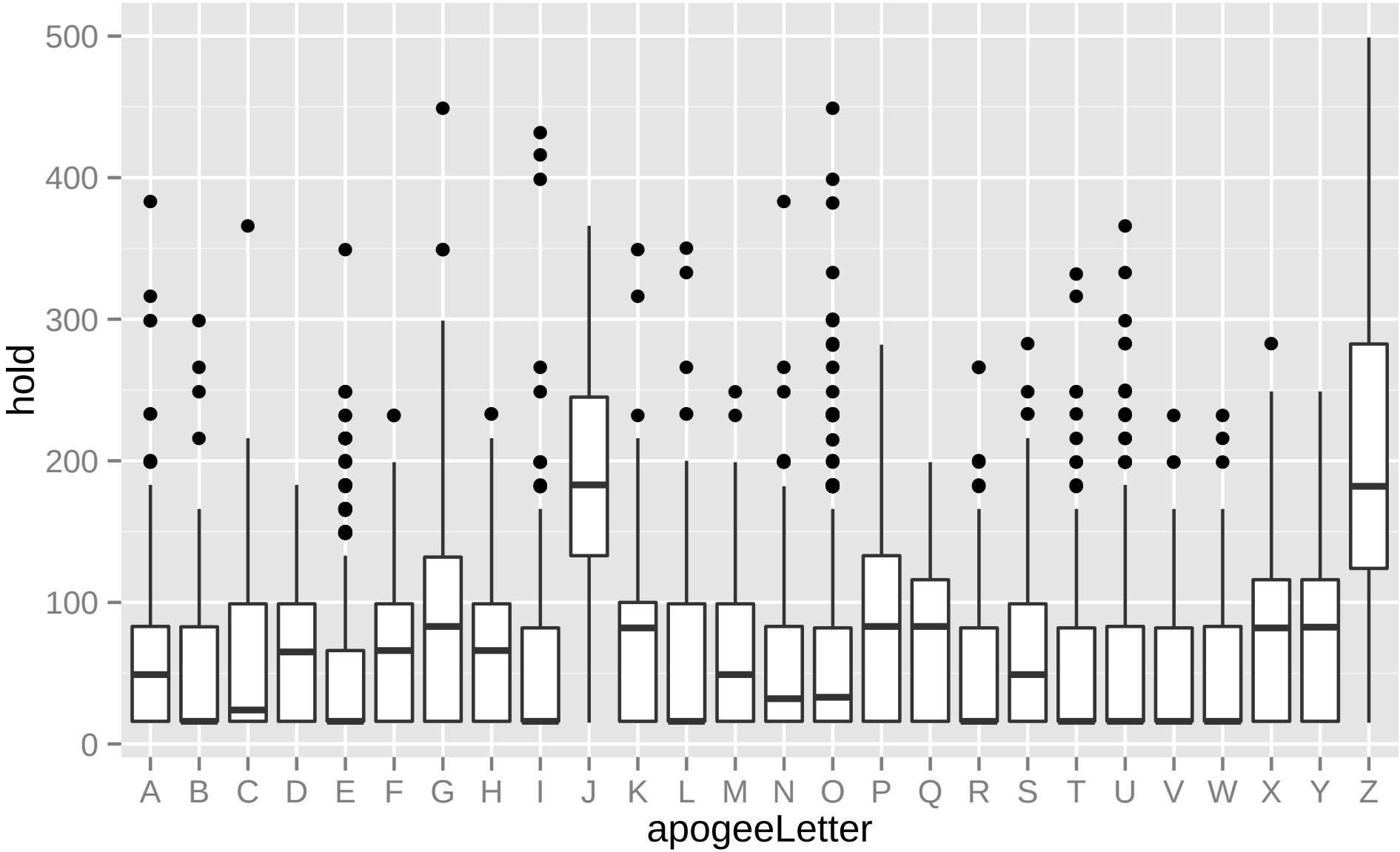
All letters


positionWithEdgelast
positionWithEdge13
positionWithEdge12
positionWithEdge11
positionWithEdge10
positionWithEdge9
positionWithEdge8
positionWithEdge7
positionWithEdge6
positionWithEdge5
positionWithEdge4
positionWithEdge3
positionWithEdge2
currGroupside
currGroupmovement
currGroupdown
wordtypenonEnglish
wordtypename
signers4
signers3
signers2
(Intercept)
−200
−100
0
100

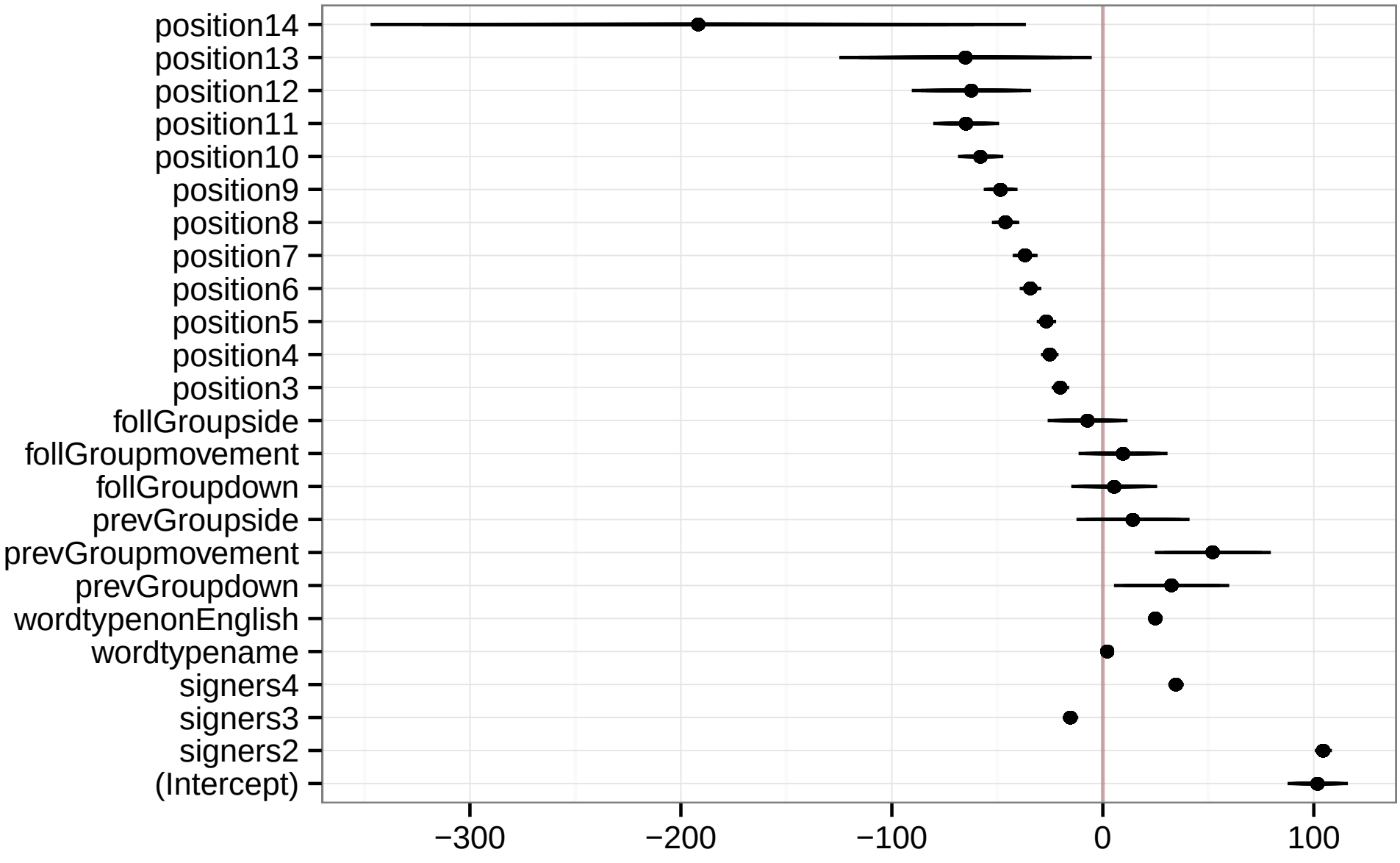
Medial holds



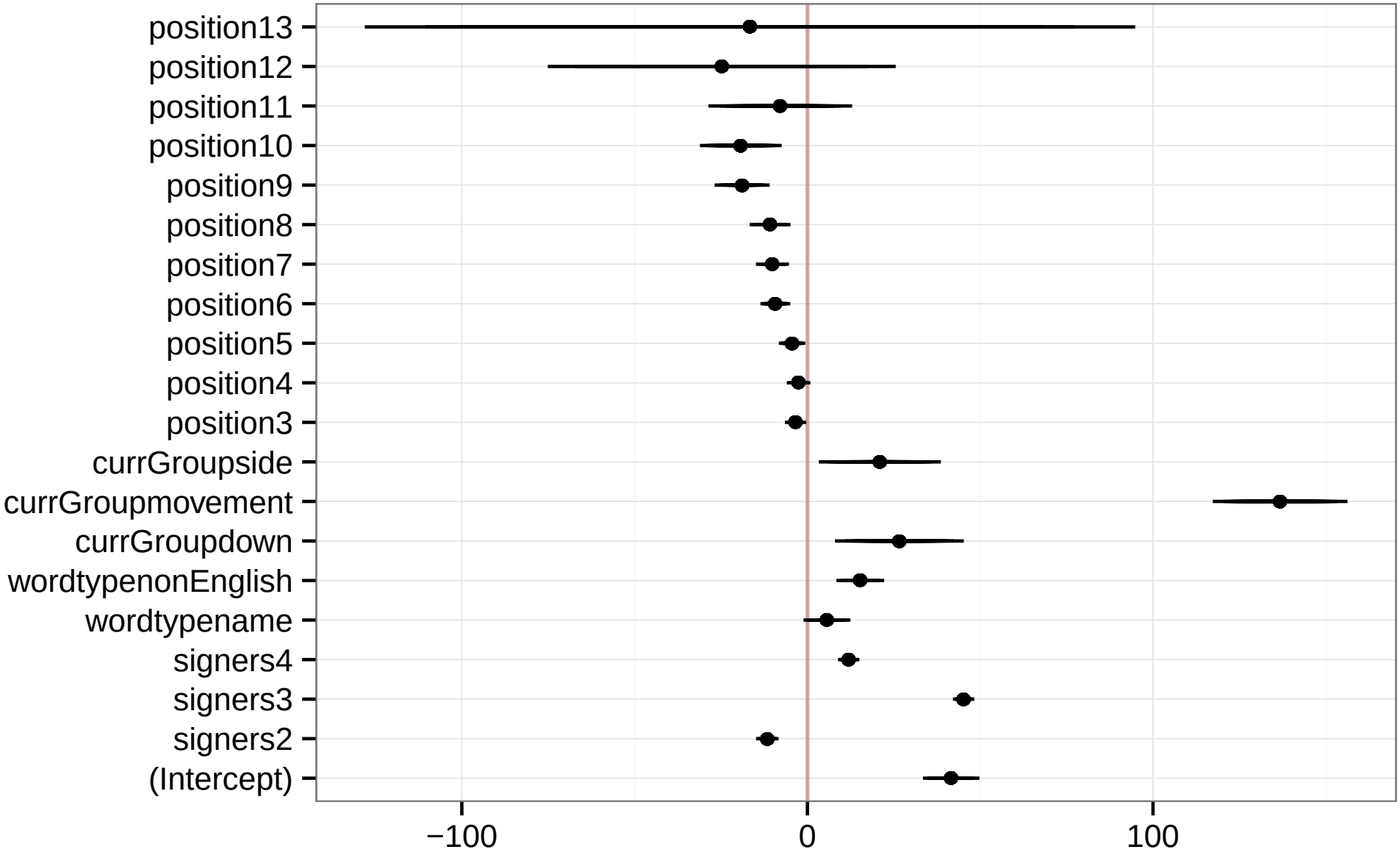
Letter Based Variation



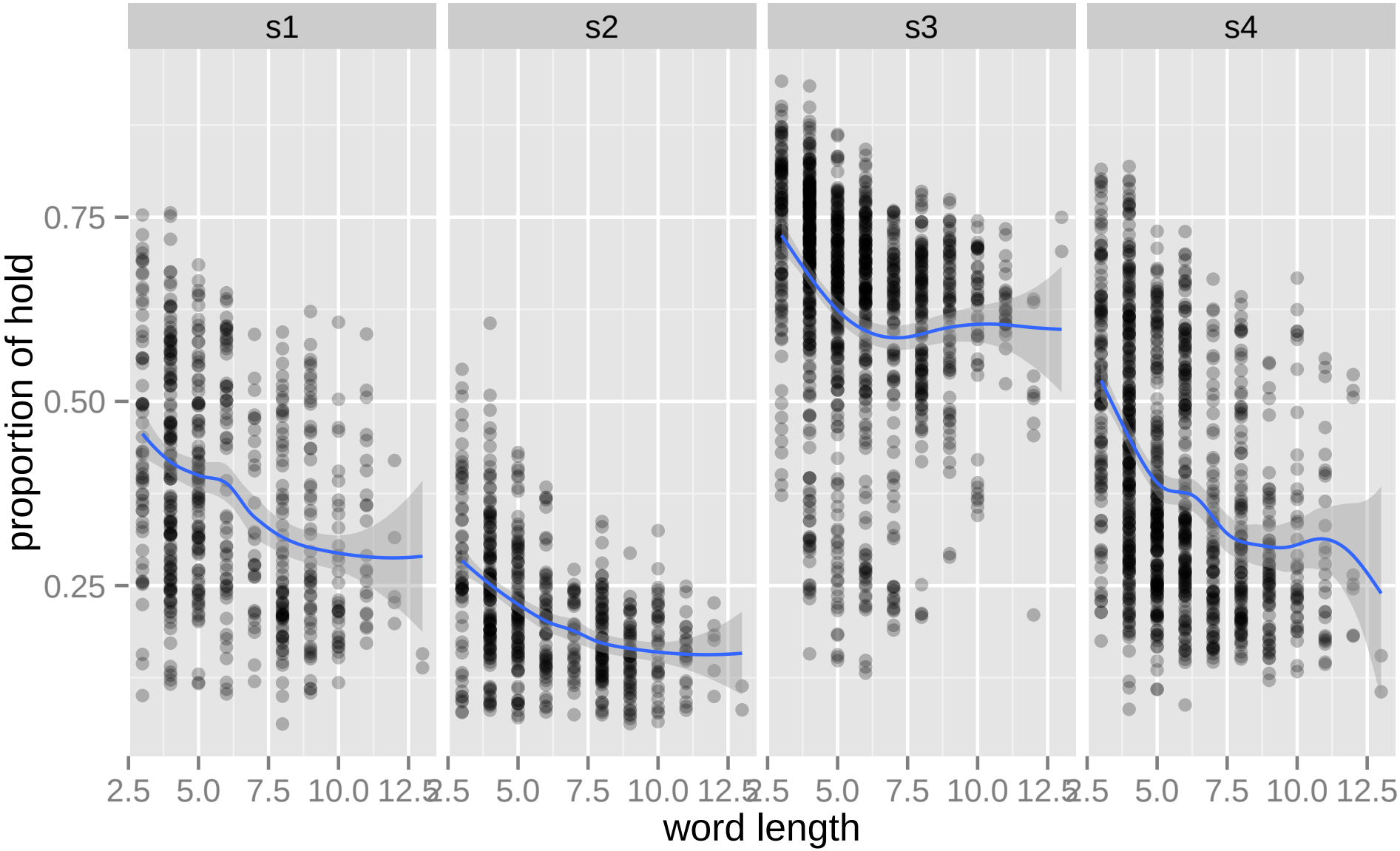
All Transitions



Medial holds, again



Hold/Transitions ratio



Conclusions

- 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

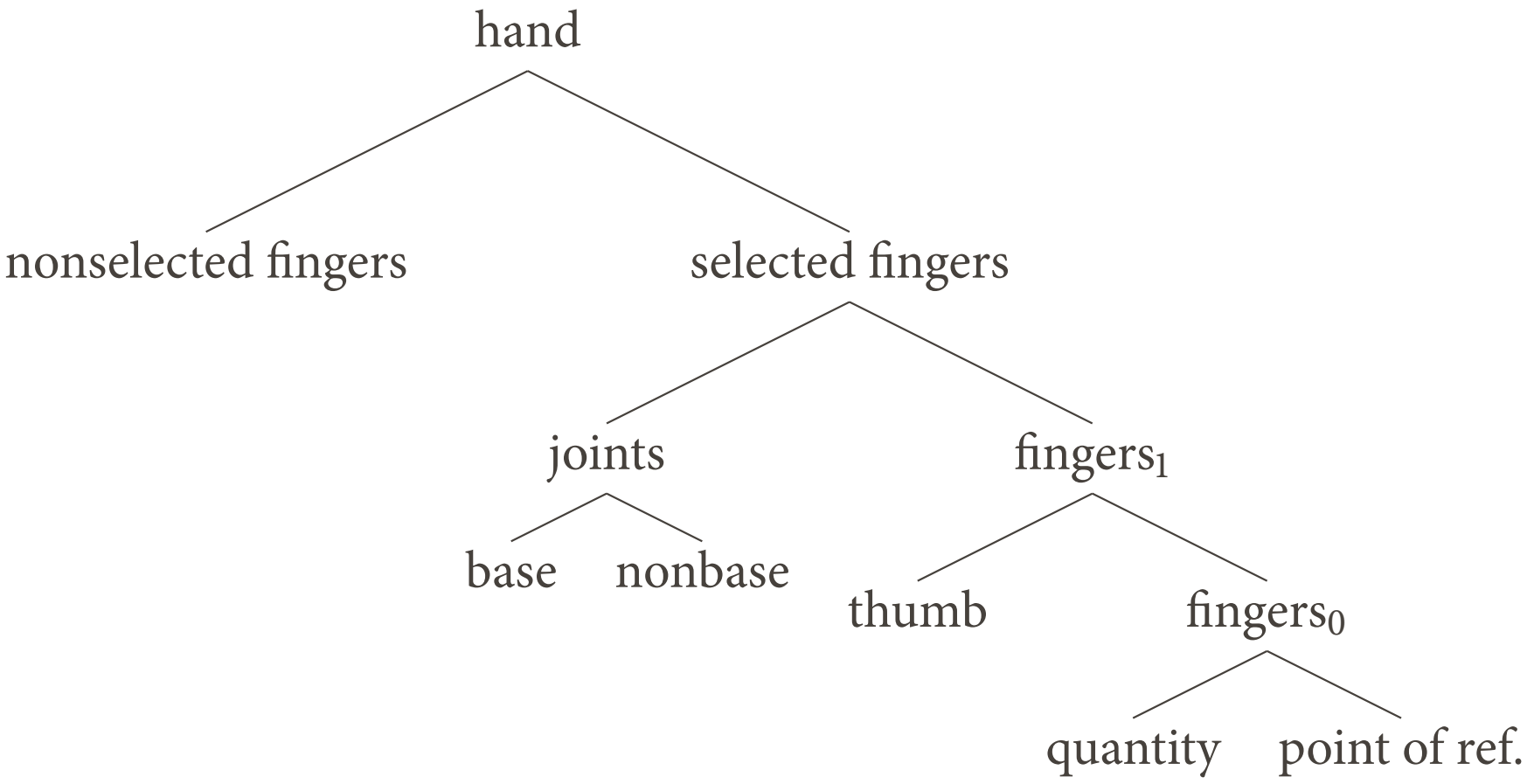
Future implications

Timing information is important for

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

The articulatory model of handshape

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.

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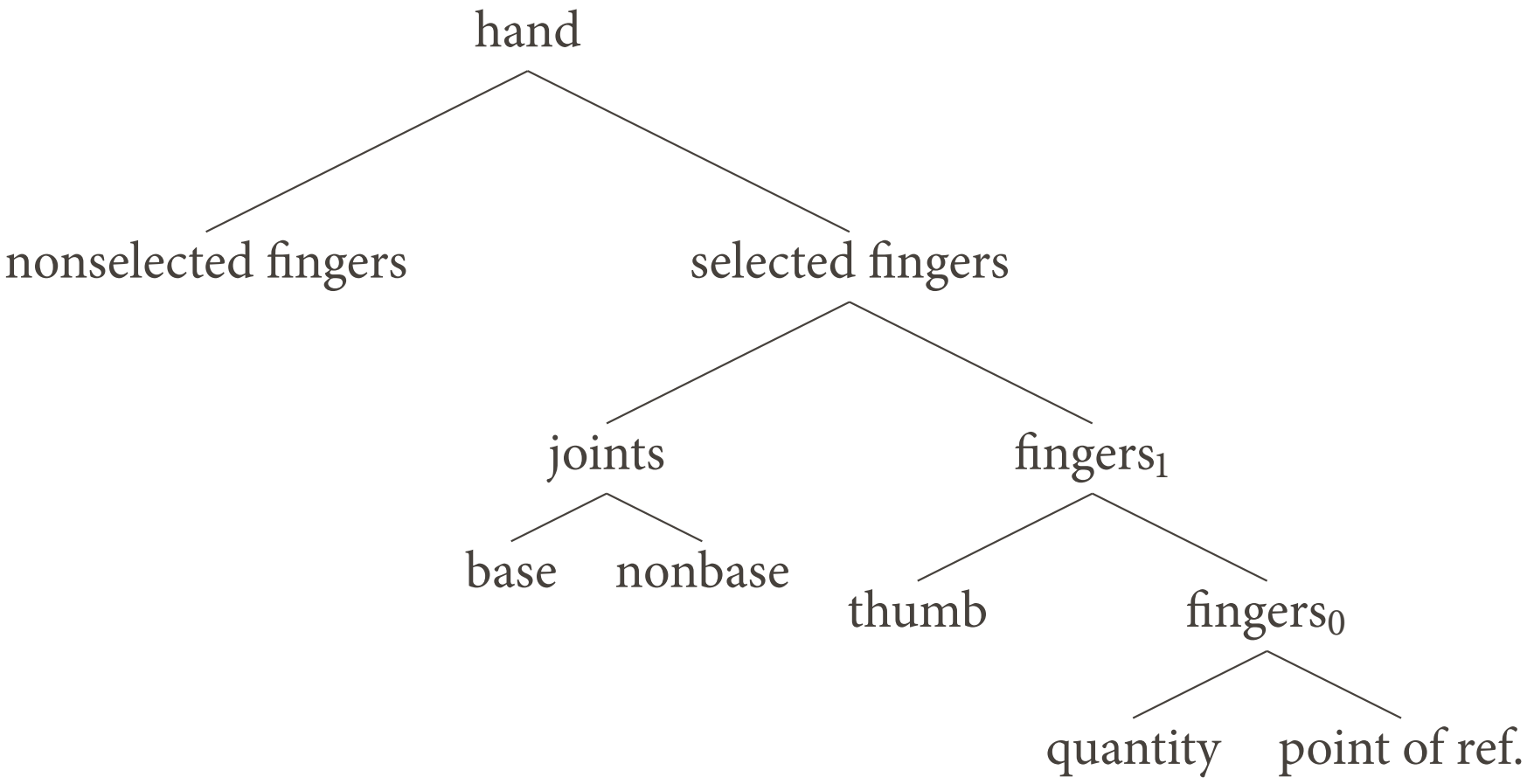
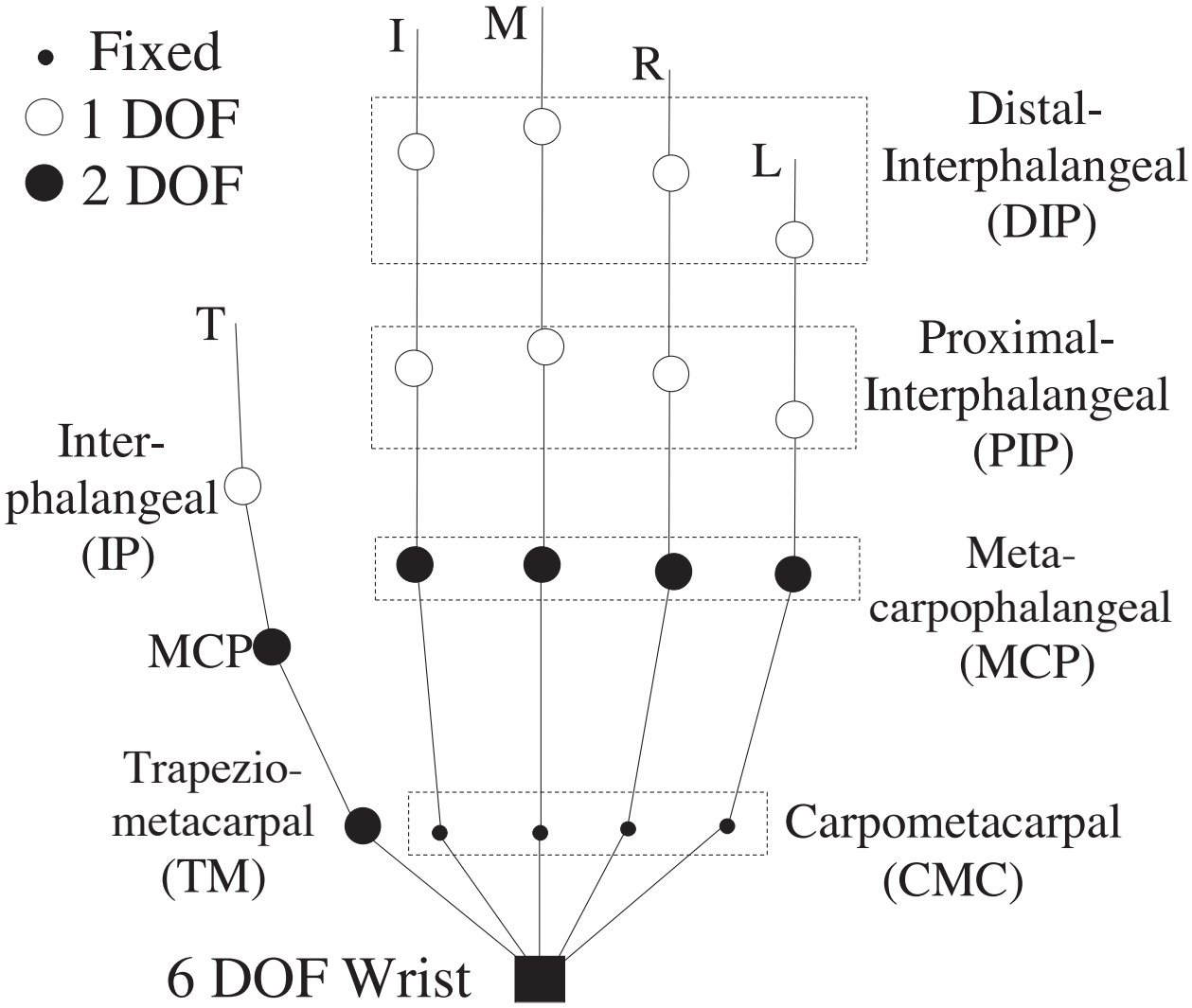


(Brentari, 1998)

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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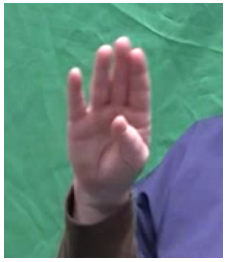
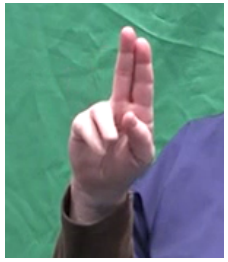
2. The selected fingers are the sources of coarticulatory pressure.

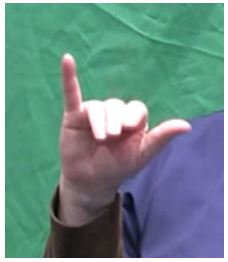
Pinky extension

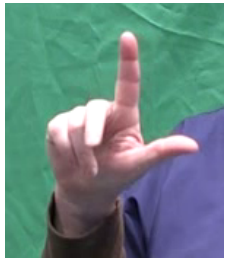
B-U-I-L-D-I-N-G; half speed

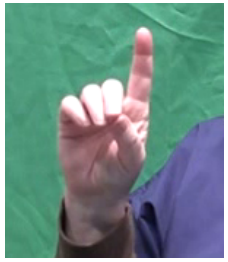
building.mp4

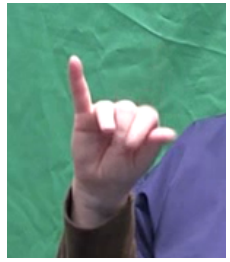

-B-

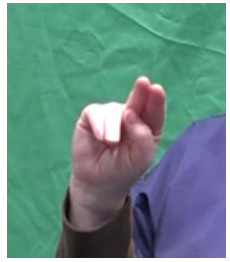

-U-

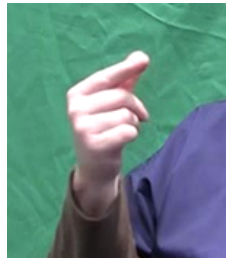

-I-


*-L-


*-D-

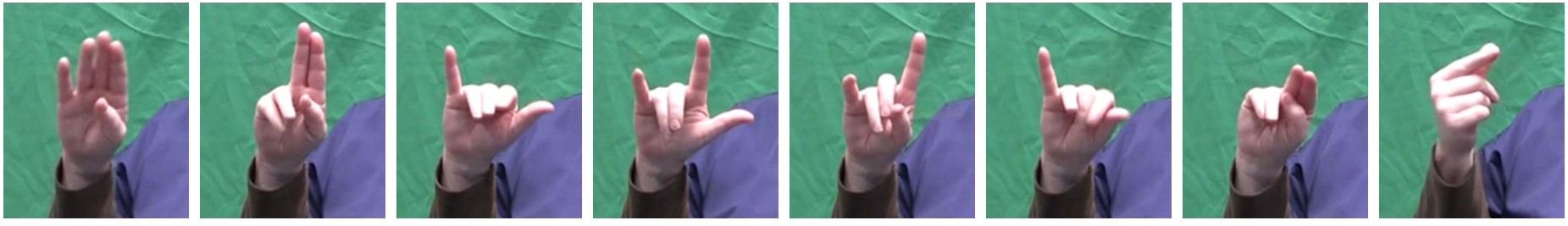

-I-


-N-


-G-

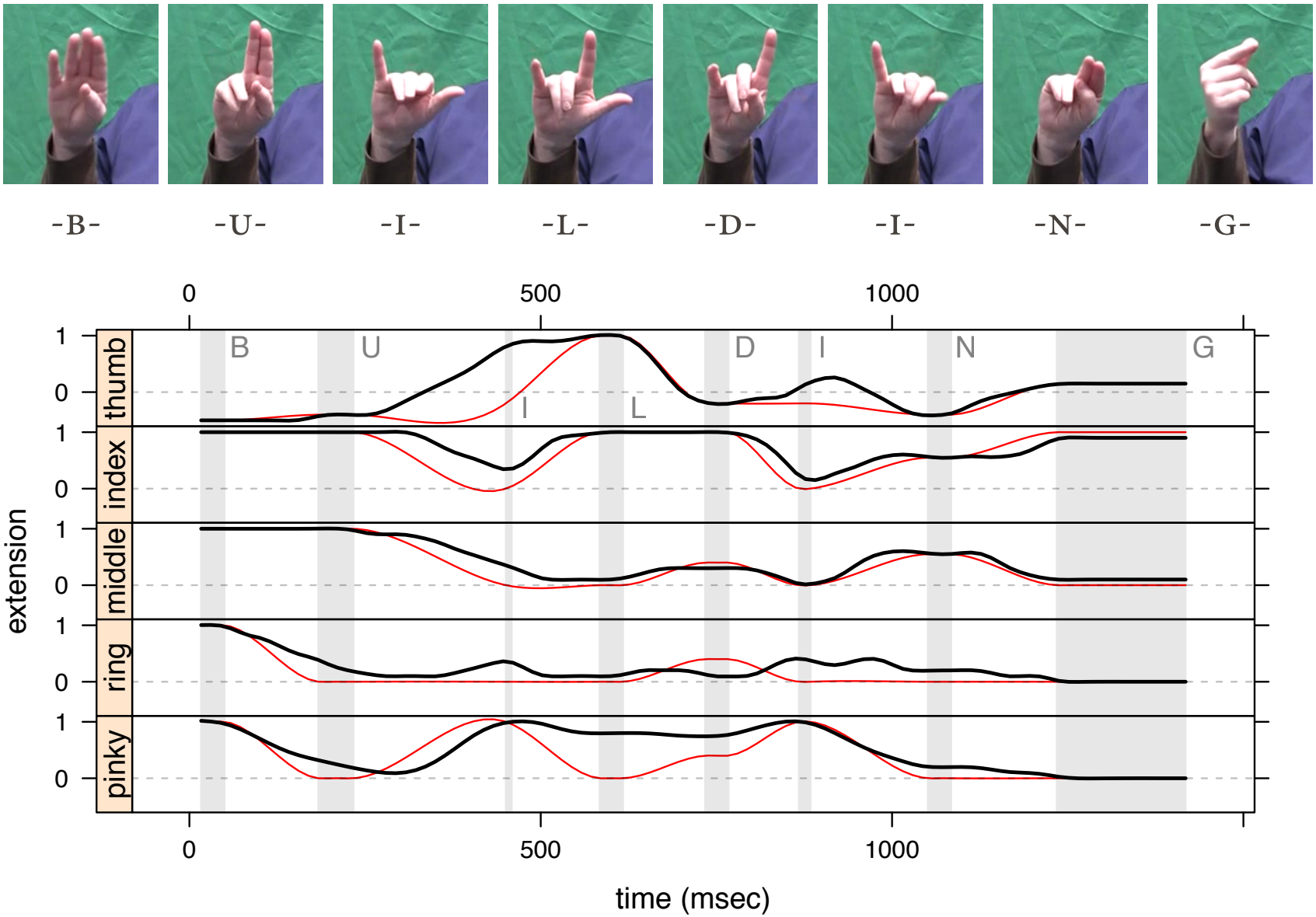
B-U-I-L-D-I-N-G; half speed

building.mp4



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

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



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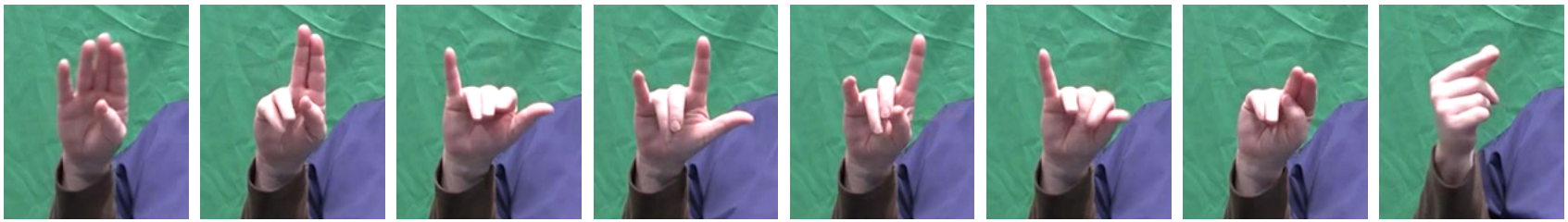
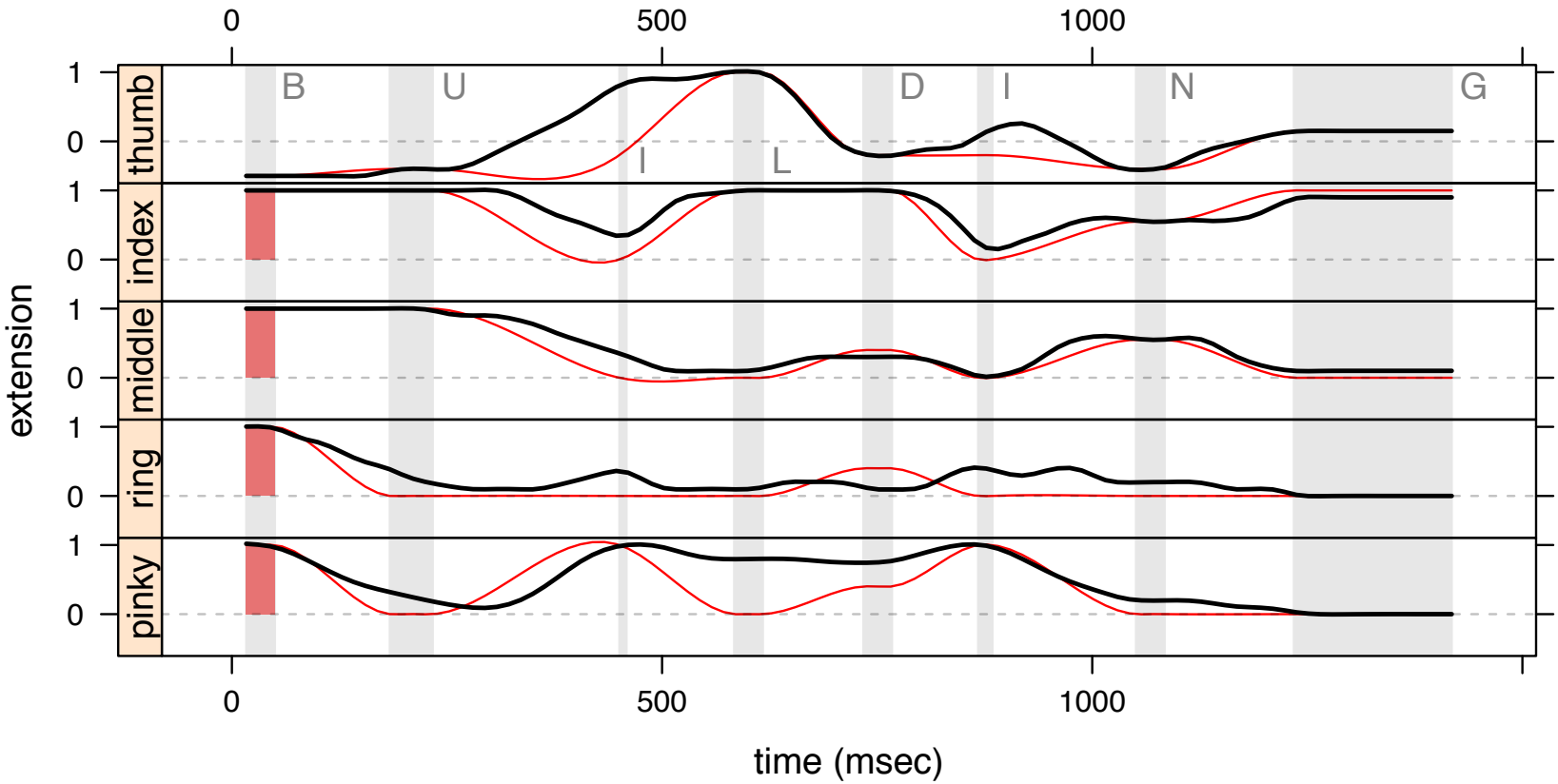
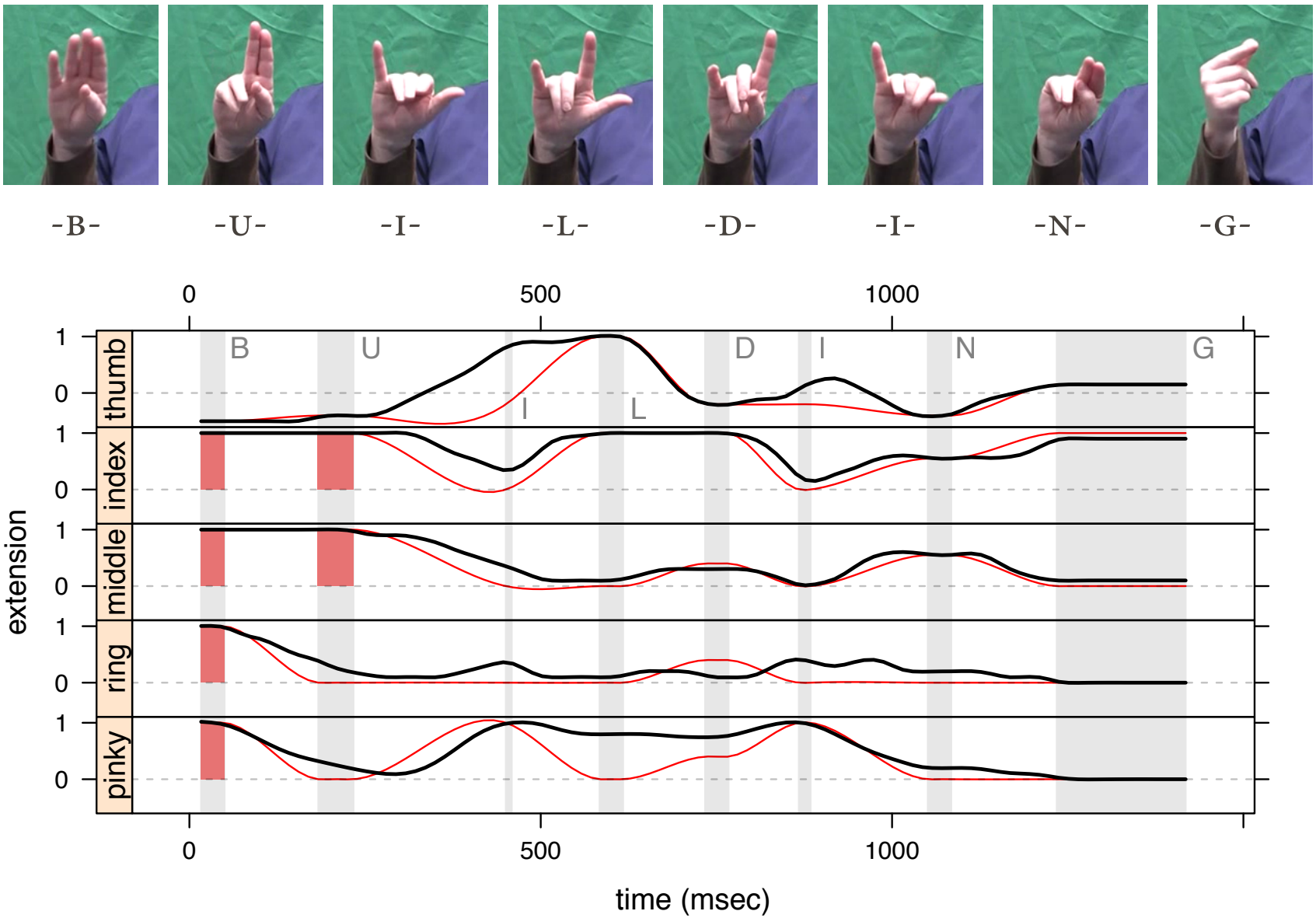


-B- -U- -I- -L- -D- -I- -N- -G-



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



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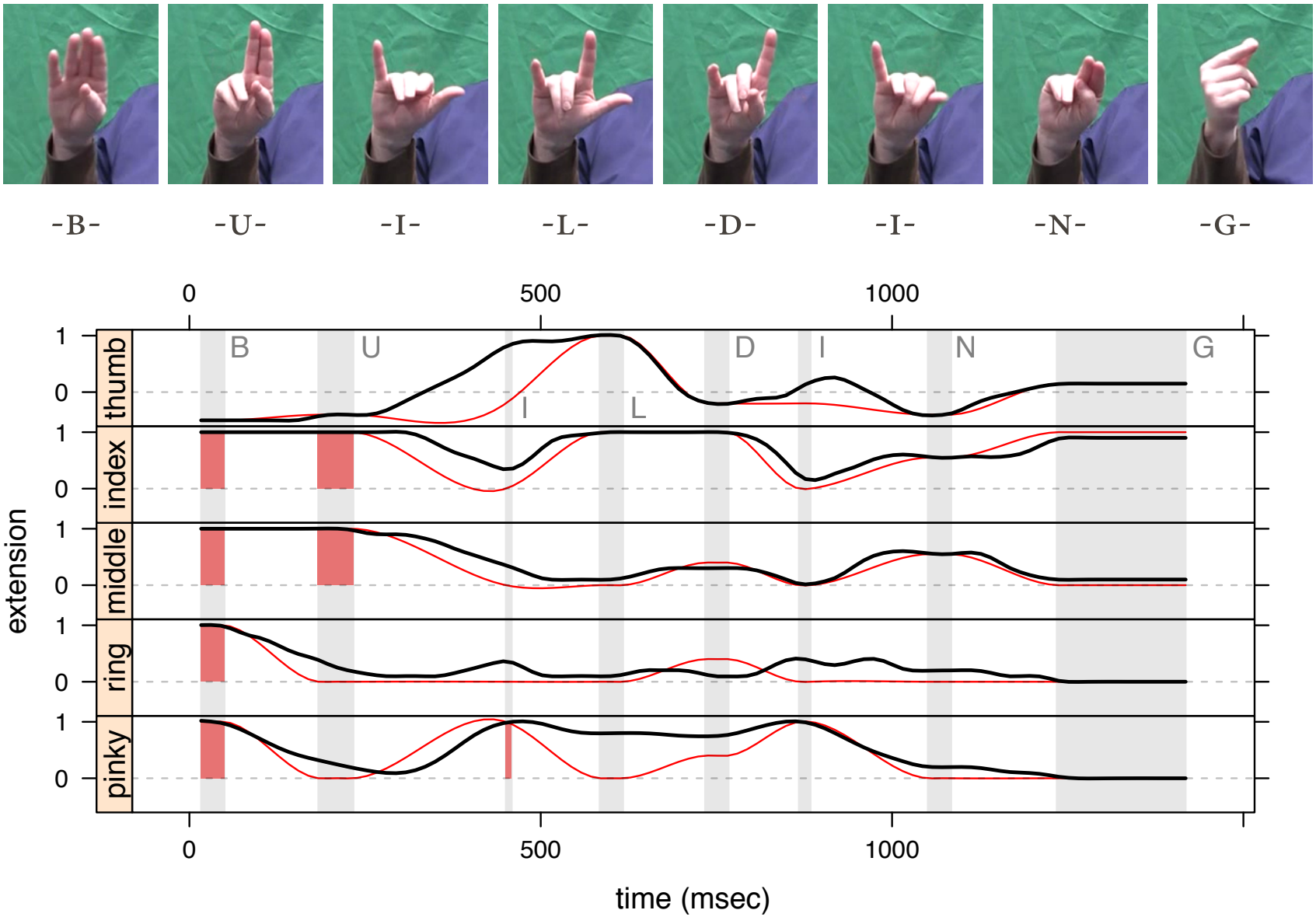

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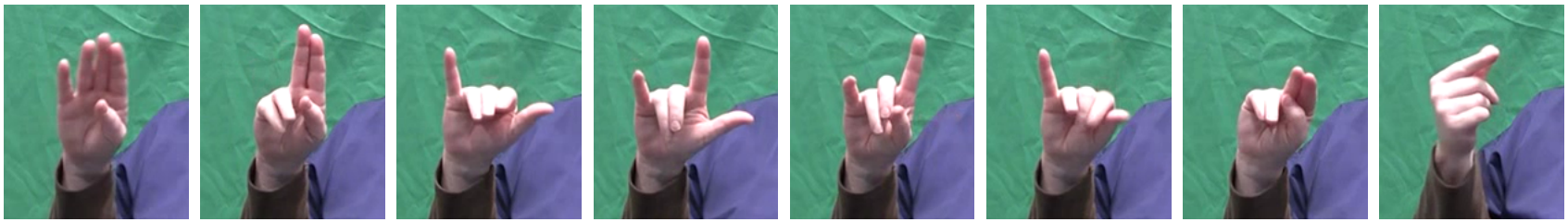
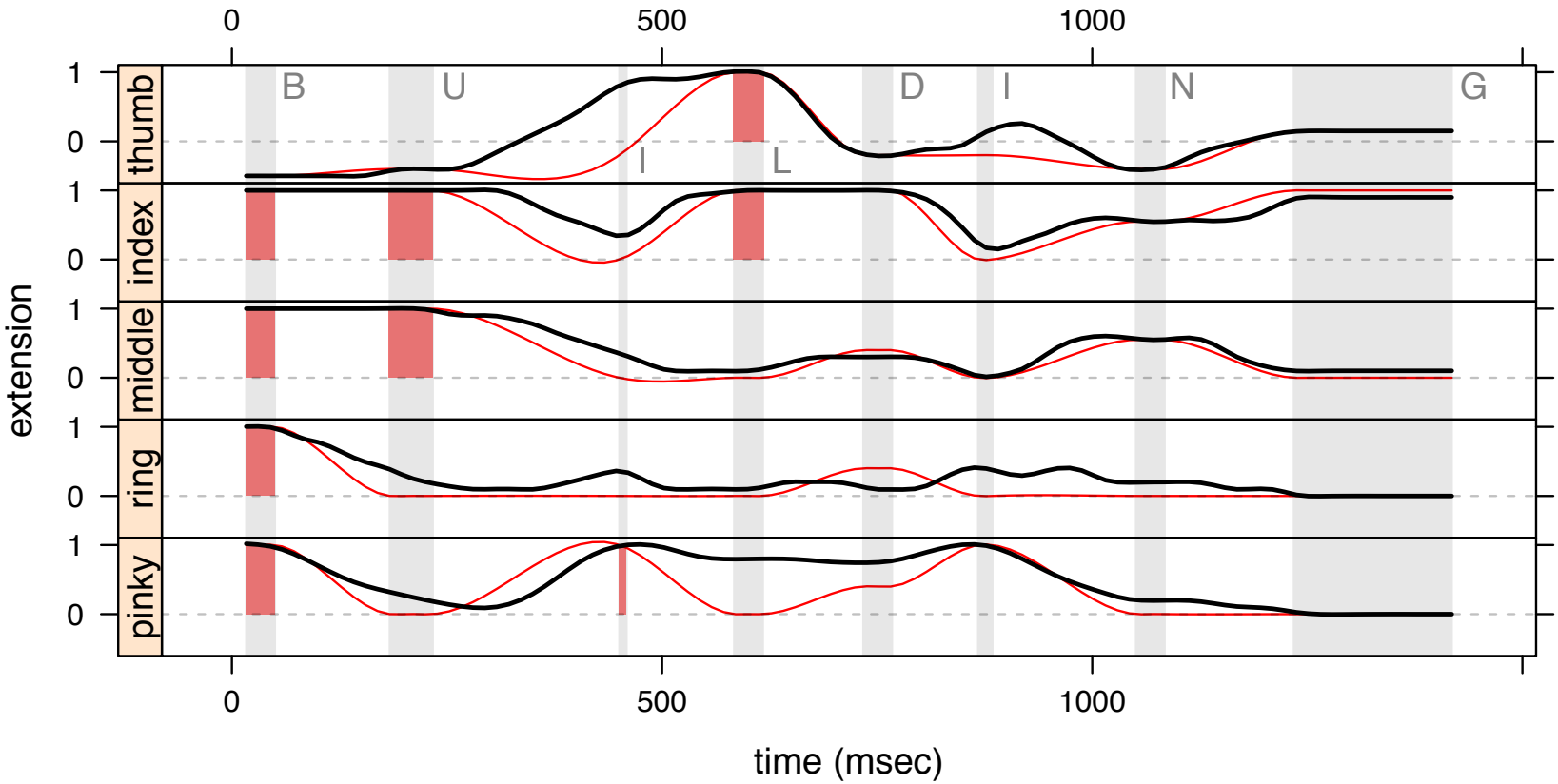


-B- -U- -I- -L- -D- -I- -N- -G-



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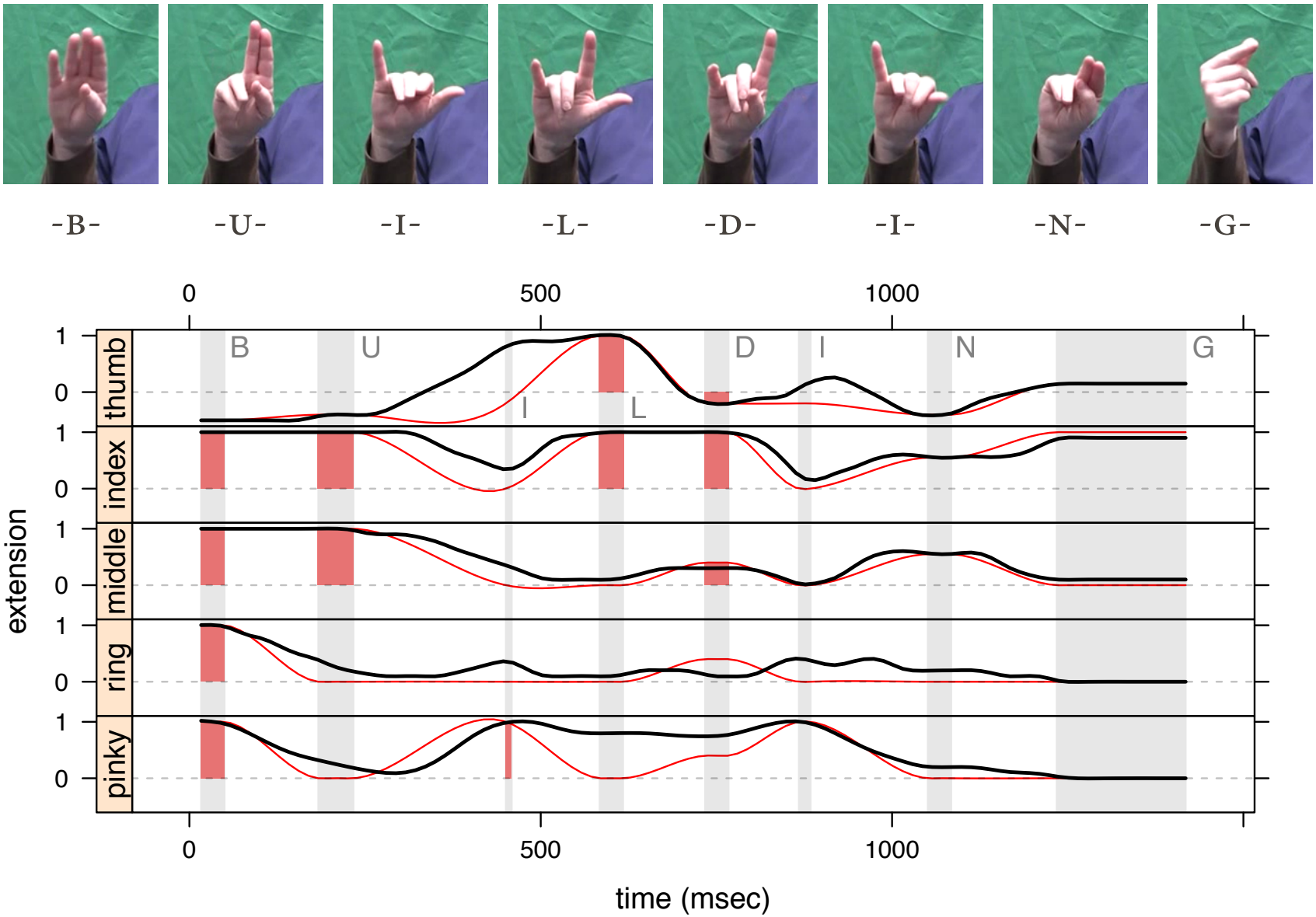

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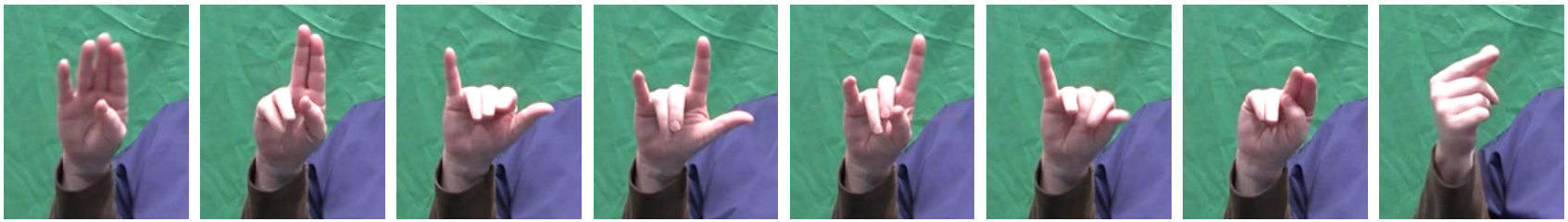
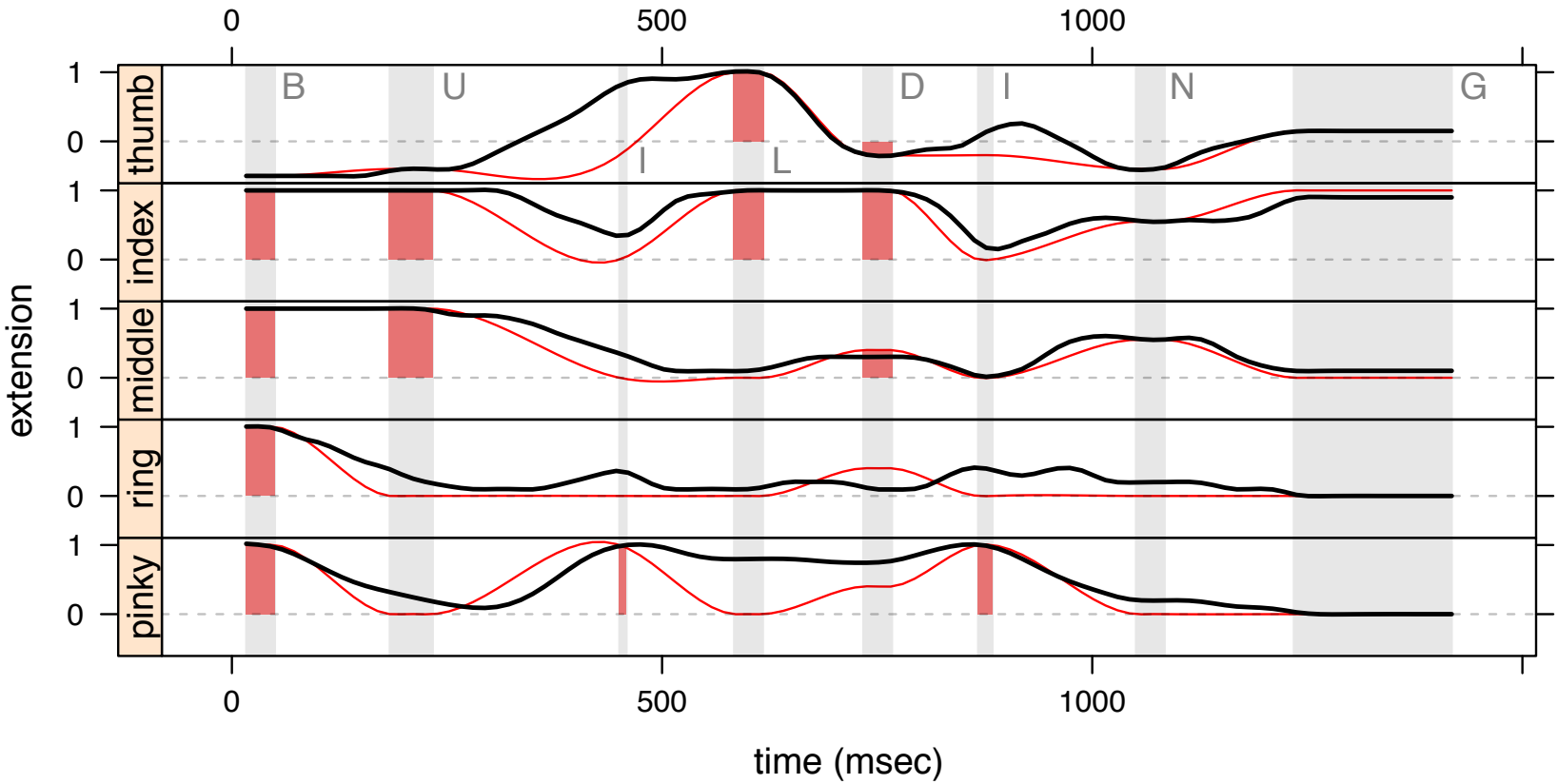


-B- -U- -I- -L- -D- -I- -N- -G-



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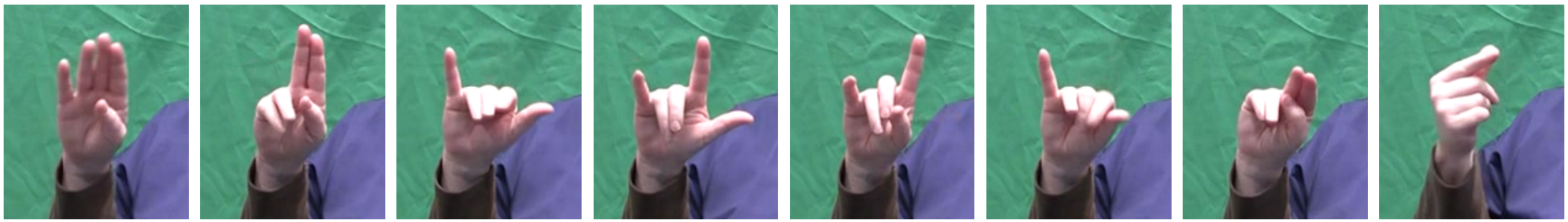

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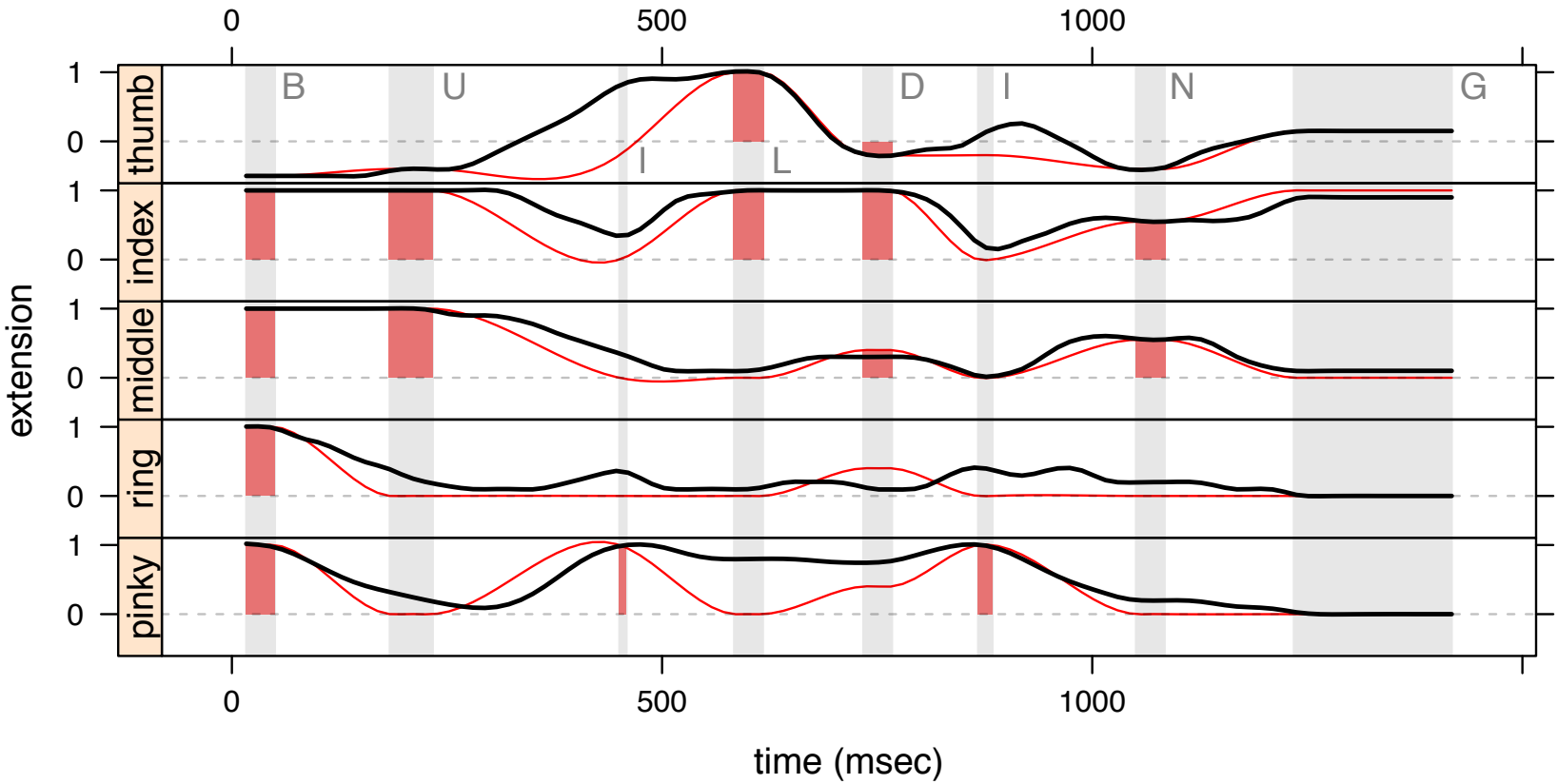

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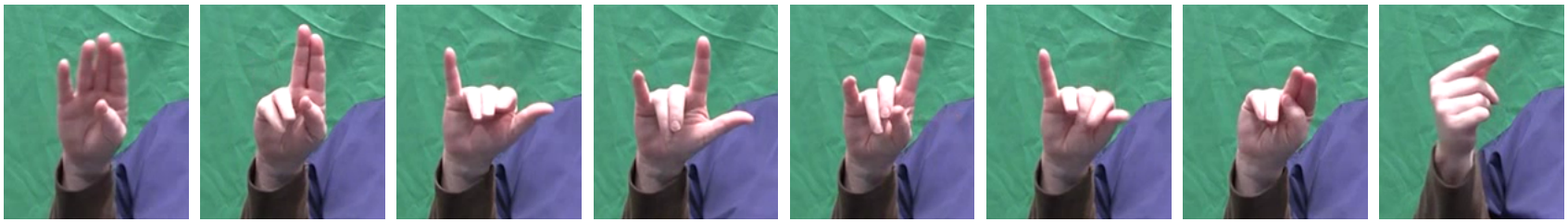

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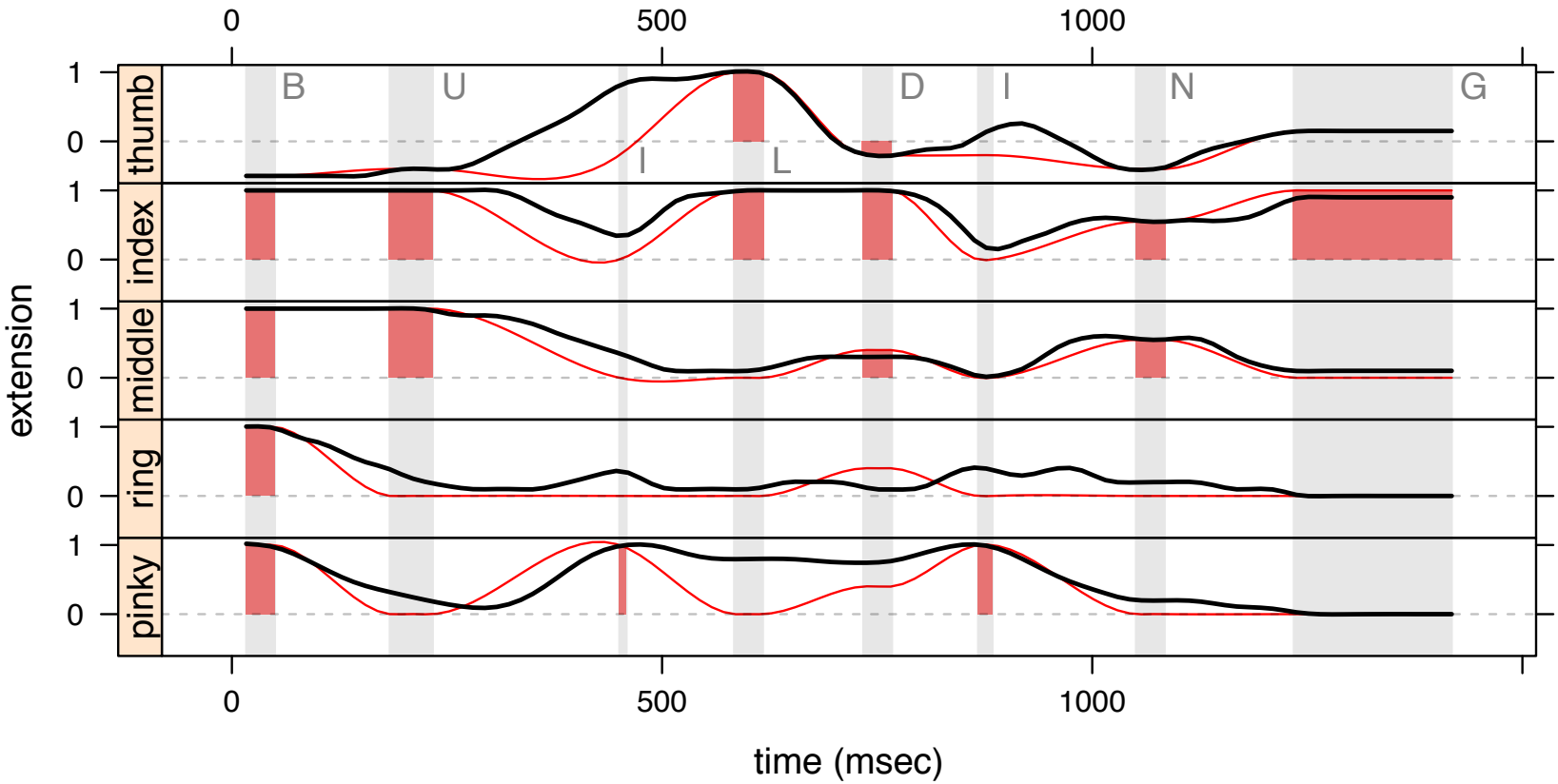

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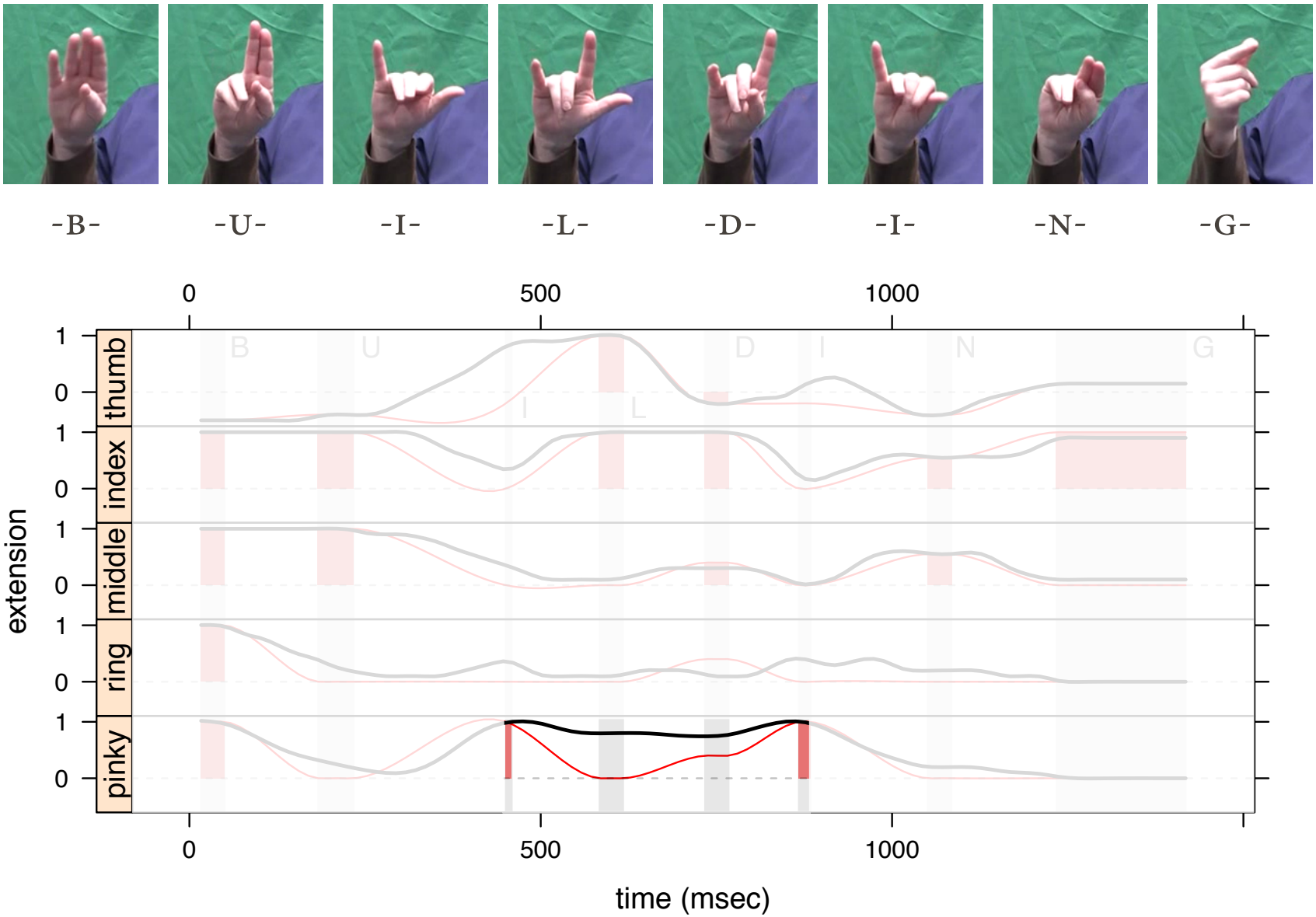

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- 600 words
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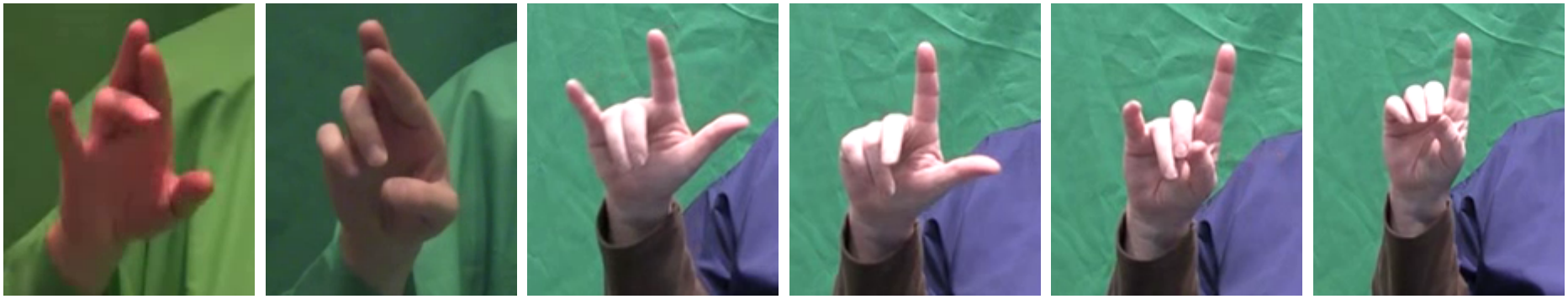
- for a total of 21,453 letters

Pinky extension

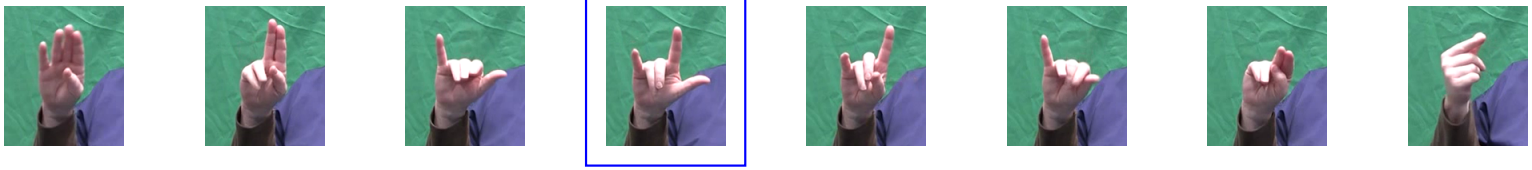
A still image of each letter was annotated for pinky extension, defined as:

- 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.

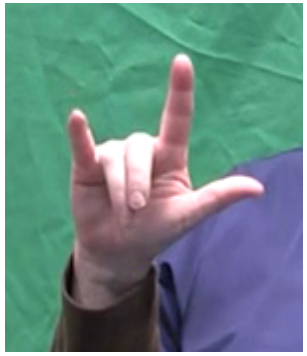


-R- [+ext] -R- [−ext] -L- [+ext] -L- [−ext] -D- [+ext] -D- [−ext]

What affects the -L- handshape?



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



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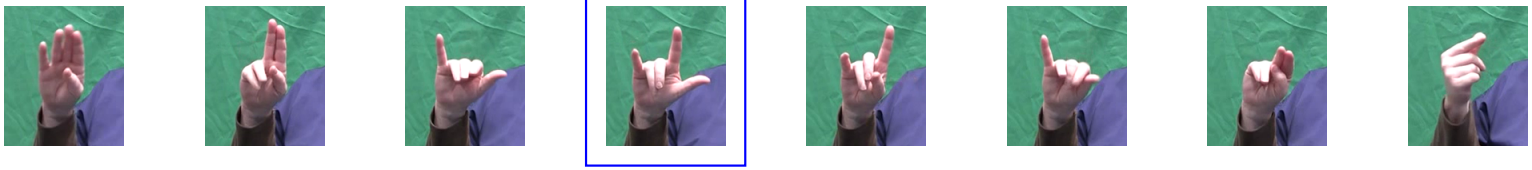
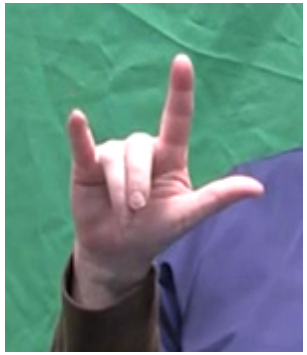


-B- -U- -I- -L- -D- -I- -N- -G-



↑

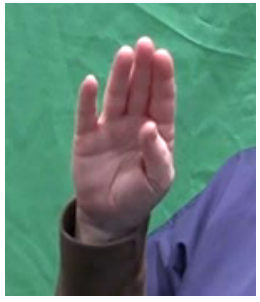
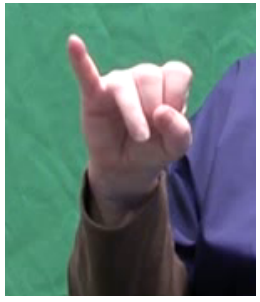
current handshape

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

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

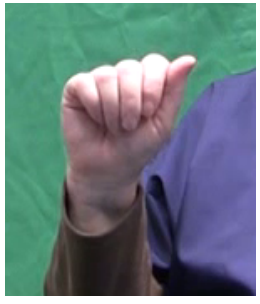
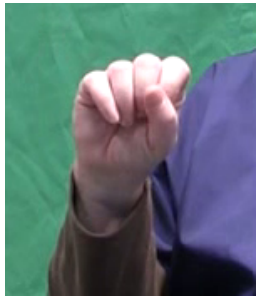
What affects the -L- handshape?

current handshape groups

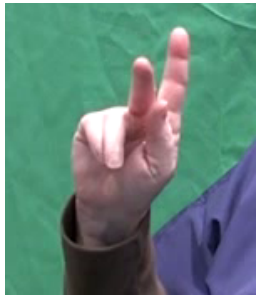
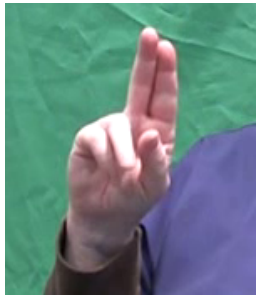
Extended (and selected) pinky:

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

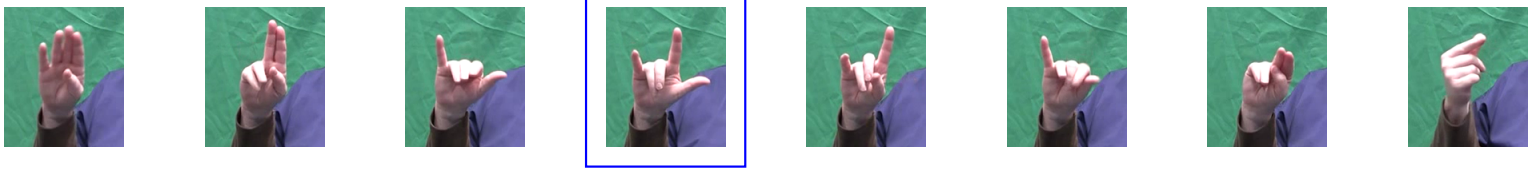
Flexed and selected pinky:

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

other

What affects the -L- handshape?



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

word type

name; noun;

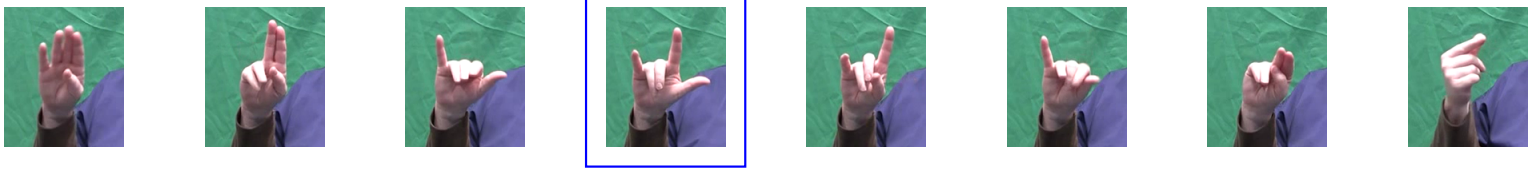
non-English

current 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;

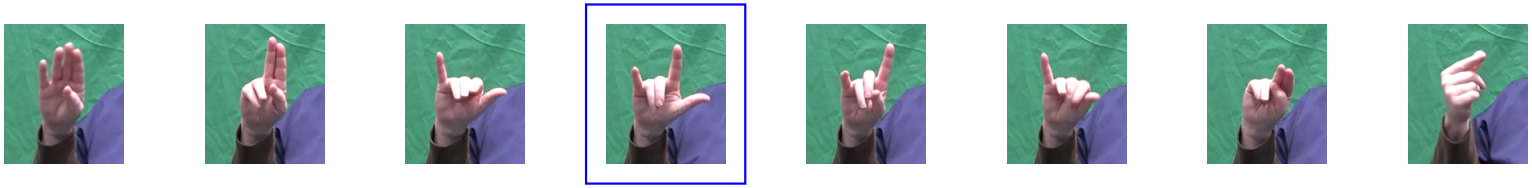
non-English

current 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-

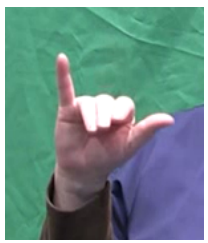
local transition time

zscore of log(time)

word type

name; noun;

non-English



previous handshape

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

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

other;

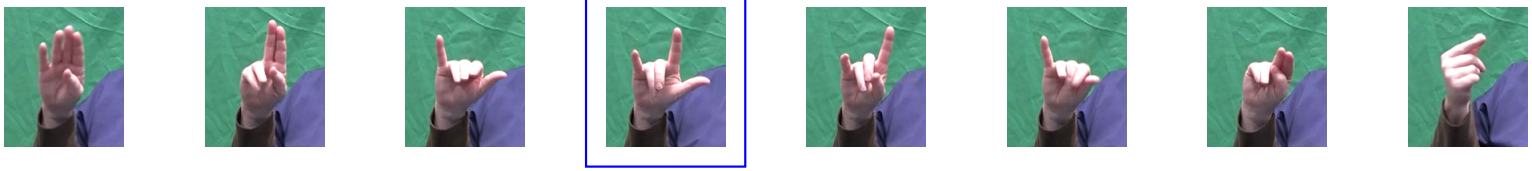
word boundary

current handshape

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

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

What affects the -L- handshape?



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

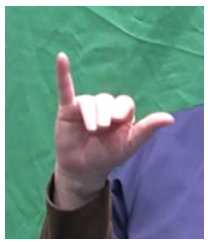
local transition time

zscore of log(time)

word type

name; noun;

non-English



previous handshape

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

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

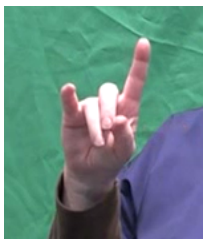
other;

word boundary

current handshape

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

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



following handshape

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

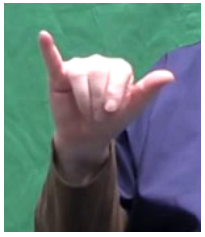
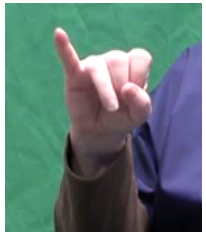
-I-, -J-, or -Y-;

other;

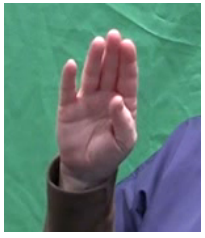
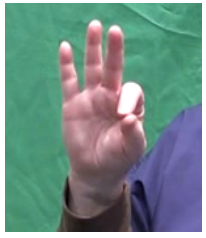
word boundary

What affects the -L- handshape?

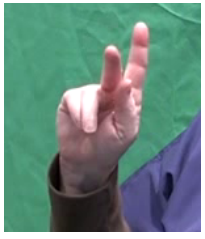
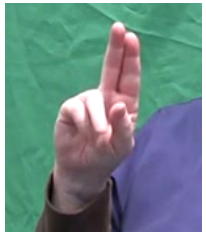
previous/following handshape groups

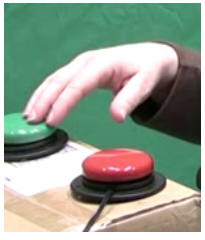
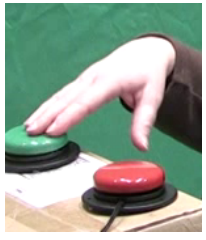
Extended pinky (alone):
-I-, -J-, or -Y-

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

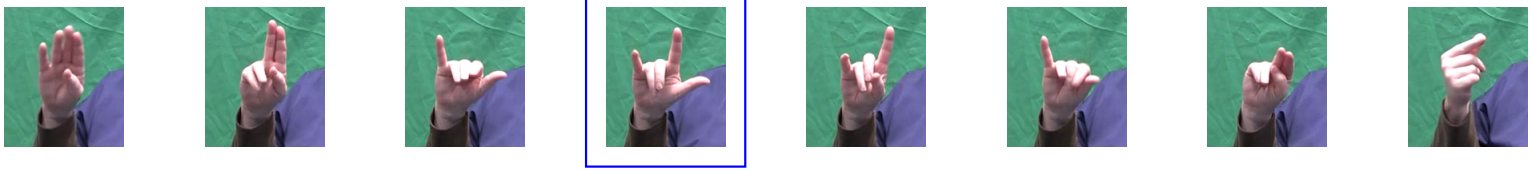



other

word boundary

What affects the -L- handshape?



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

local transition time

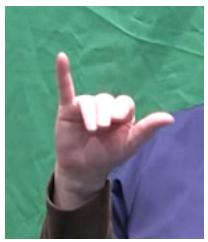
zscore of log(time)

interaction → | ← *interaction*

word type

name; noun;

non-English



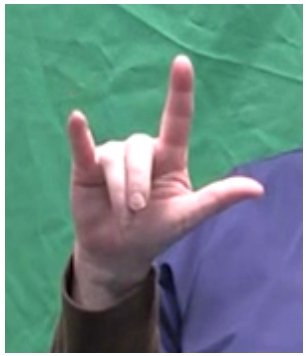
previous handshape

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

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

other;

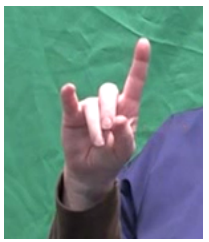
word boundary



current handshape

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

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



following handshape

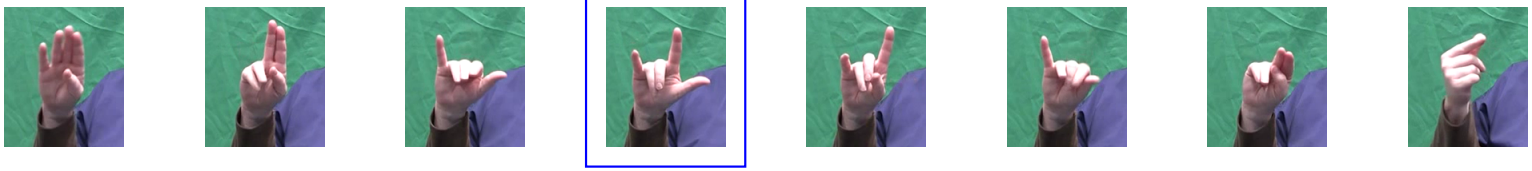
-B-, -C-, or -F-;

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

other;

word boundary

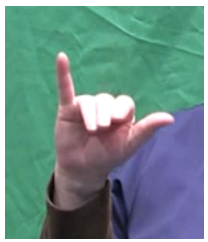
What affects the -L- handshape?



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

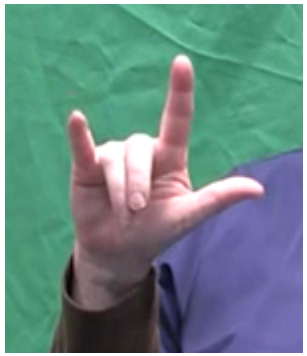
interaction → local transition time
zscore of log(time)
← *interaction*

word type
name; noun;
non-English



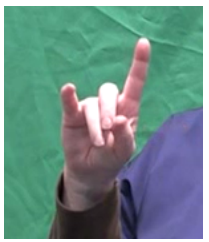
previous handshape

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



current handshape

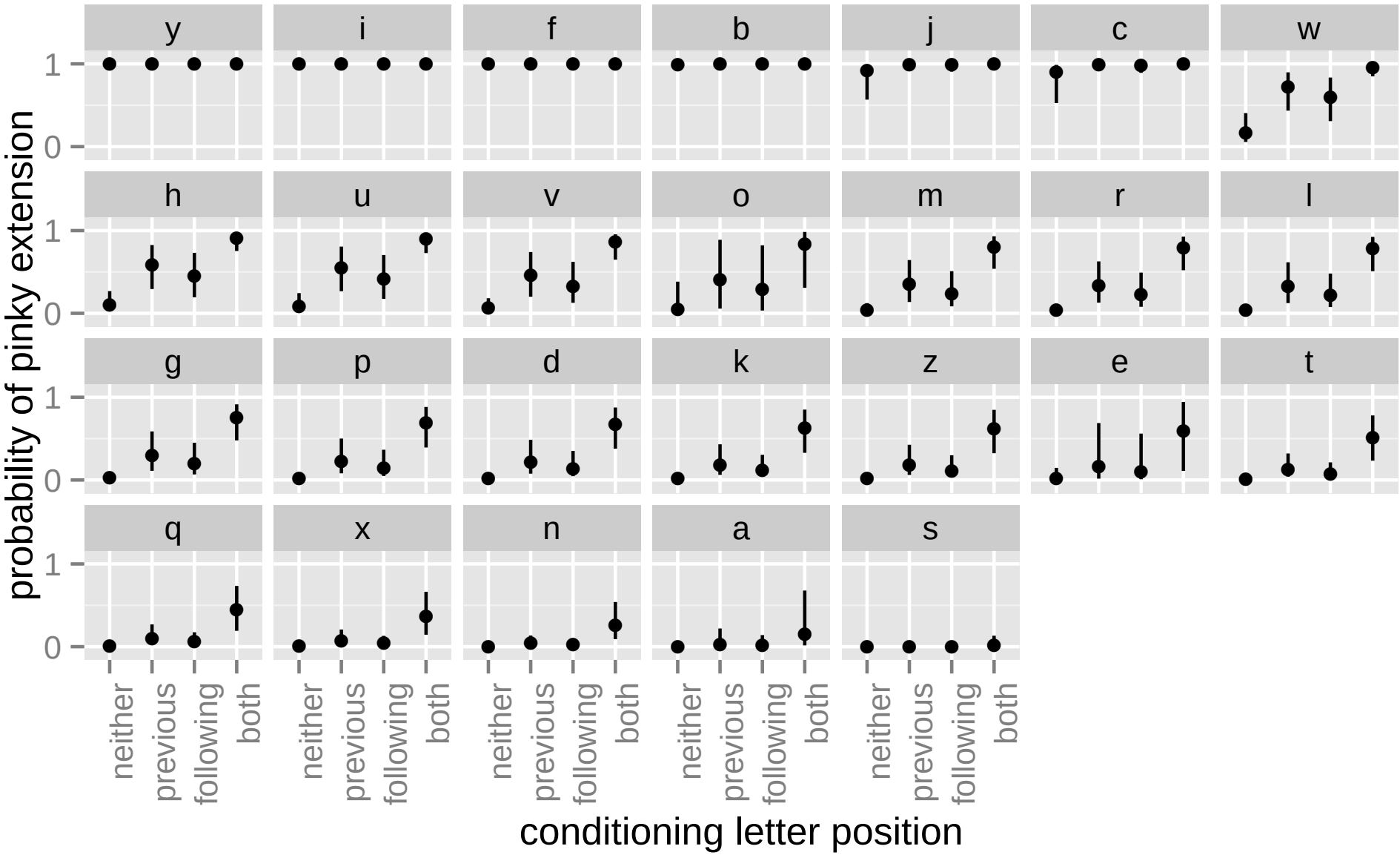
-B-, -C-, -F-, -I-, -J-, or -Y-;
-A-, -S-, -E-, or -O-; other



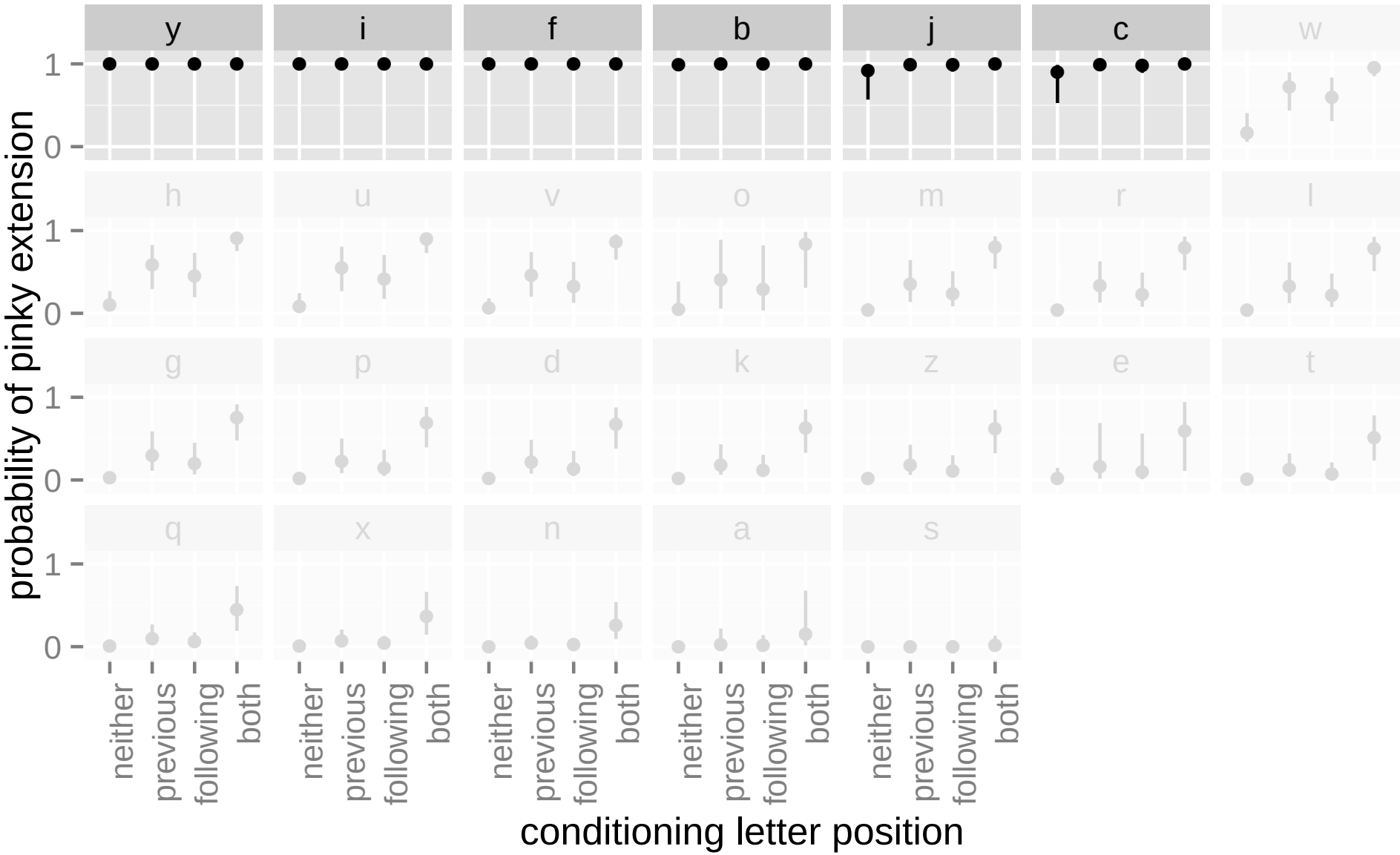
following handshape

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

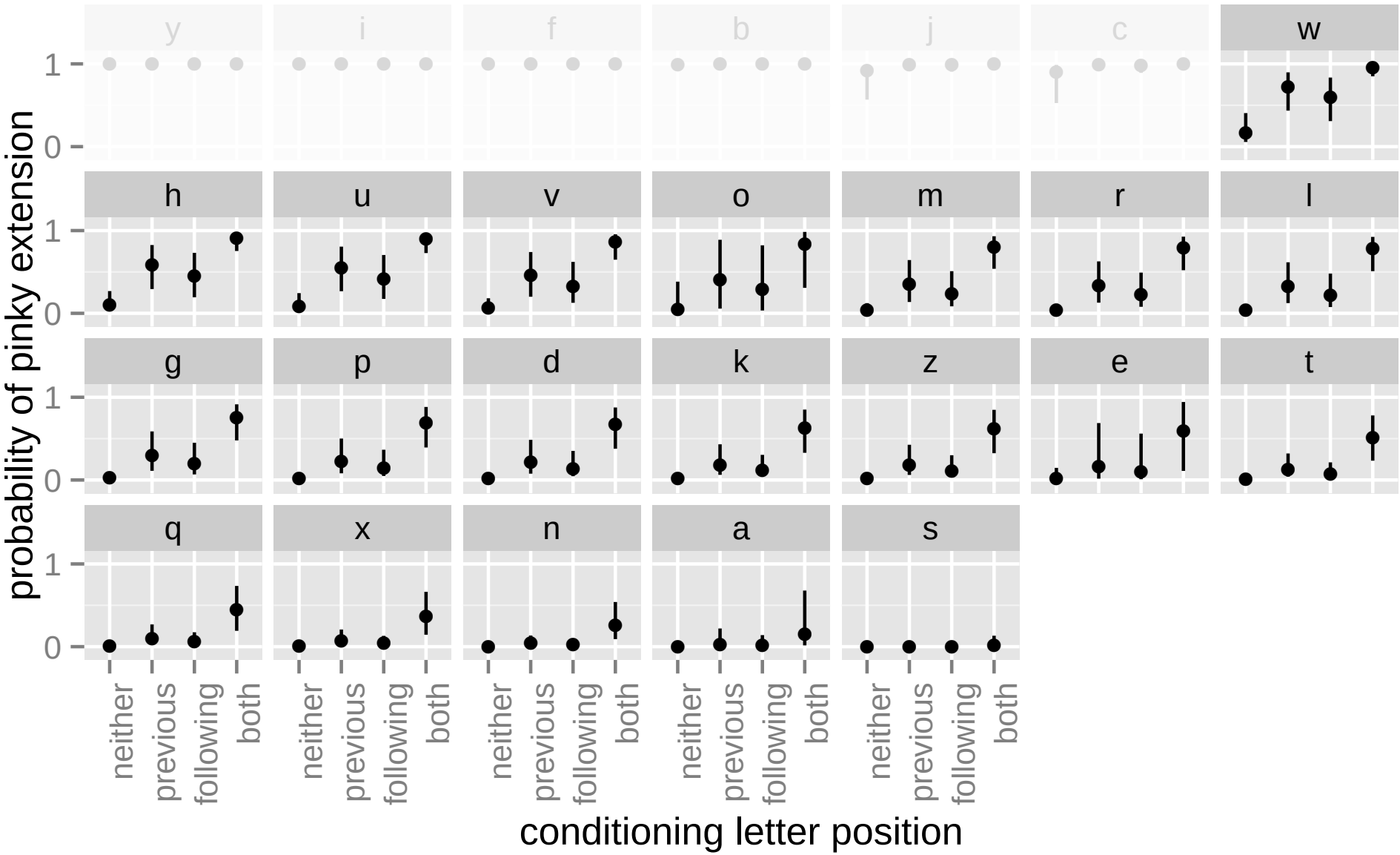
Model predictions around -I-, -J-, or -Y-



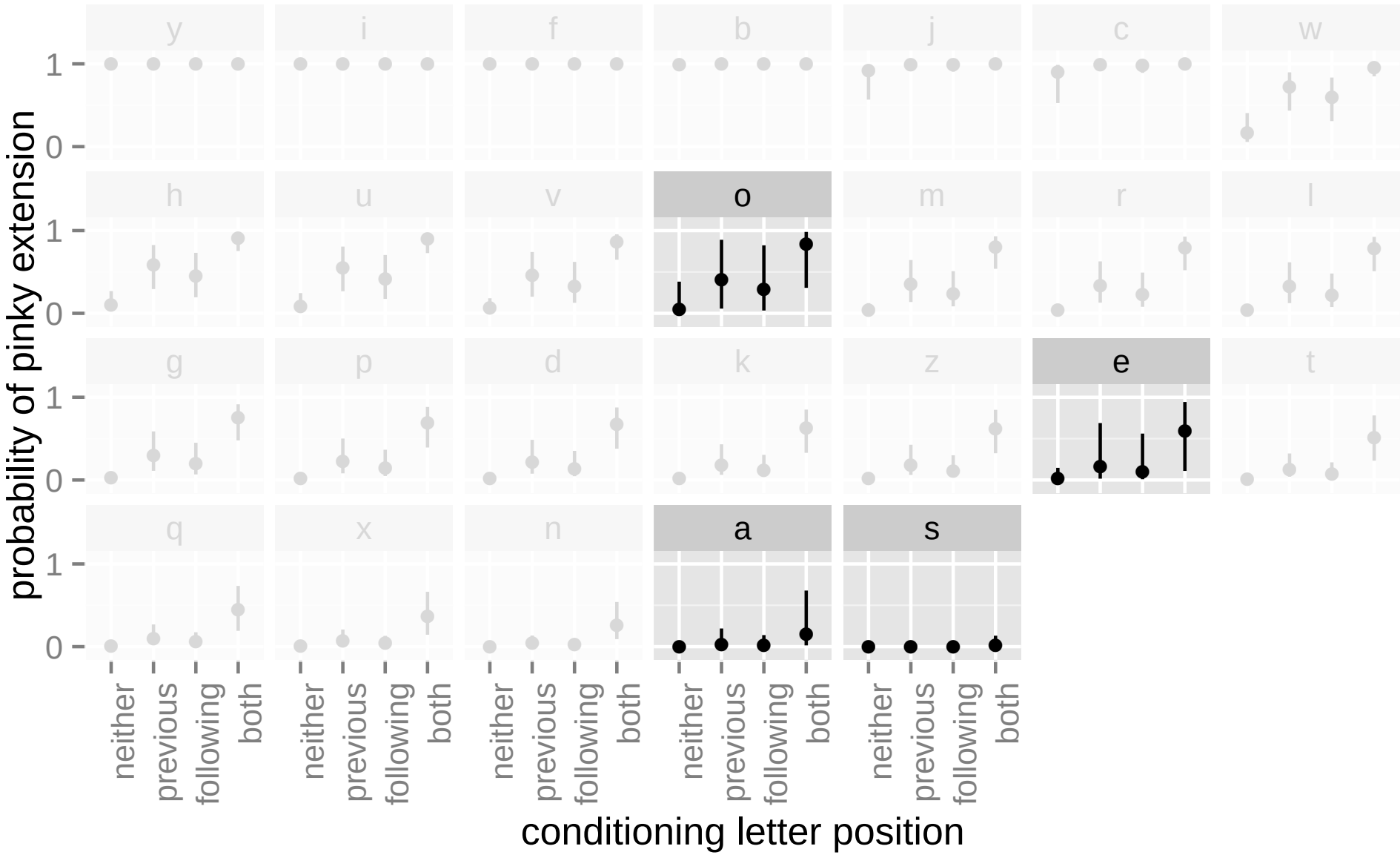
Model predictions around -I-, -J-, or -Y-



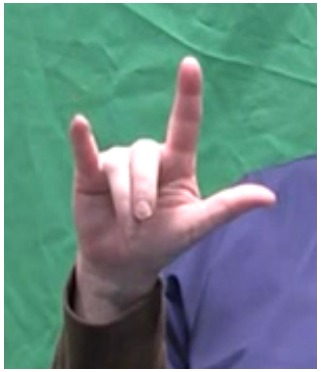
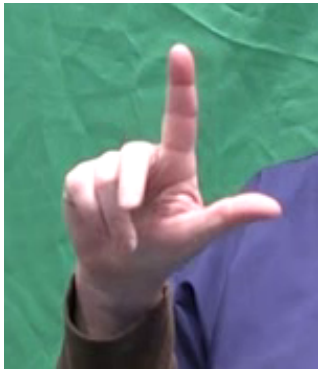
Model predictions around -I-, -J-, or -Y-



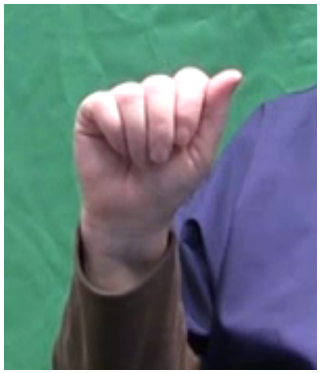
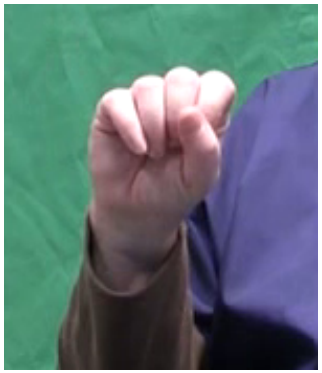
Model predictions around -I-, -J-, or -Y-



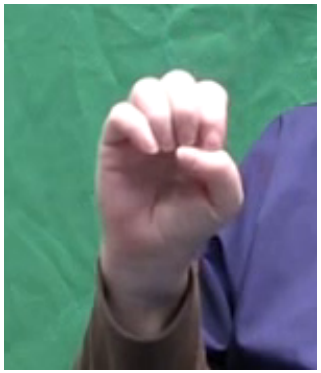
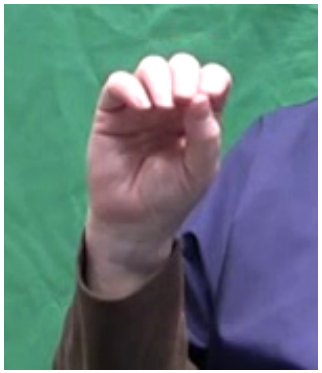
What's special about -A-, -S-, -E-, and -O-?

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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   - 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.

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

Fingerspelling data
Andy Gabel, Rita Mowl, Drucilla Ronchen, and Robin Shay

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Other researchers
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NSF Doctoral Dissertation Research Improvement Grant
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