SEGMENTS IN ASL FINGERSPELLING

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CUNY Phonology Forum 2012: Conference on the Segment

Outline

Introduction

- Background
- Pinky Extension

Methods

- Data collection
- Coding method

Data

- Description
- Conditioning variables

Results

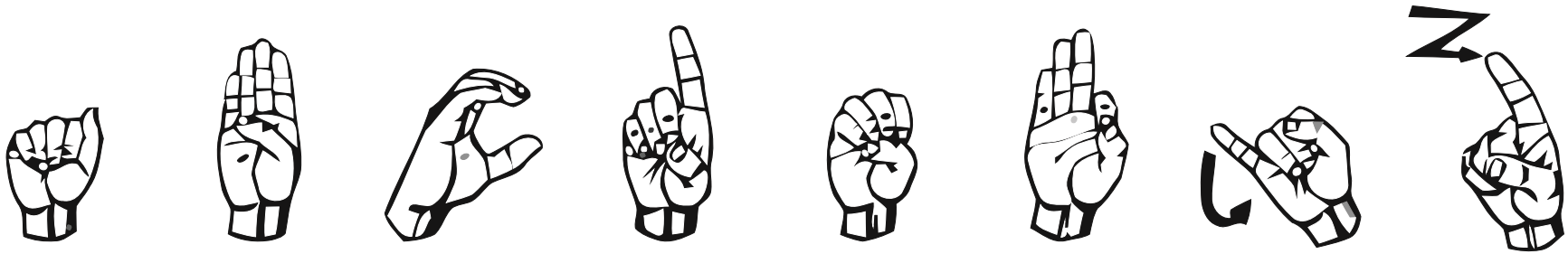
- Model

Segmentation

- 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-) handshape-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.
- Hoopes (1998) notes pinky extension and coarticulation in fingerspelling.

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

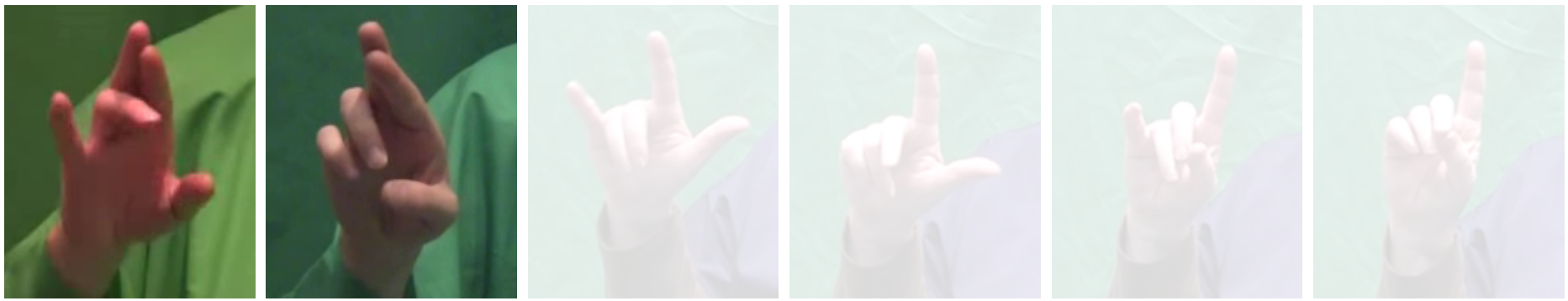
- We extracted still images from the data that has been coded.
- We hand coded pinky extension for all apogees.
- There are total of 4,741 word medial apogees annotated.

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.



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

Apogees from C-H-R-I-S, D-I-N-O-S-A-U-R, O-I-L, W-O-R-L-D, B-U-I-L-D-I-N-G, W-O-R-L-D

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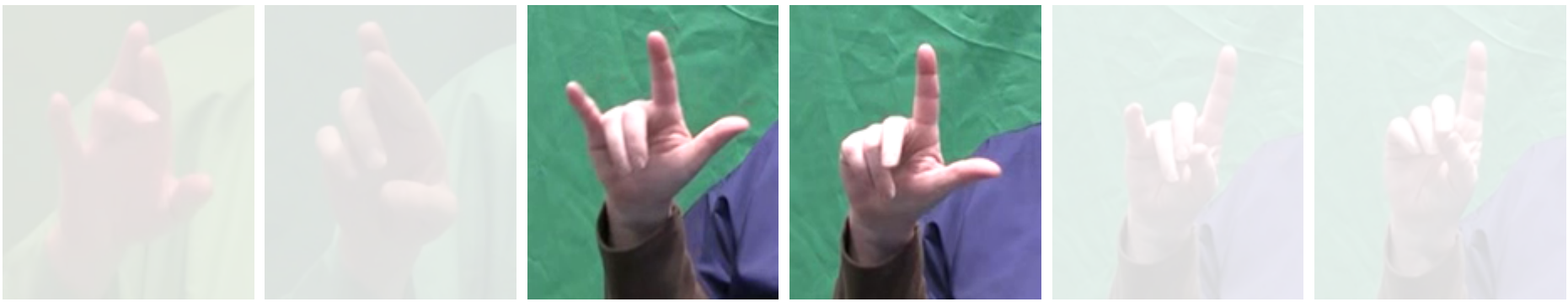

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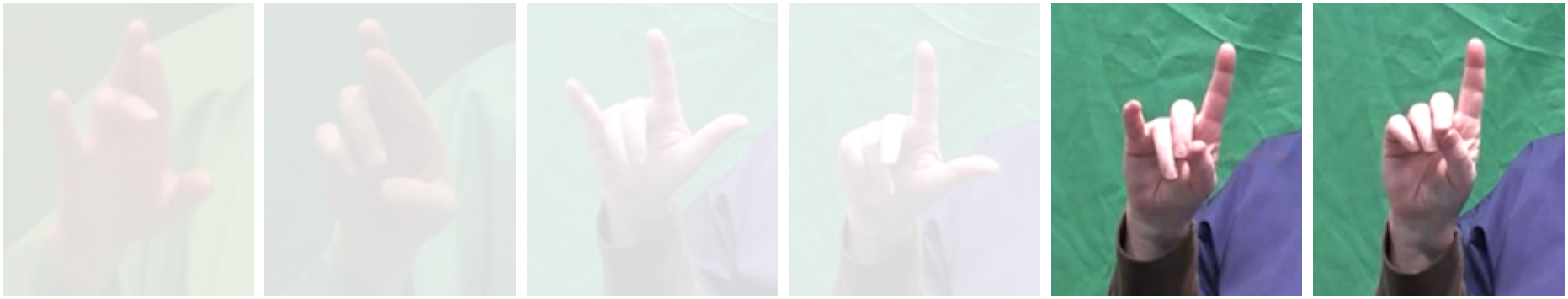

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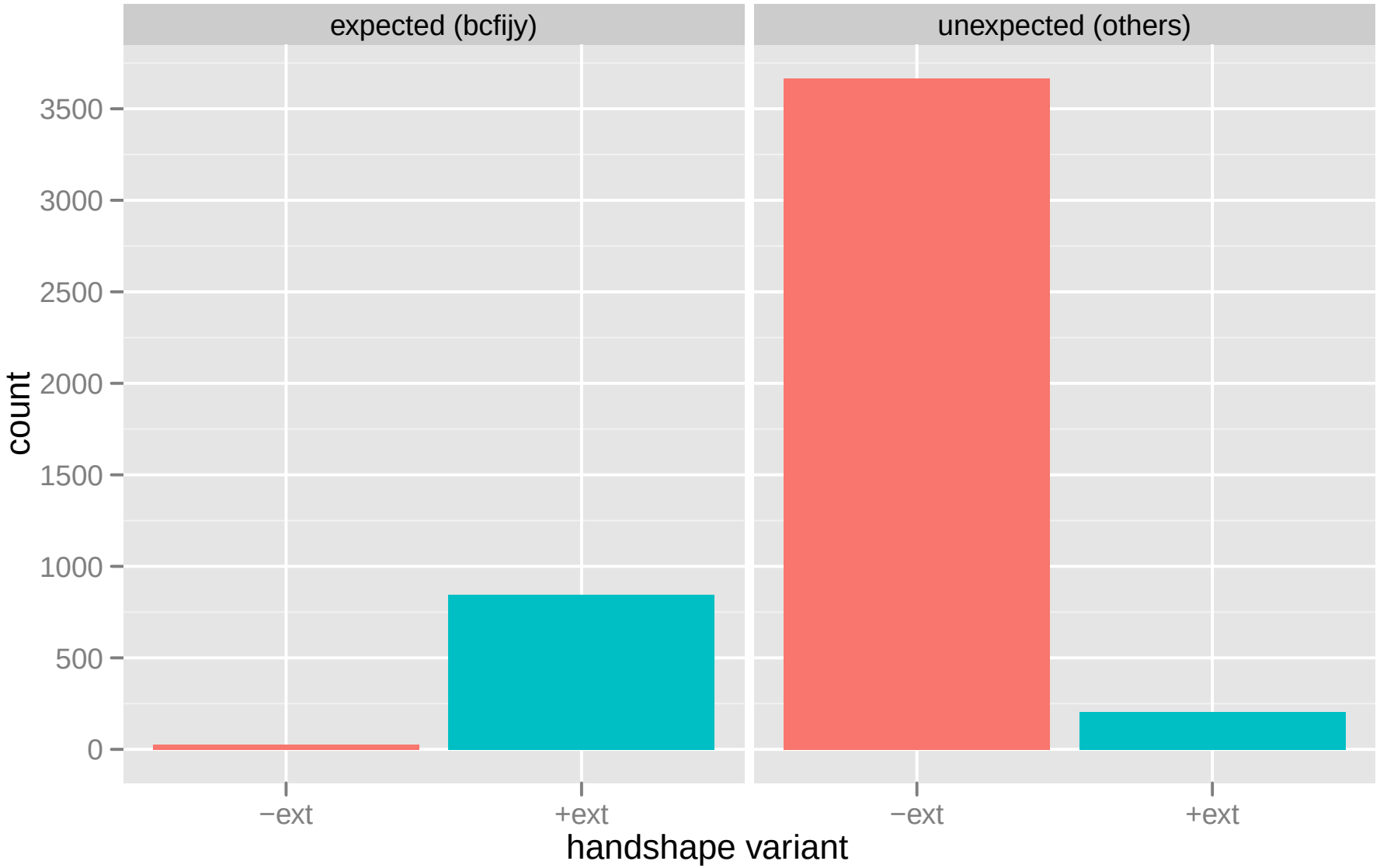
Handshape variation



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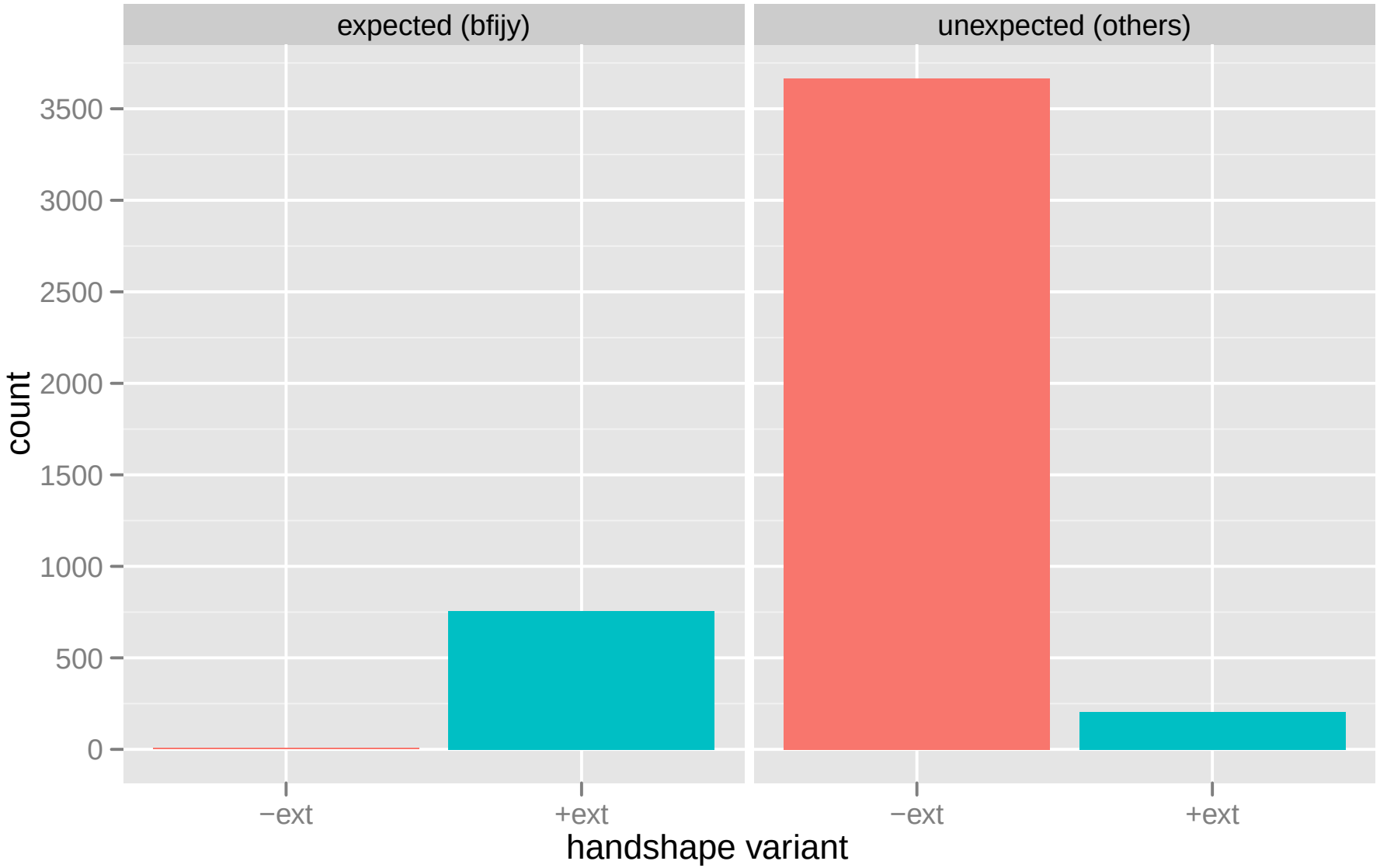
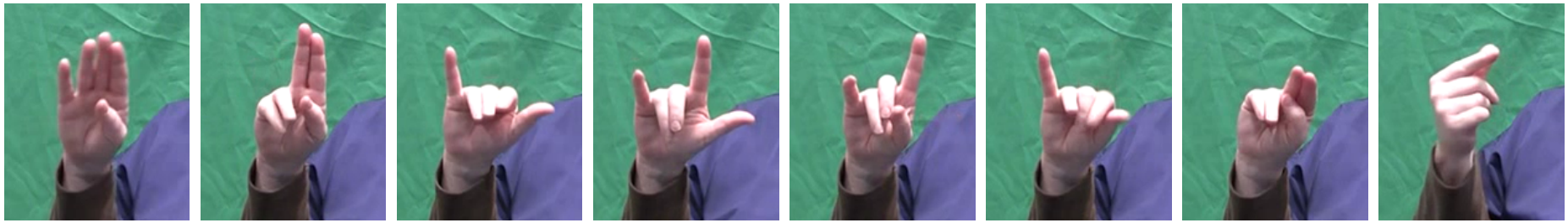


B-U-I-L-D-I-N-G; full speed

building.mp4



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

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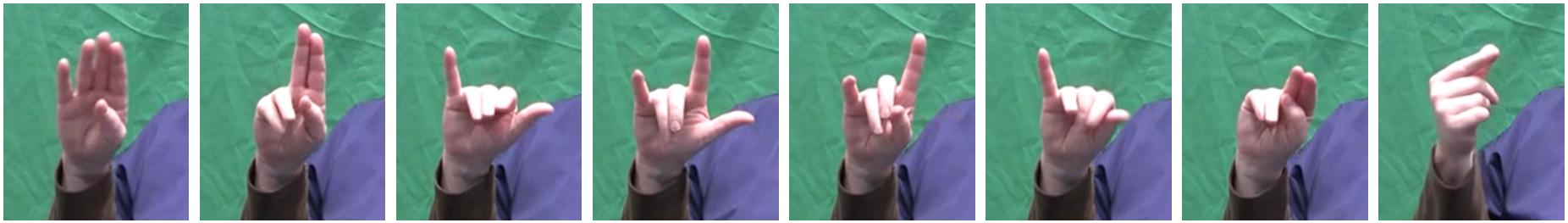
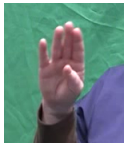
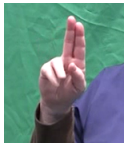
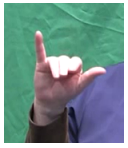


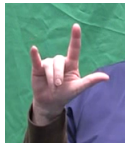
-B- -U- -I- -L- -D- -I- -N- -G-

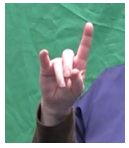
What affects the -L- handshape?

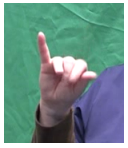

-B-

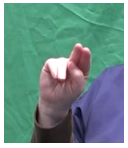

-U-

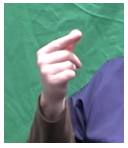

-I-

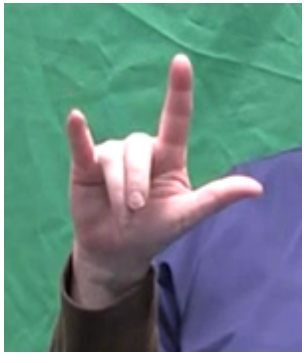

-L-


-D-

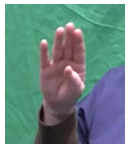
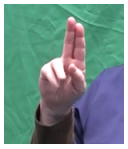
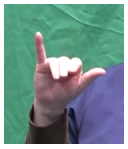
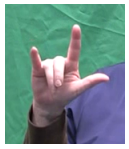
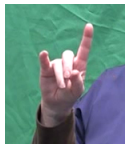
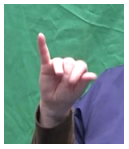
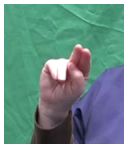
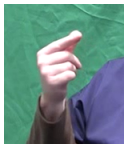

-I-


-N-


-G-



What affects the -L- handshape?

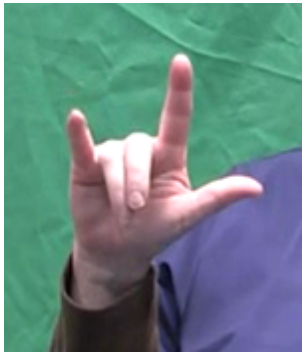
-B- -U- -I- -L- -D- -I- -N- -G-

word type

name, noun, non-English

signer

S1, S2



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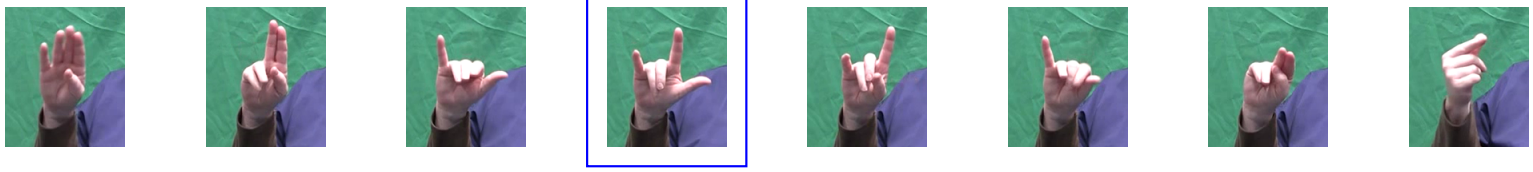

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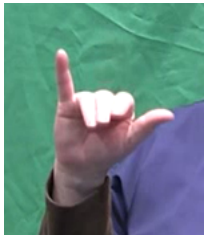
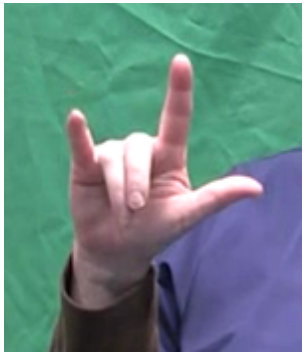


previous handshape ⟶



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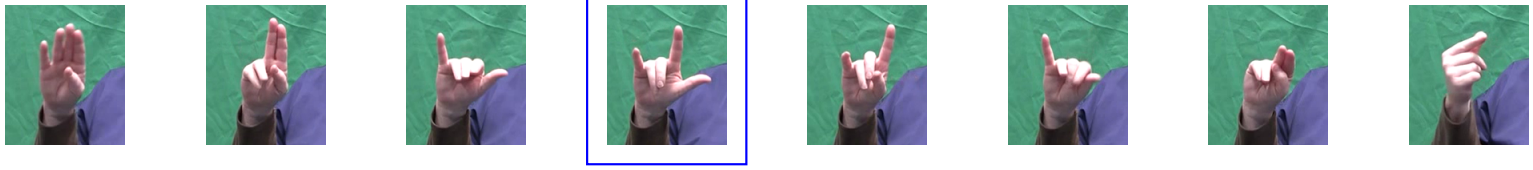

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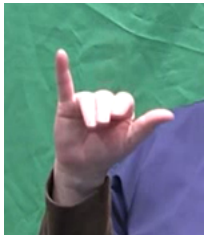
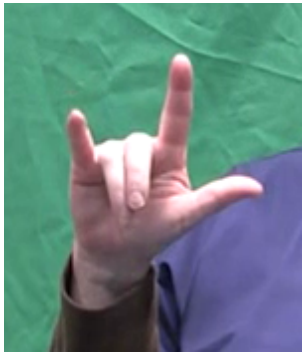
s1, s2



previous handshape

previous transition time



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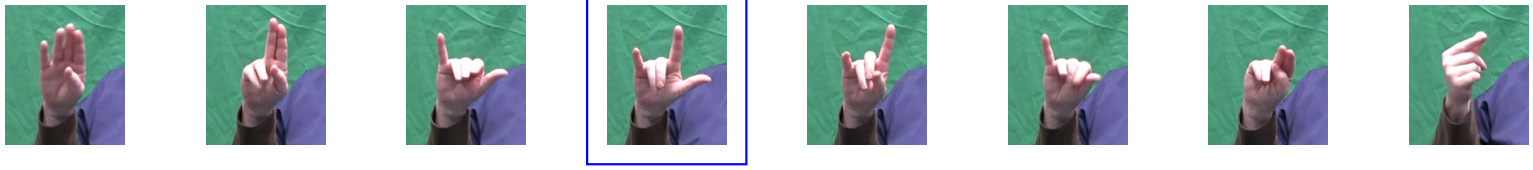

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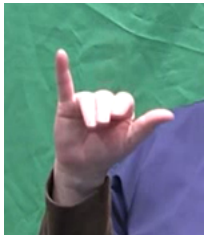
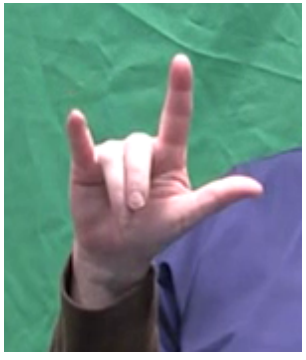
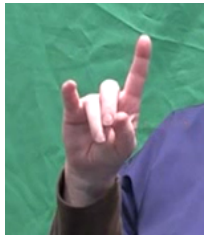
s1, s2



previous handshape

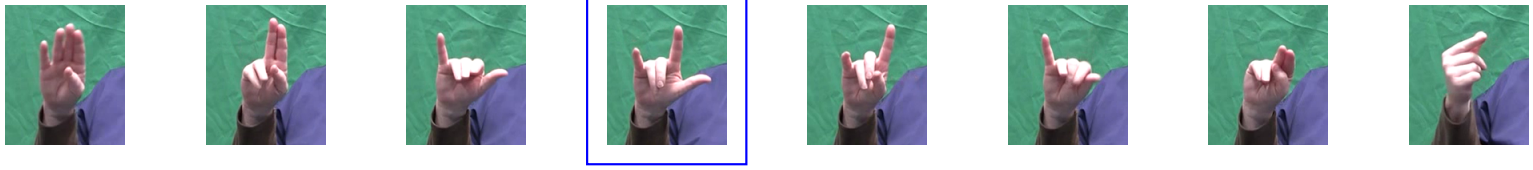




following handshape

previous transition time

What affects the -L- handshape?



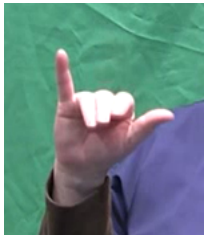
-B- -U- -I- -L- -D- -I- -N- -G-

word type

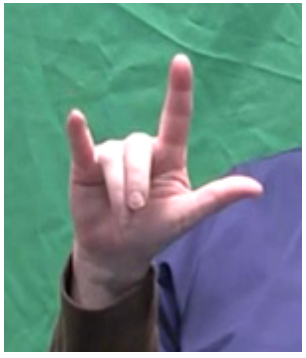
name, noun, non-English

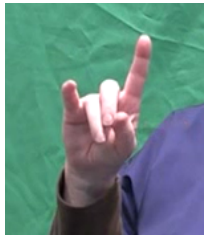
signer

s1, s2



previous handshape



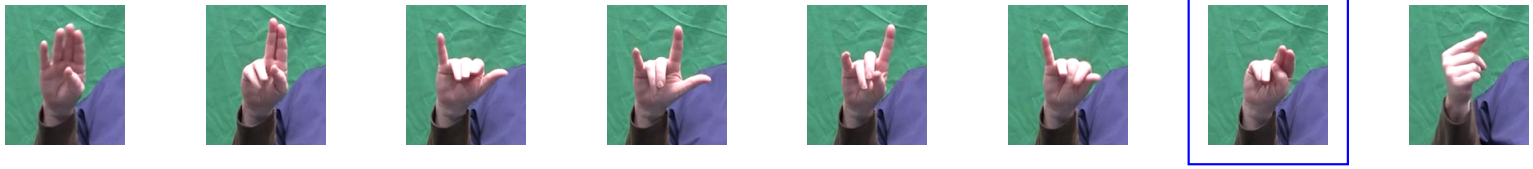


following handshape

previous transition time

following transition time

What affects the -N- handshape?



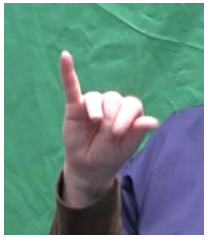
-B- -U- -I- -L- -D- -I- -N- -G-

word type

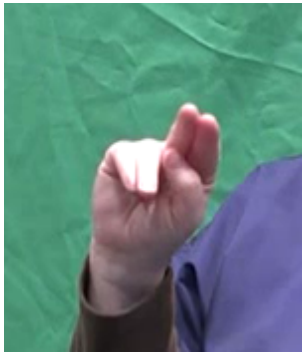
name, noun, non-English

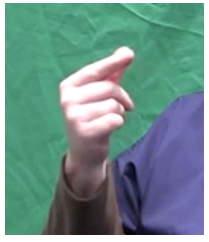
signer

s1, s2



previous handshape



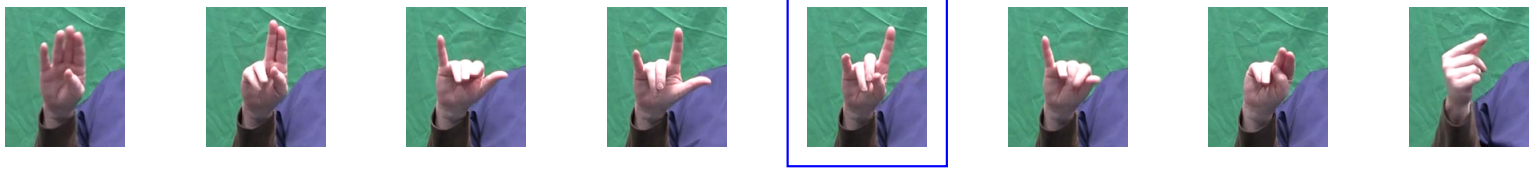


following handshape

previous transition time

following transition time

What affects the -D- handshape?



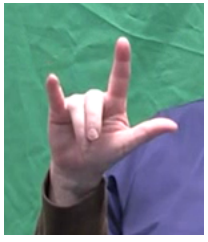
-B- -U- -I- -L- -D- -I- -N- -G-

word type

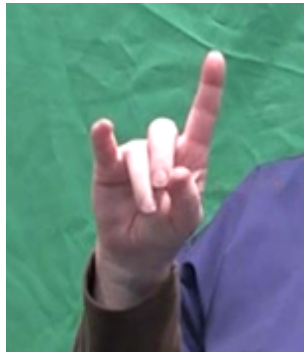
name, noun, non-English

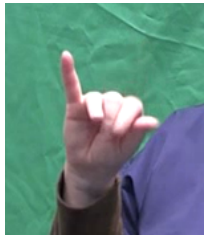
signer

s1, s2



previous handshape





following handshape

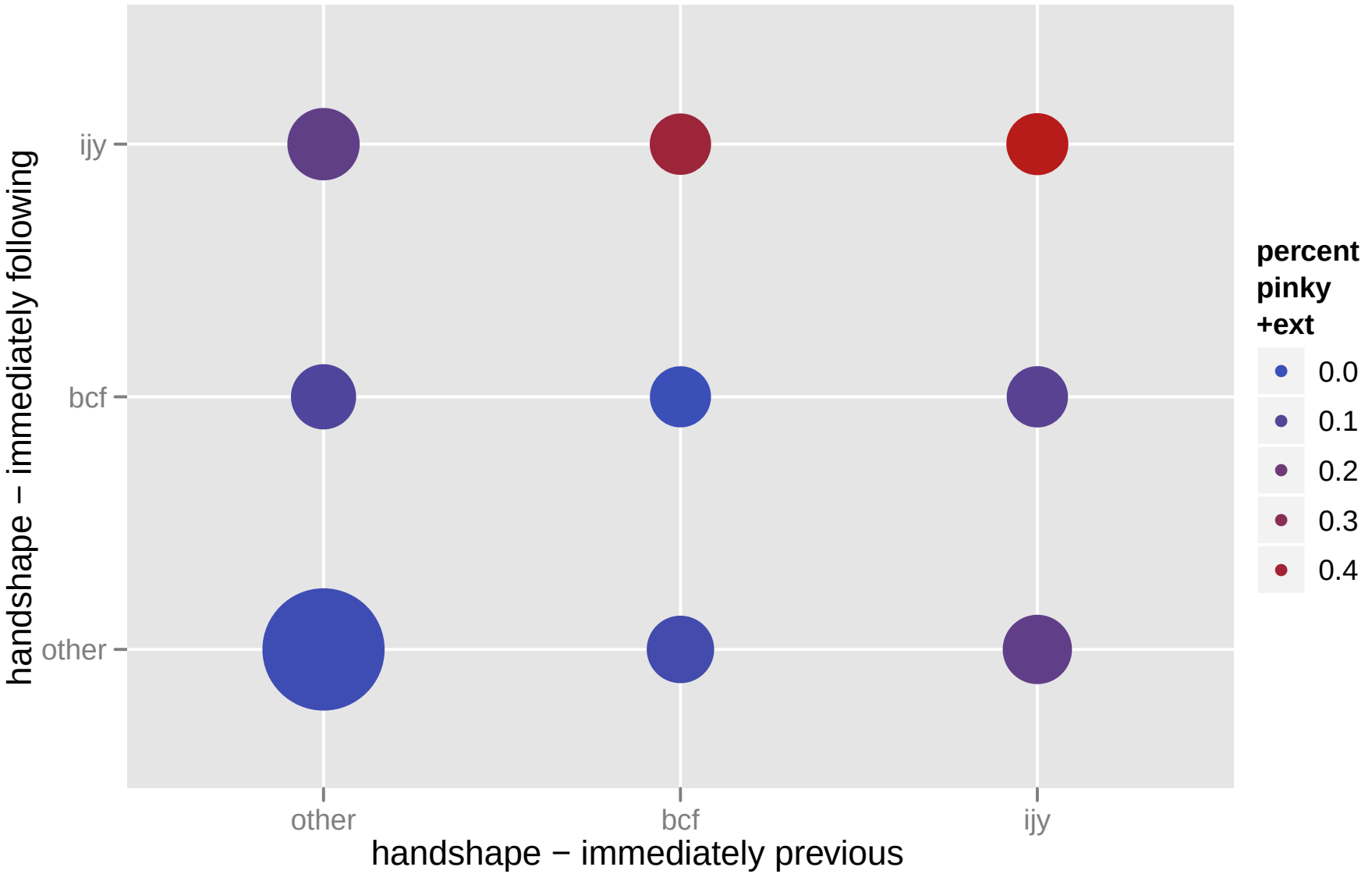
previous transition time

following transition time

Specific questions – coarticulation

1. Does the extension of the pinky finger spread to neighboring apogees?
2. What environments condition this coarticulation? Preceding handshape? Following handshape? &c.
3. Do all handshapes with an extended pinky condition coarticulation equally?
4. Is this coarticulation gradient?

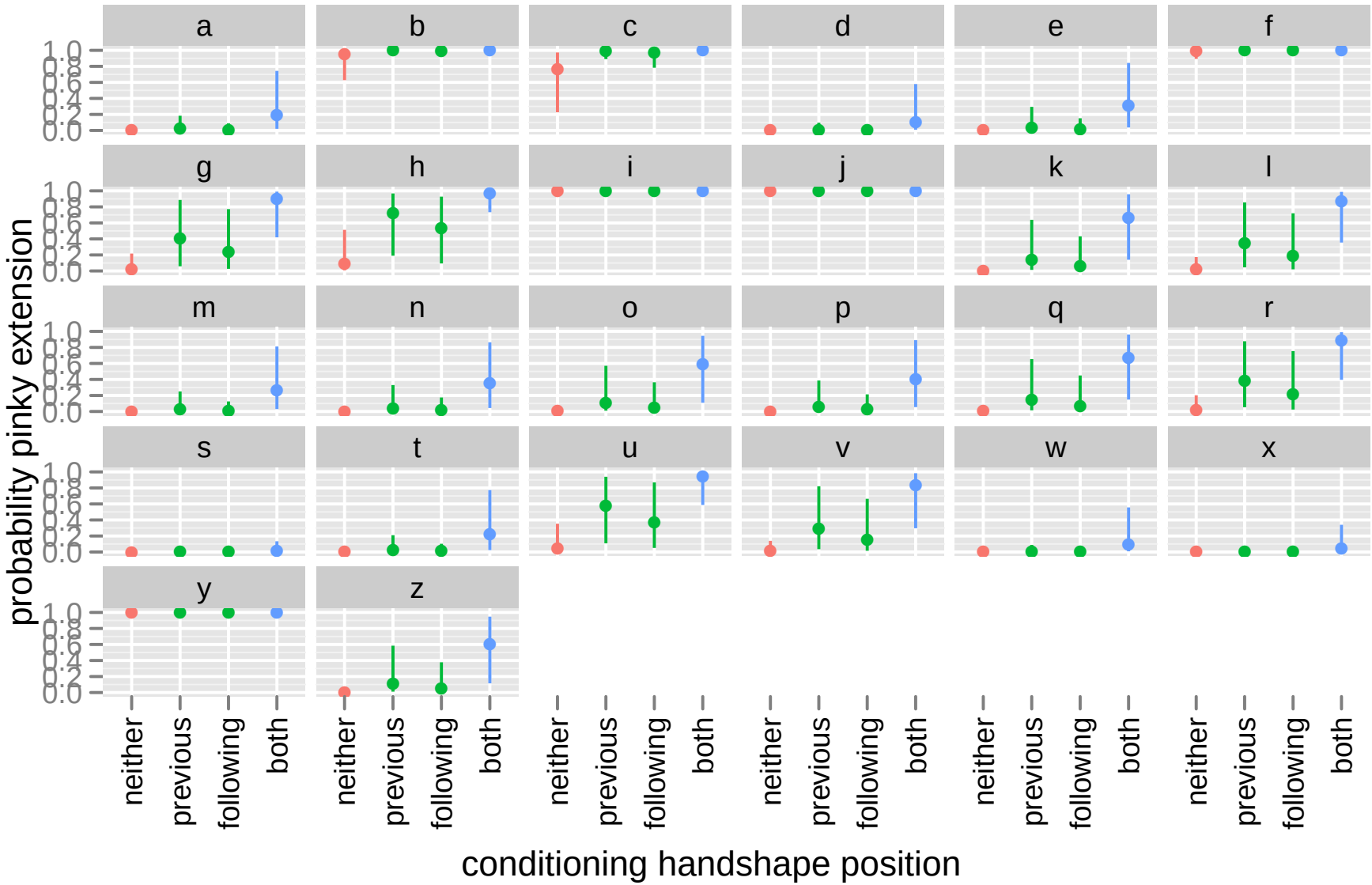
Pinky extension by surrounding handshape



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



Near -I-, -J-, and -Y-; mean transition times

In other words the following are correlated with higher probability that an apogee will have pinky extension:

- following or preceding apogee is an-ɪ-, -ɟ-, or -ʏ-
- both the following transition was shorter, and the following apogee is a -ɪ-, -ɟ-, or -ʏ-
- the wordtype was English (name or noun)

Conclusions

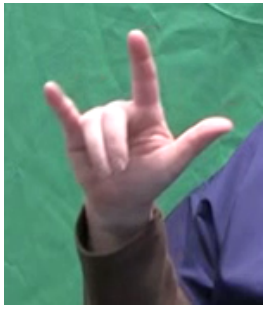
1. There is coarticulation with respect to pinky extension.
2. Both the previous and following apogee handshape condition coarticulation.
3. The handshapes for -I-, -J-, and -Y- condition pinky extension in neighboring apogees more than -B-, -C-, and -F-.
4. Gradient?

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.

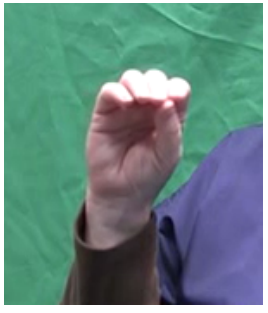
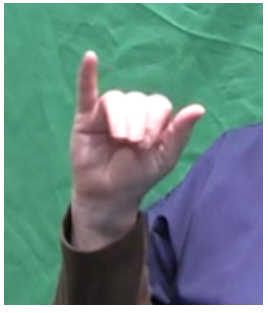
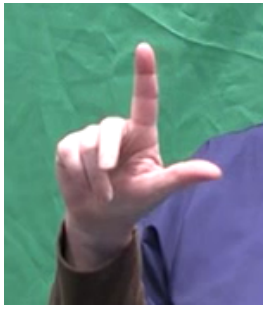
The relatively large amounts of pinky extension coarticulation additionally shows that it is difficult to segment apogees discreetly based on time.

Why not?



-O- -I- -L-

vs.

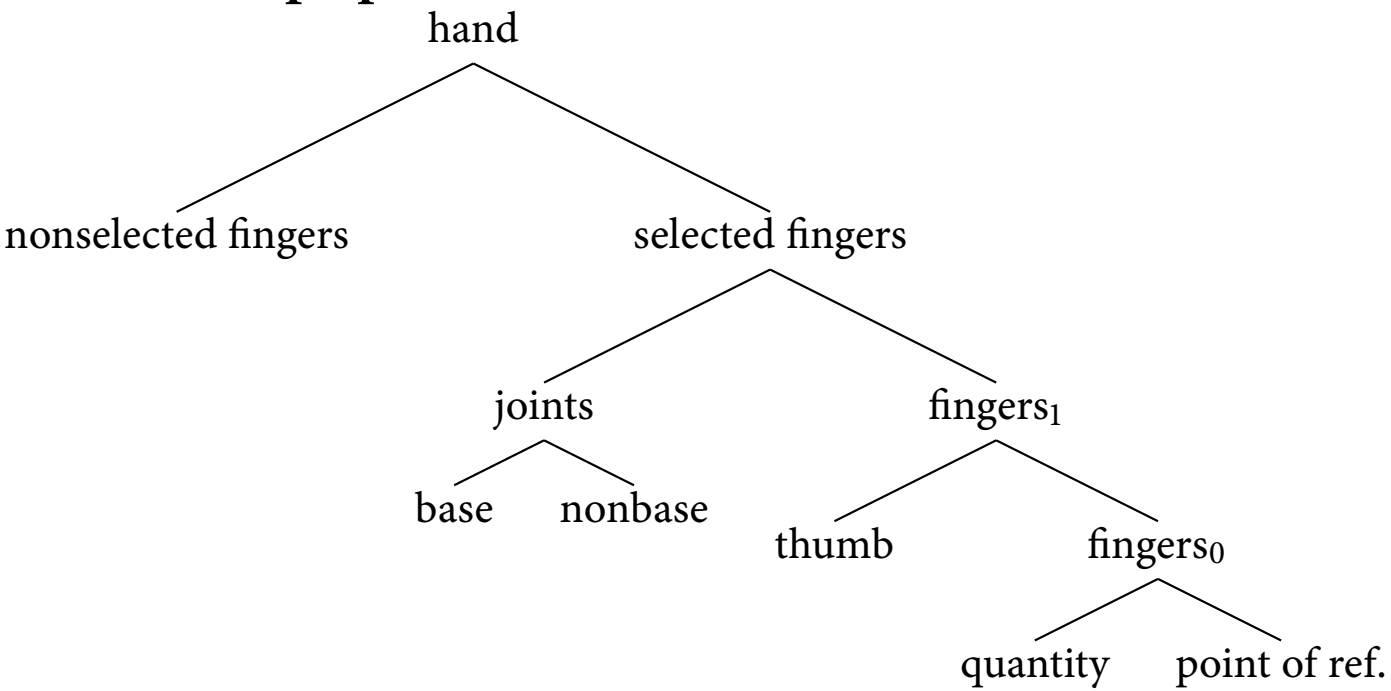
-O- -I- -L-

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



full speed

oil.mp4

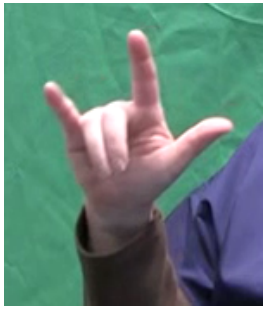
half speed

oil.mp4

Articulator trajectories

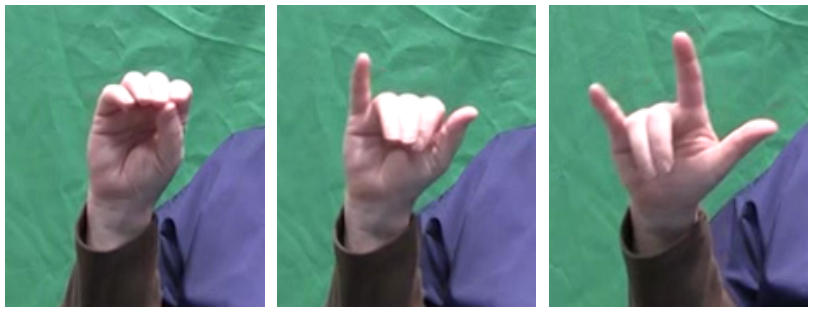
-O-

-I-

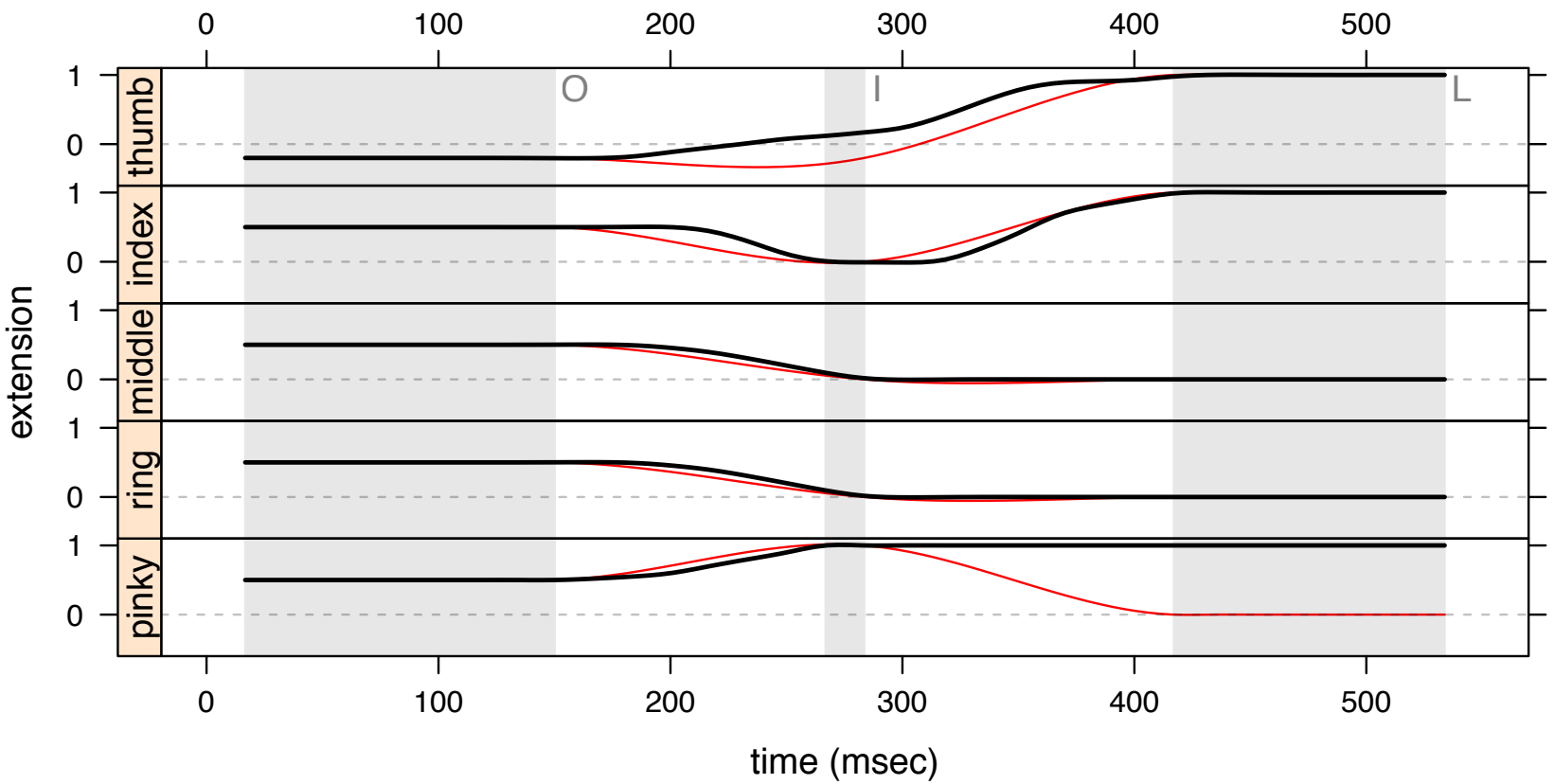


-L-

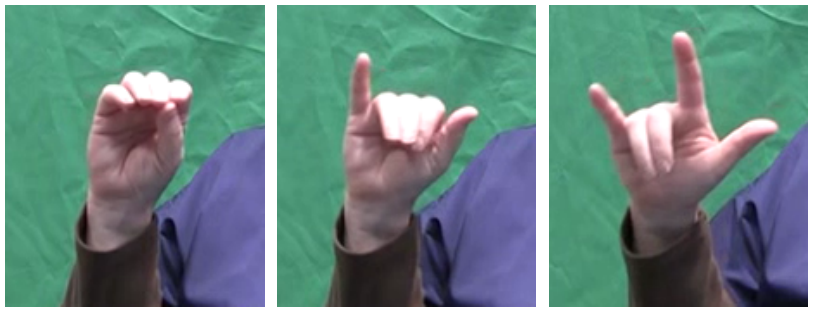
Articulator trajectories



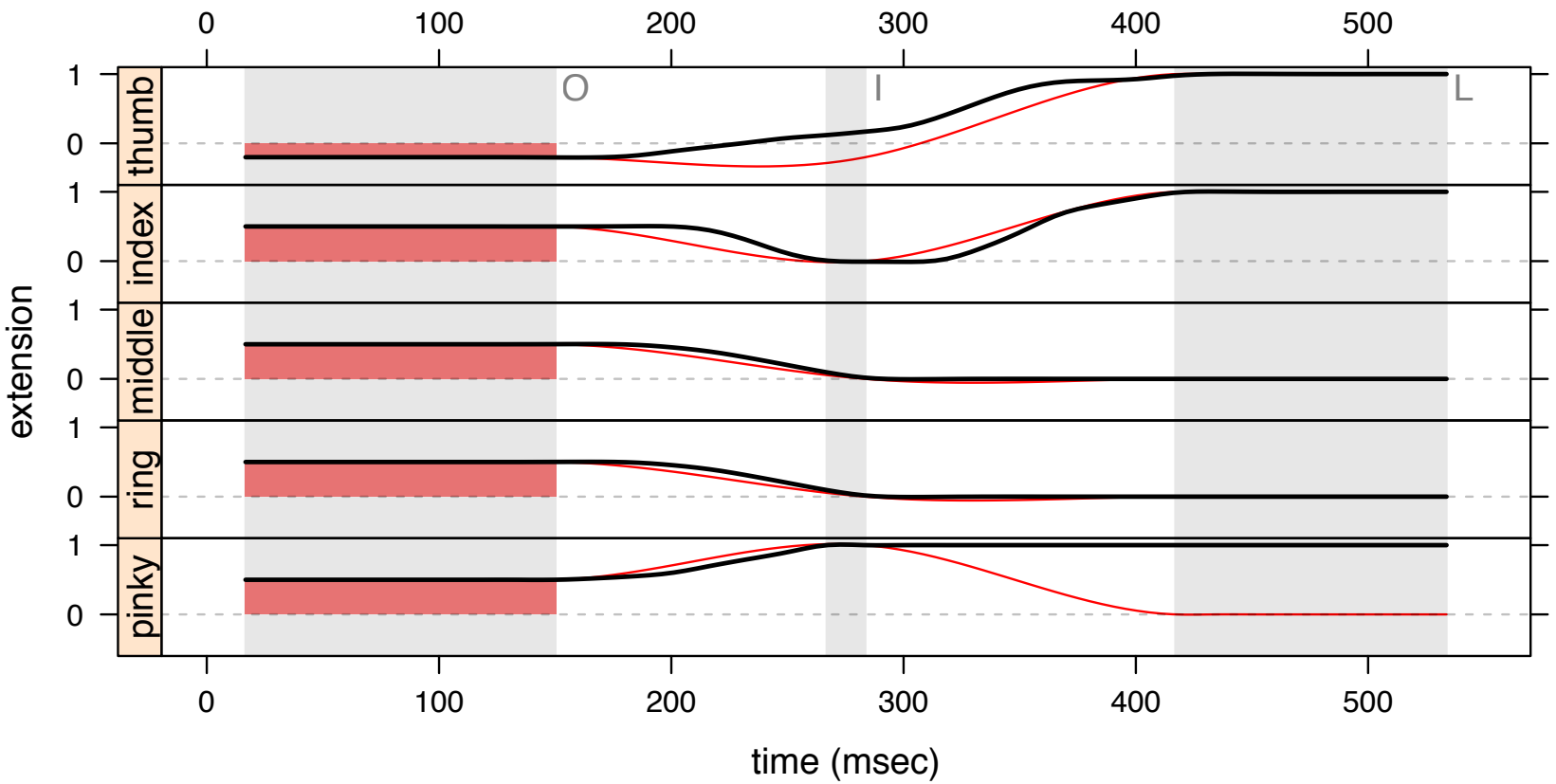
-O- -I- -L-



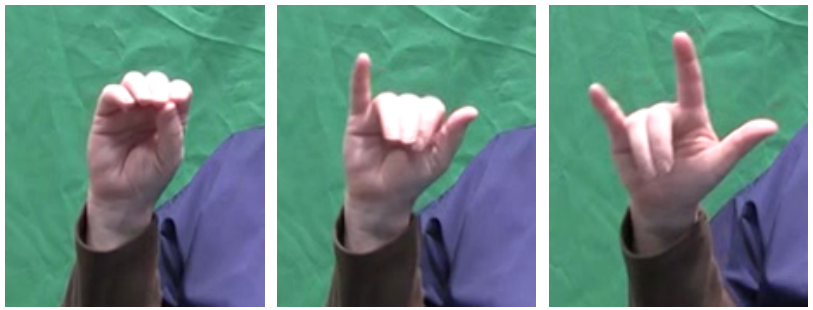
Articulator trajectories



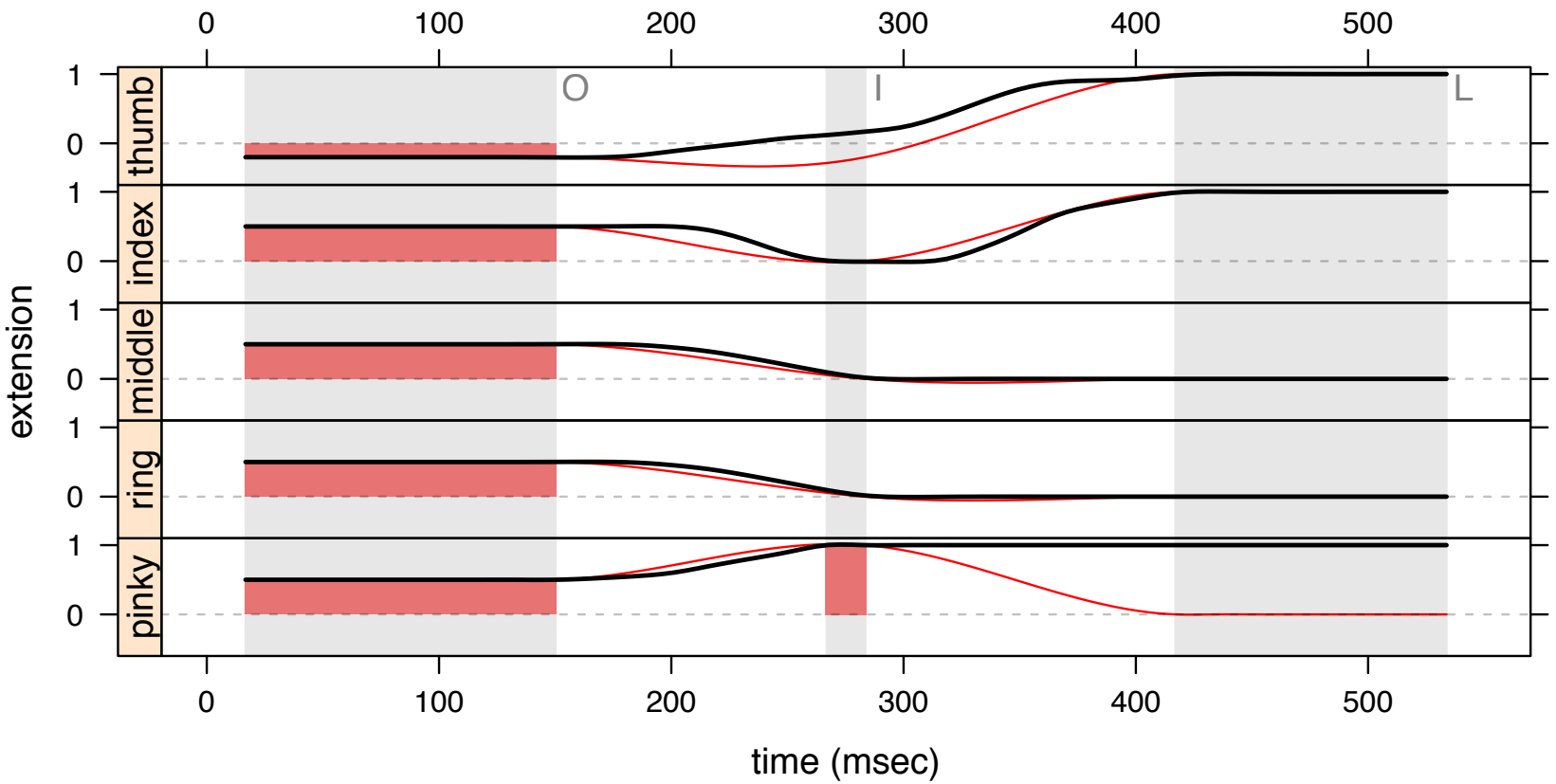
-O- -I- -L-



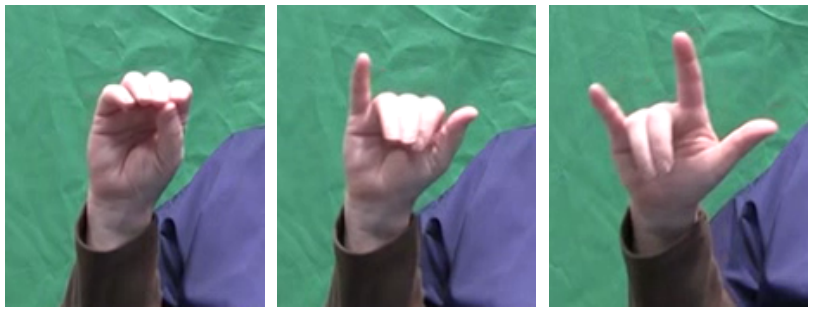
Articulator trajectories



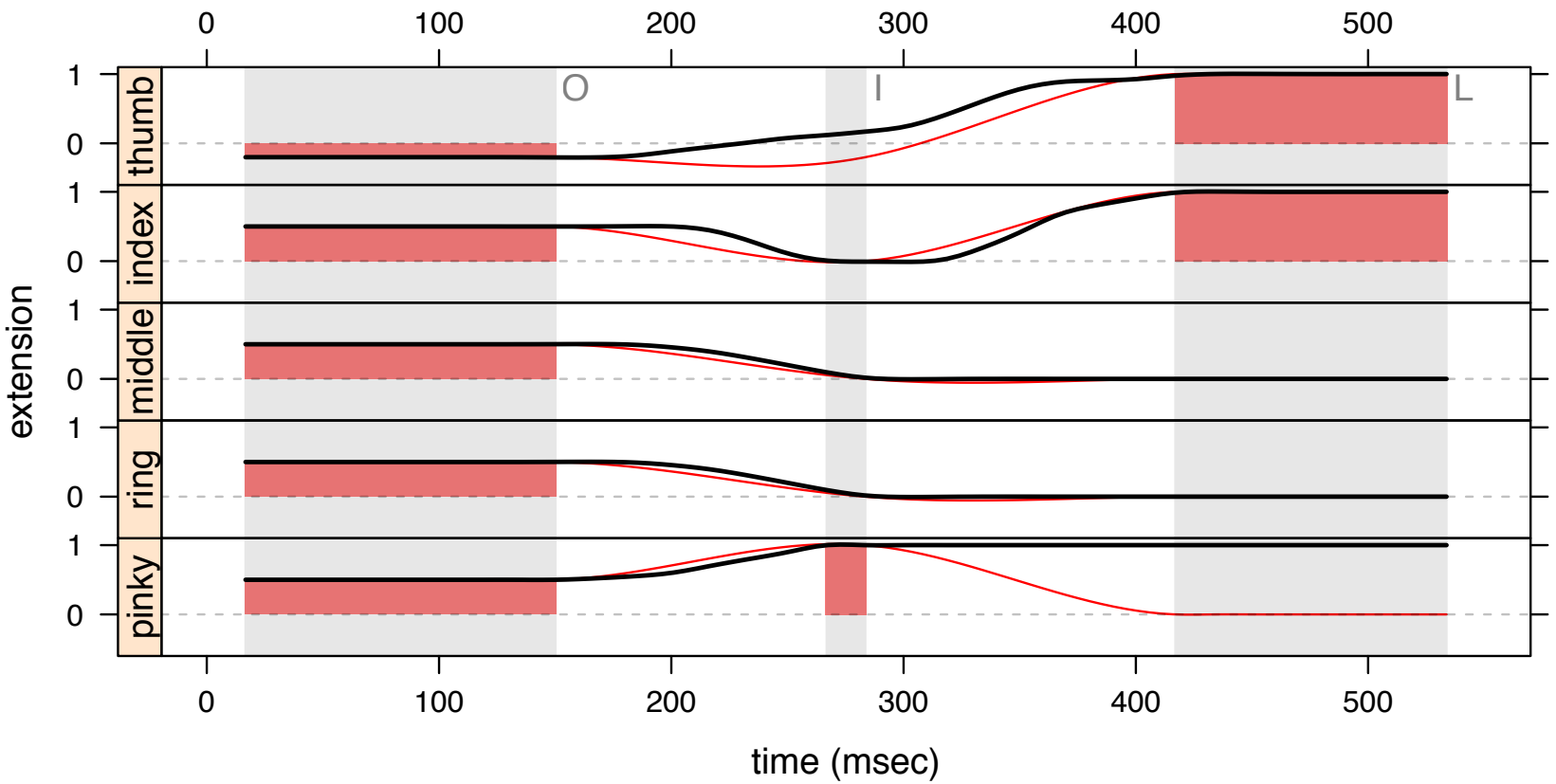
-O- -I- -L-



Articulator trajectories



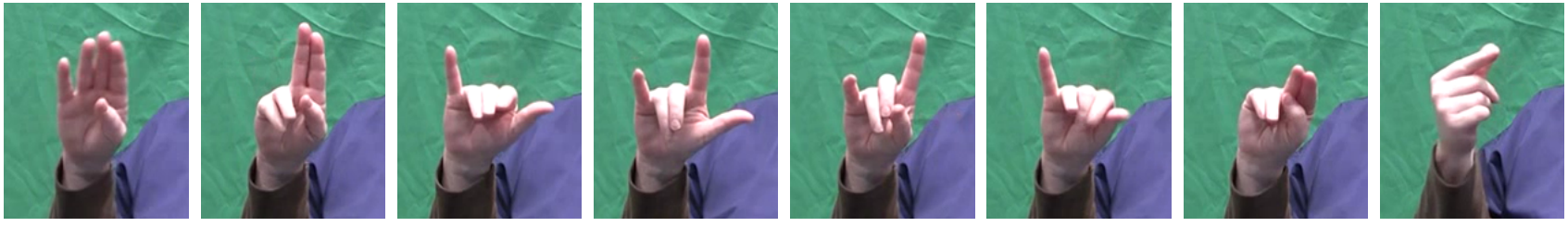
-O- -I- -L-



full speed

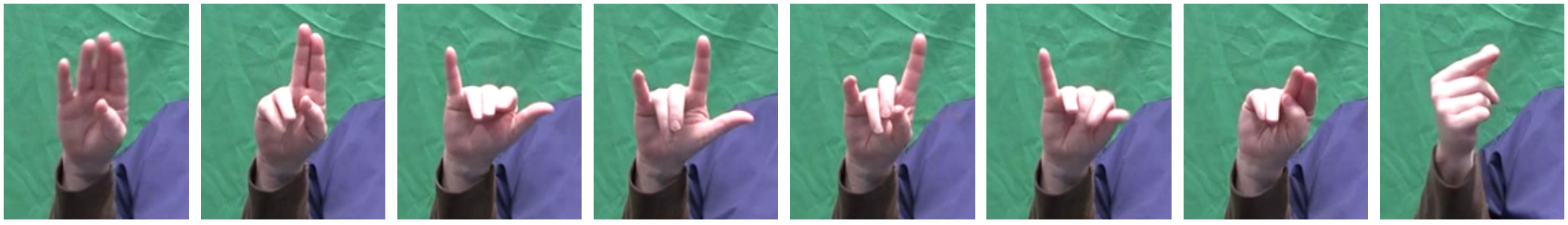
half speed

Articulator trajectories

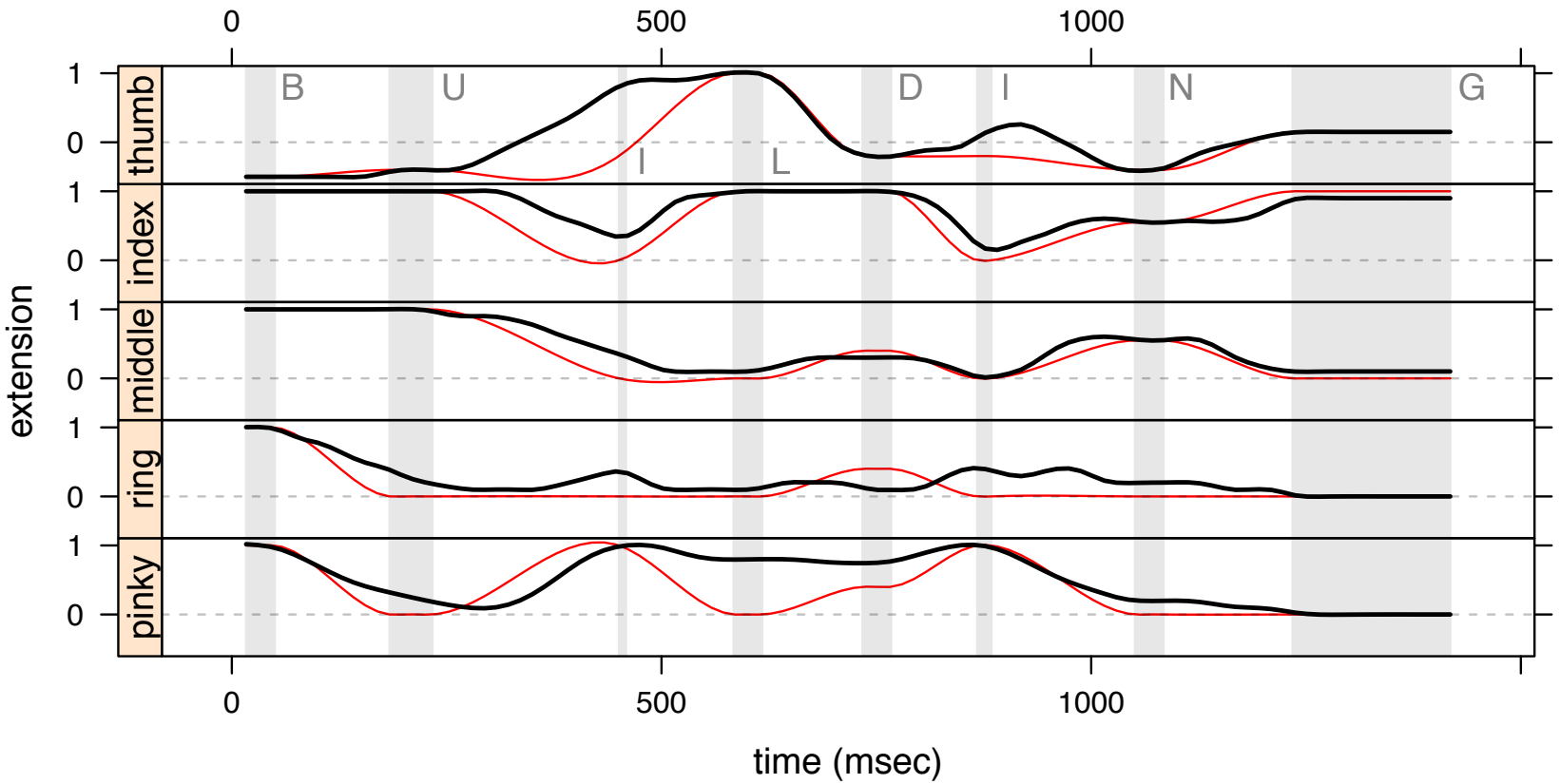


-B- -U- -I- -L- -D- -I- -N- -G-

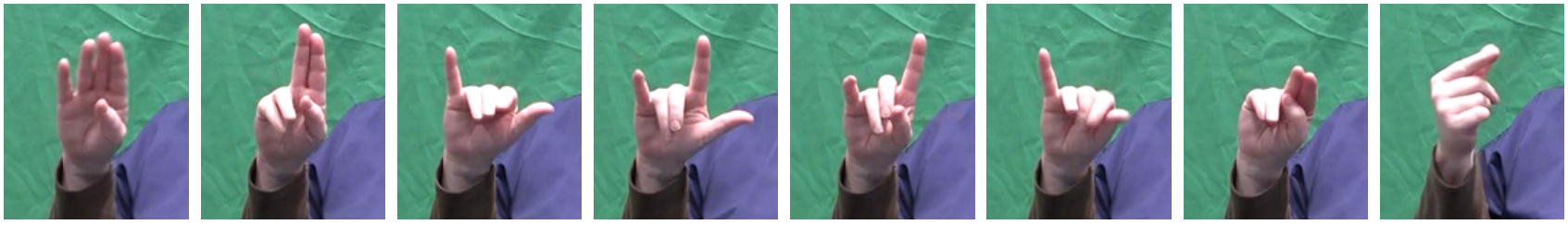
Articulator trajectories



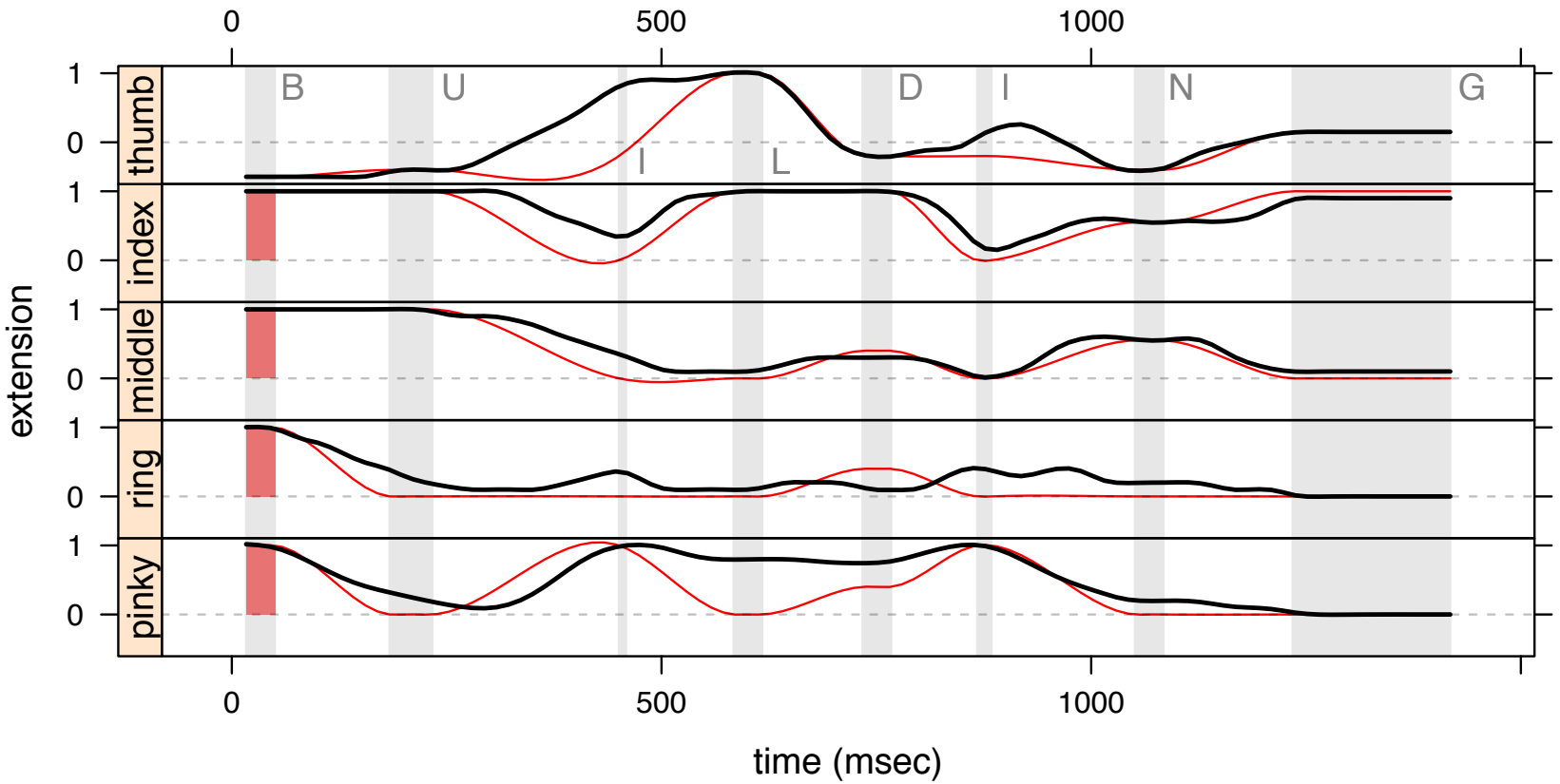
-B- -U- -I- -L- -D- -I- -N- -G-



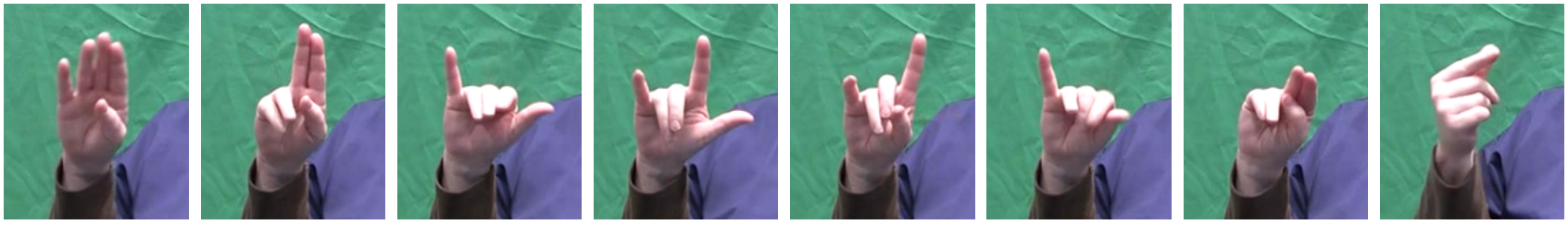
Articulator trajectories



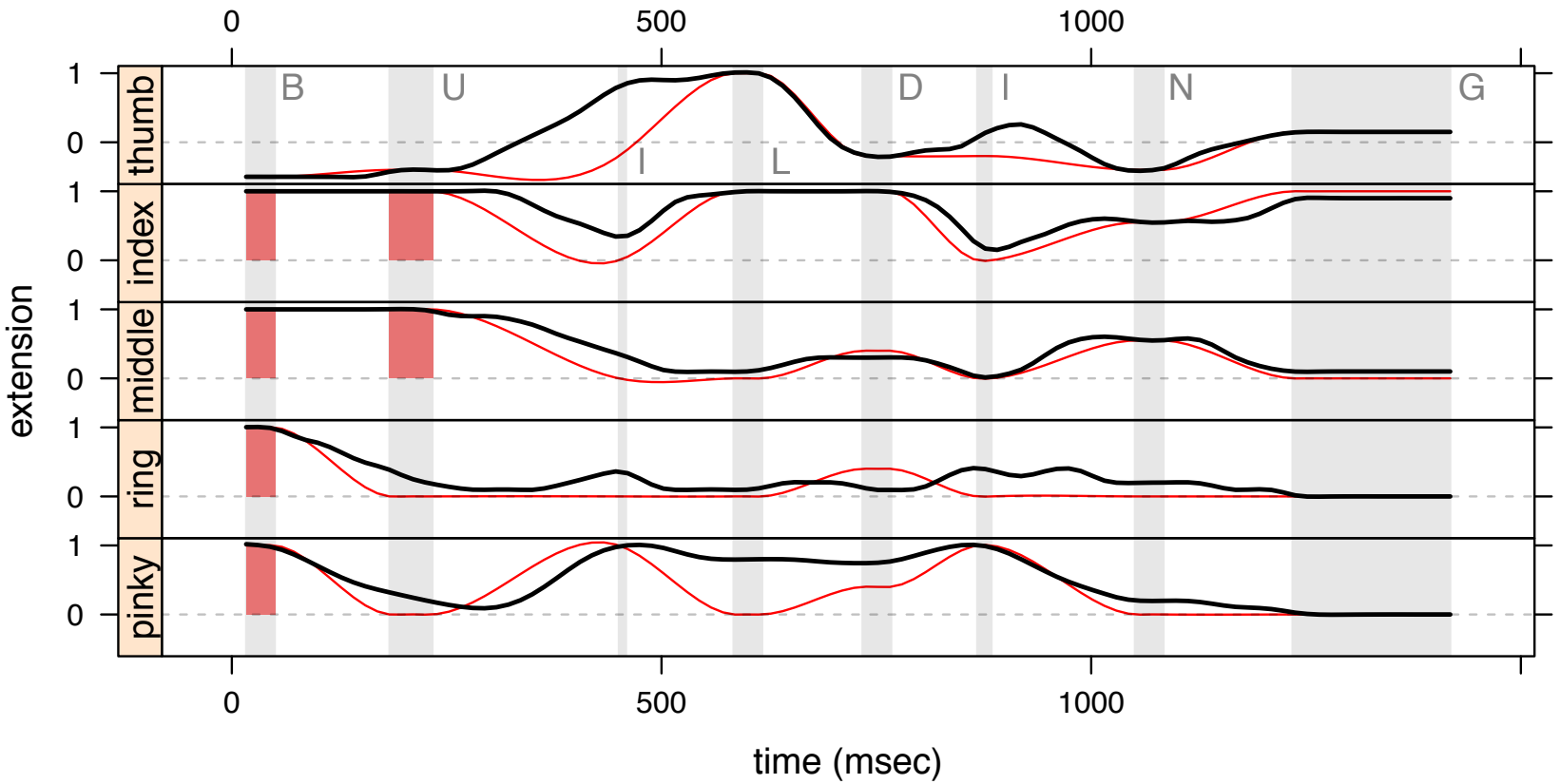
-B- -U- -I- -L- -D- -I- -N- -G-



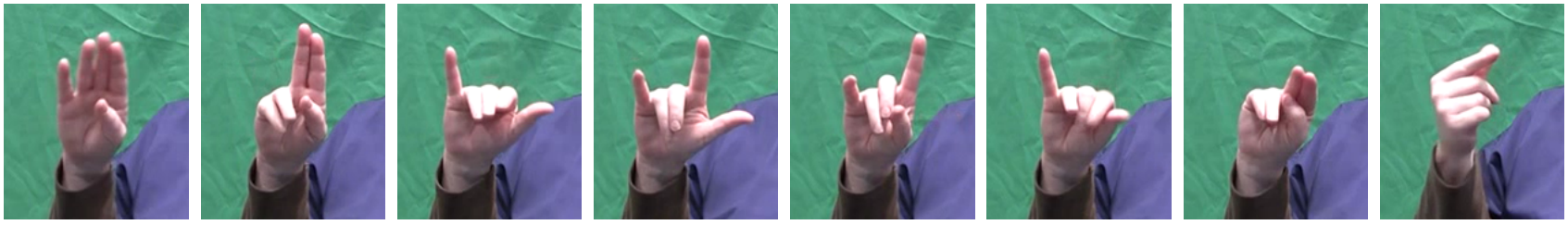
Articulator trajectories



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



Articulator trajectories



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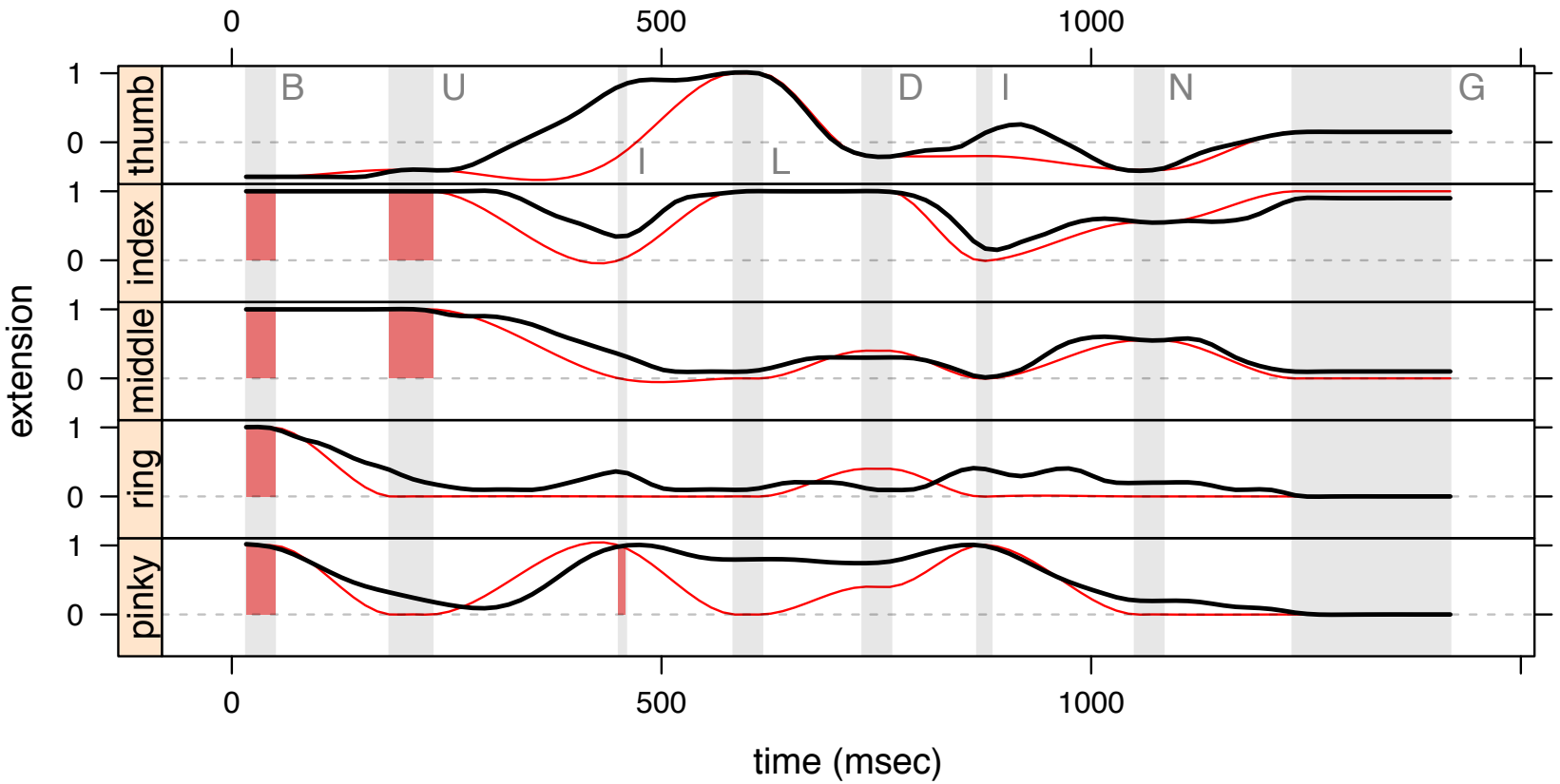
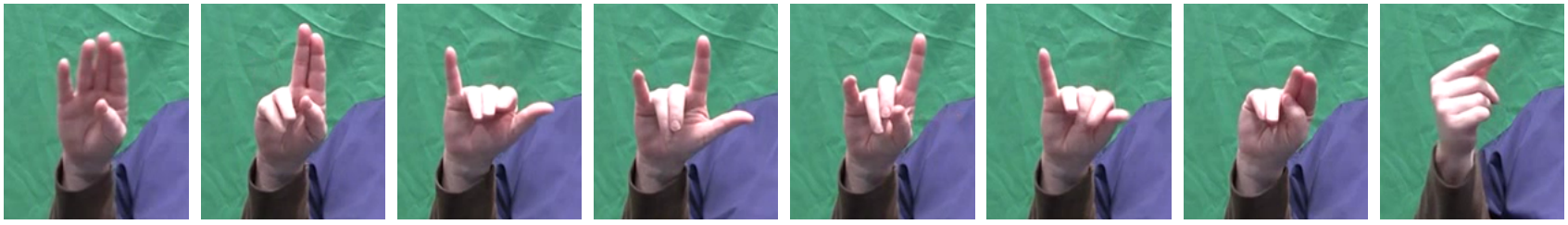
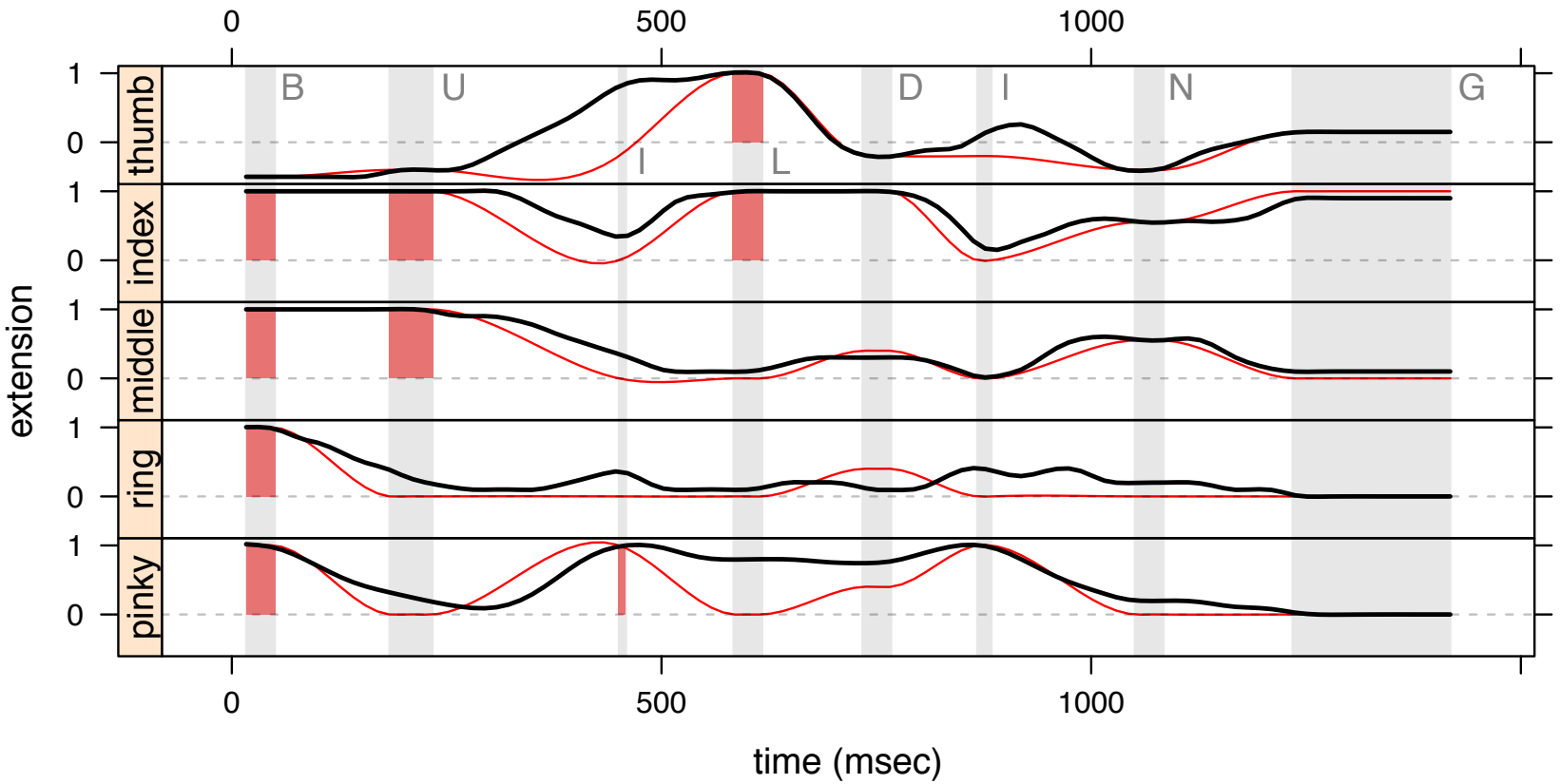


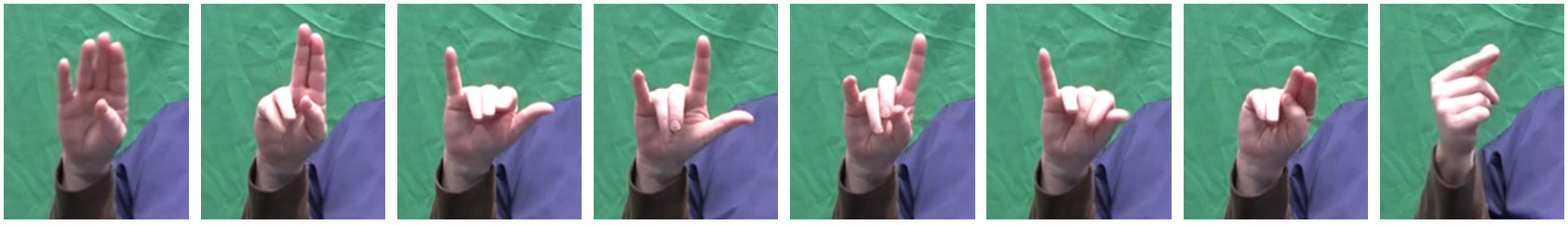
Articulator trajectories



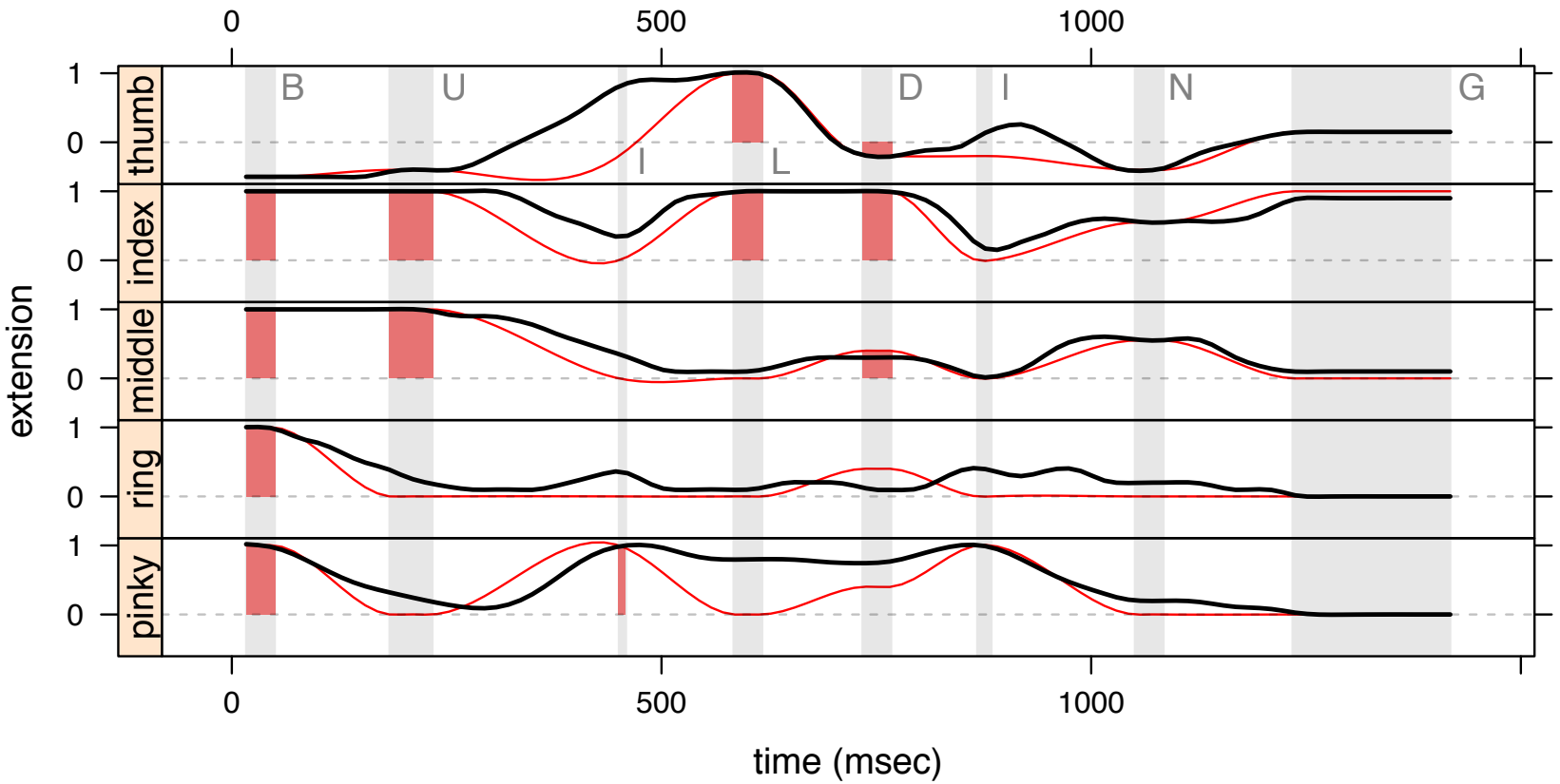
-B- -U- -I- -L- -D- -I- -N- -G-



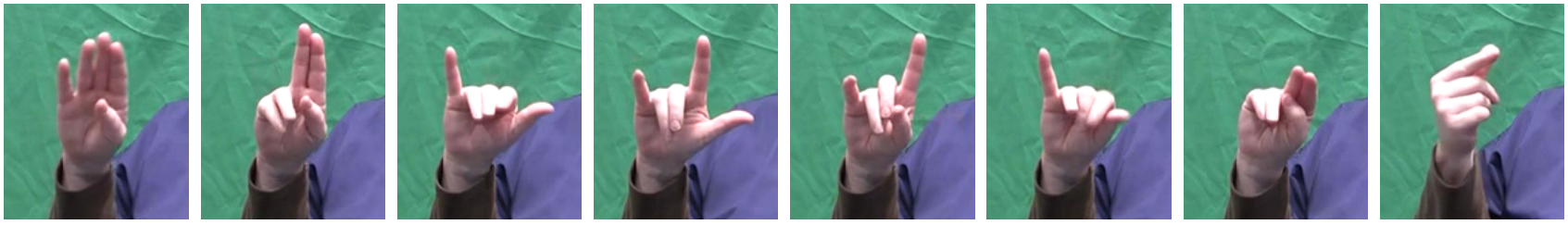
Articulator trajectories



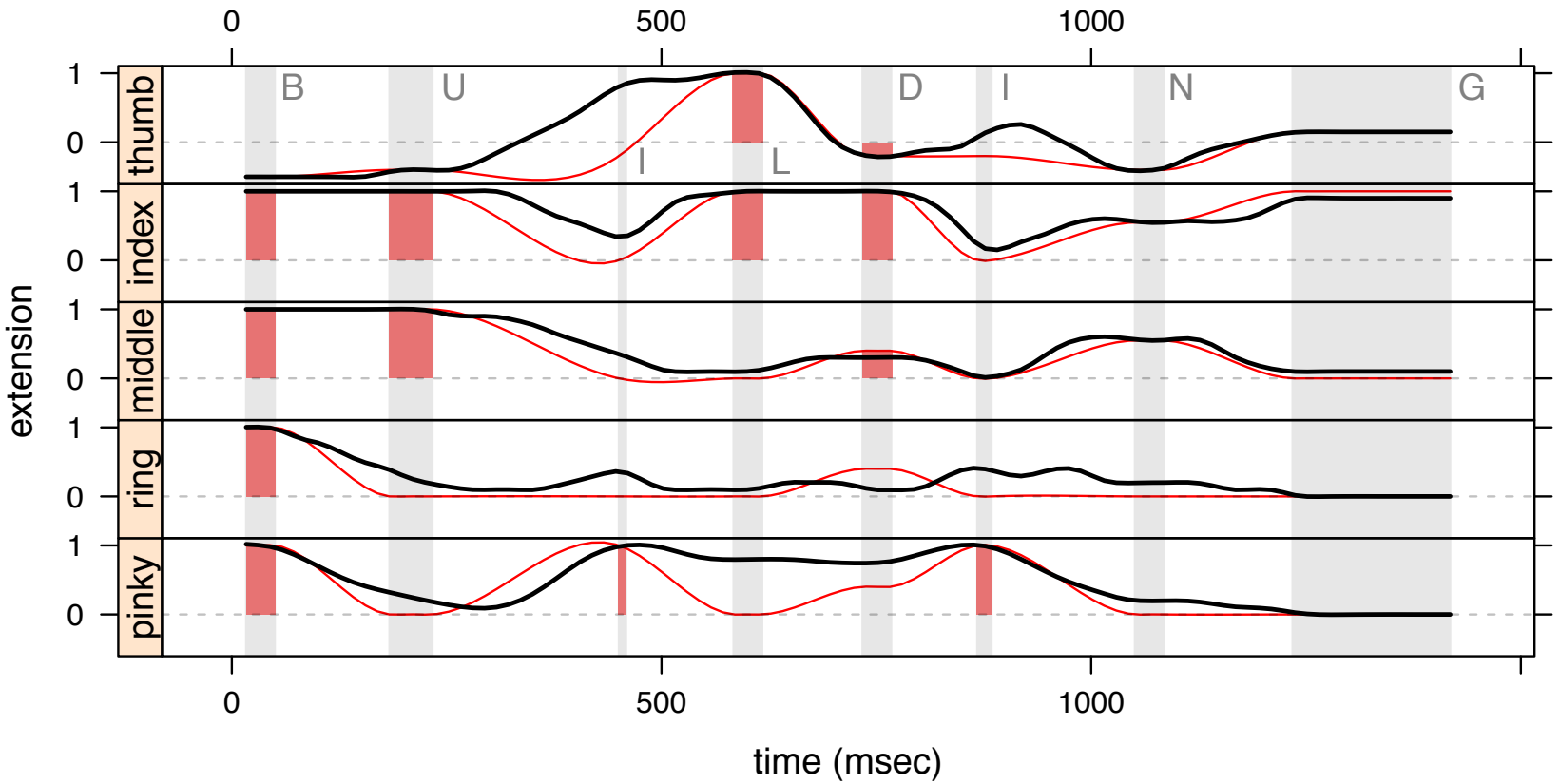
-B- -U- -I- -L- -D- -I- -N- -G-



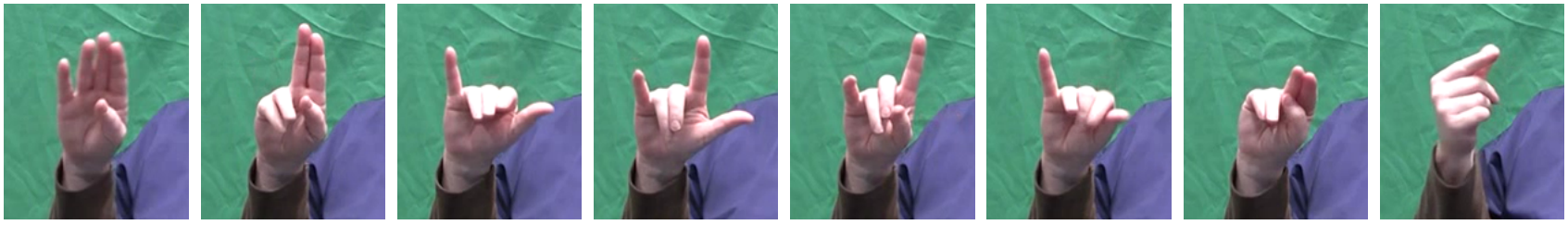
Articulator trajectories



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



Articulator trajectories



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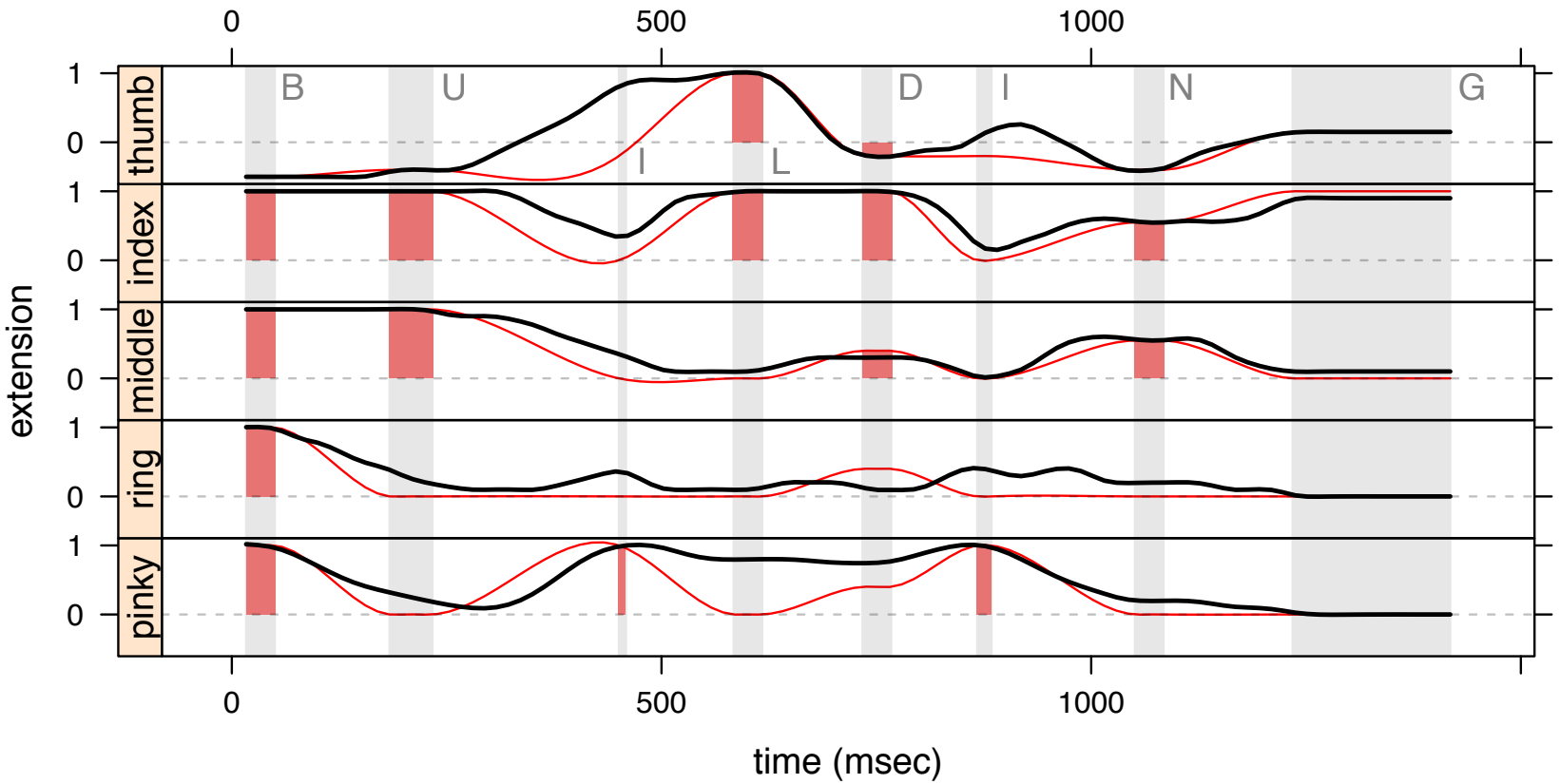
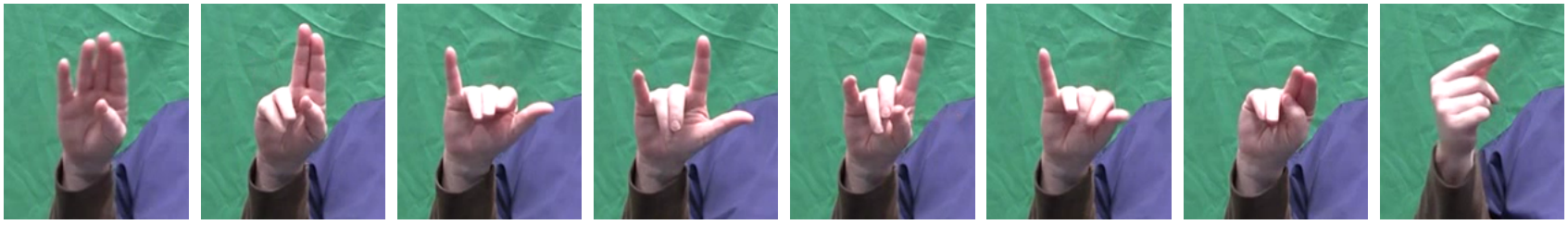
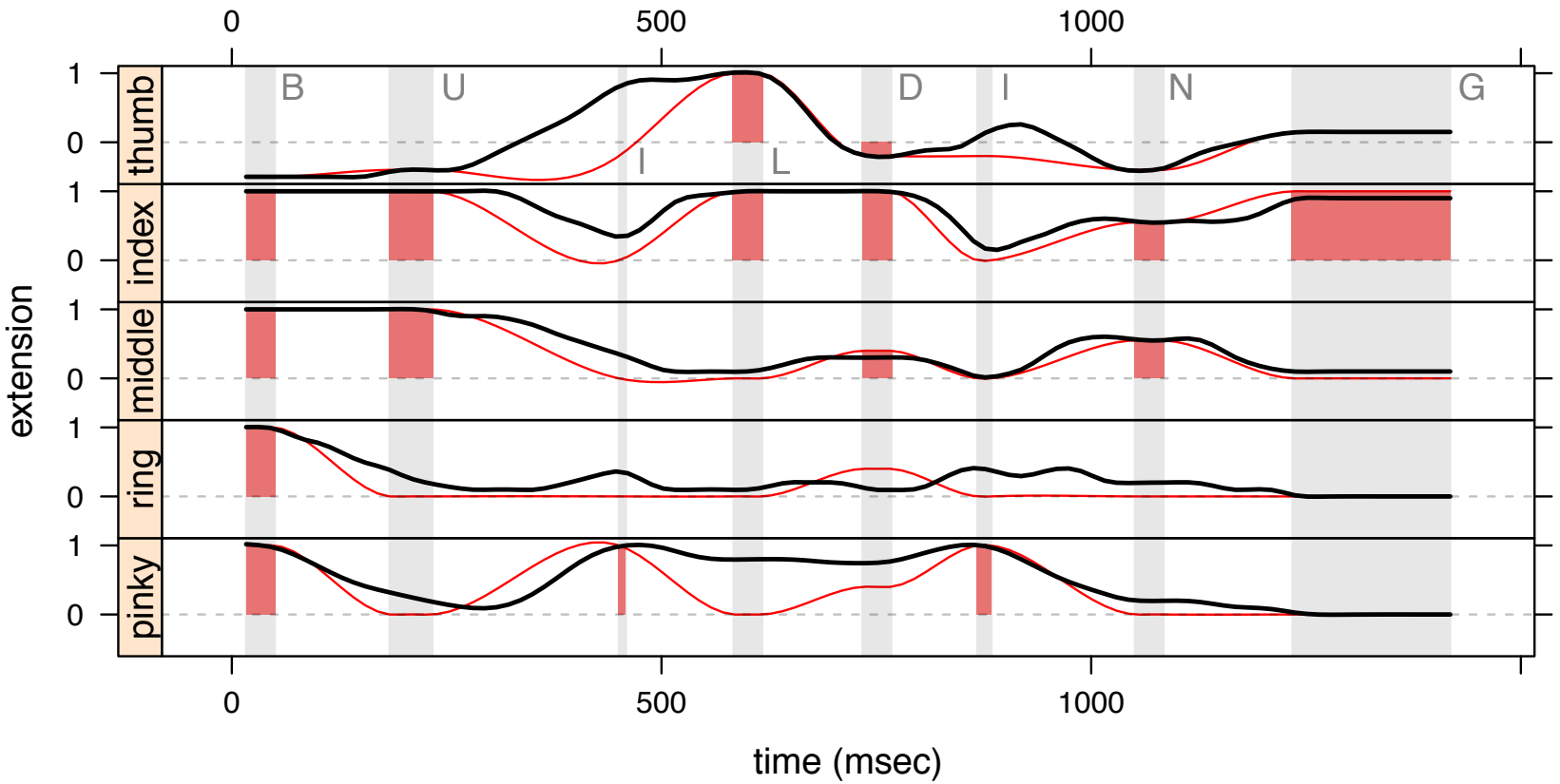


Articulator trajectories



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



full speed

activity.mp4

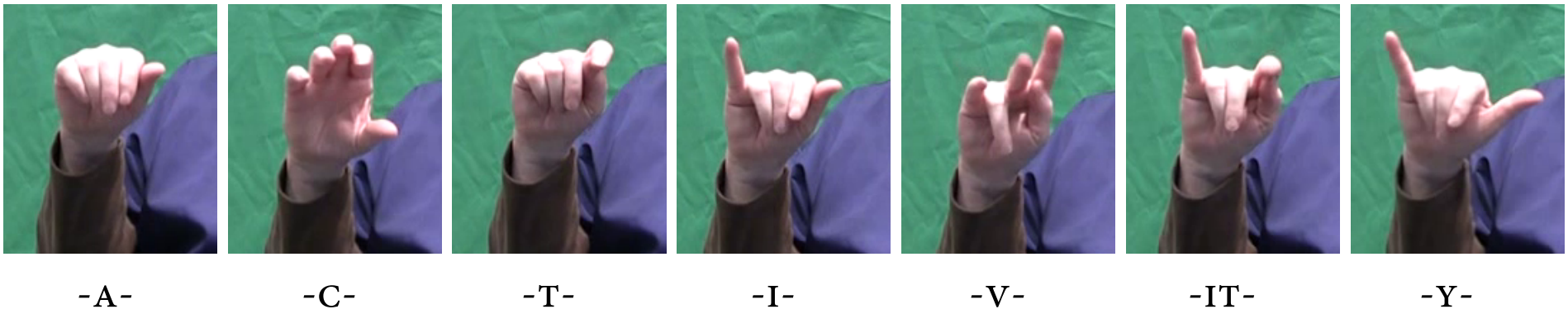
half speed

activity.mp4

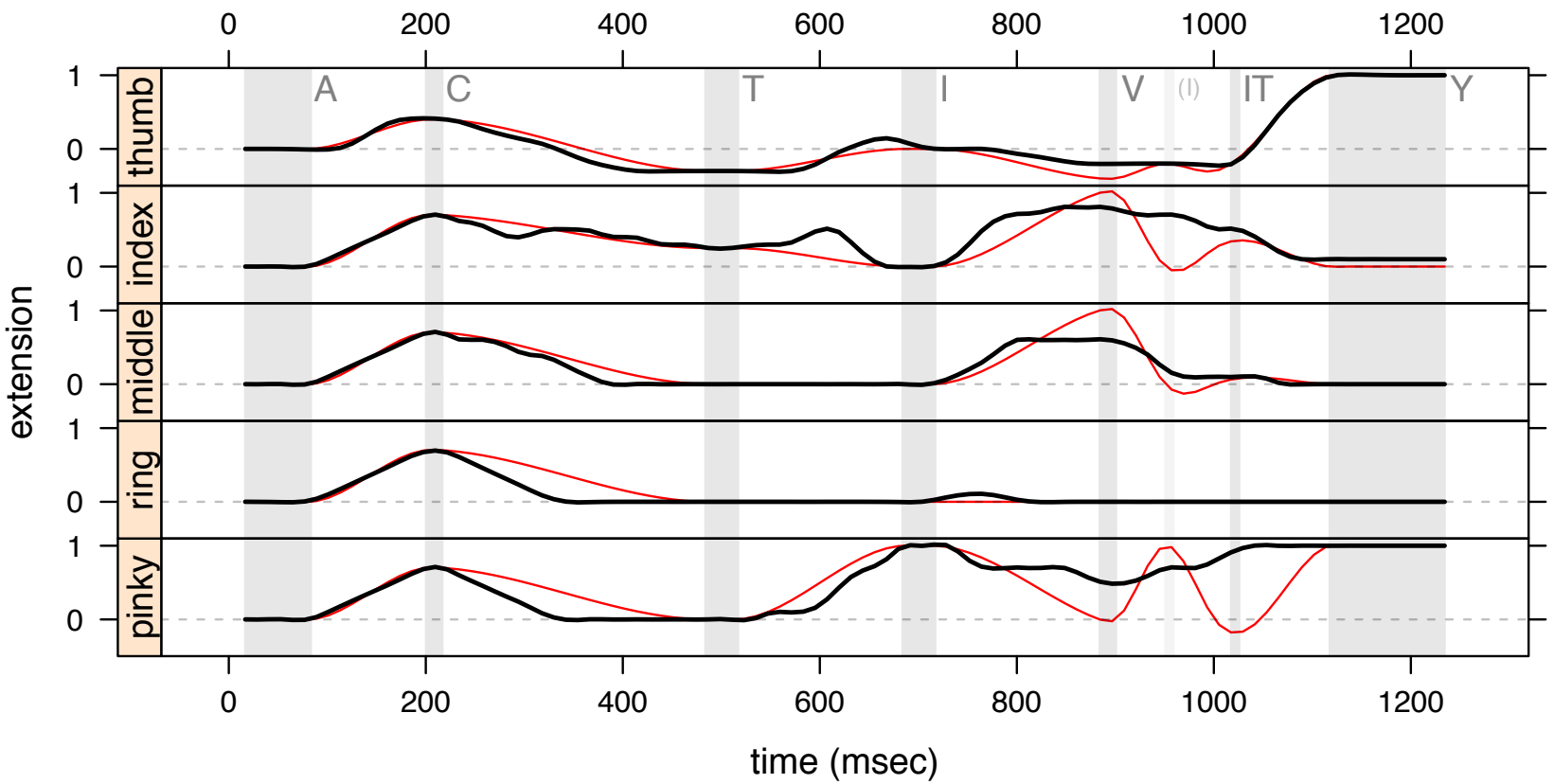
Articulator trajectories

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

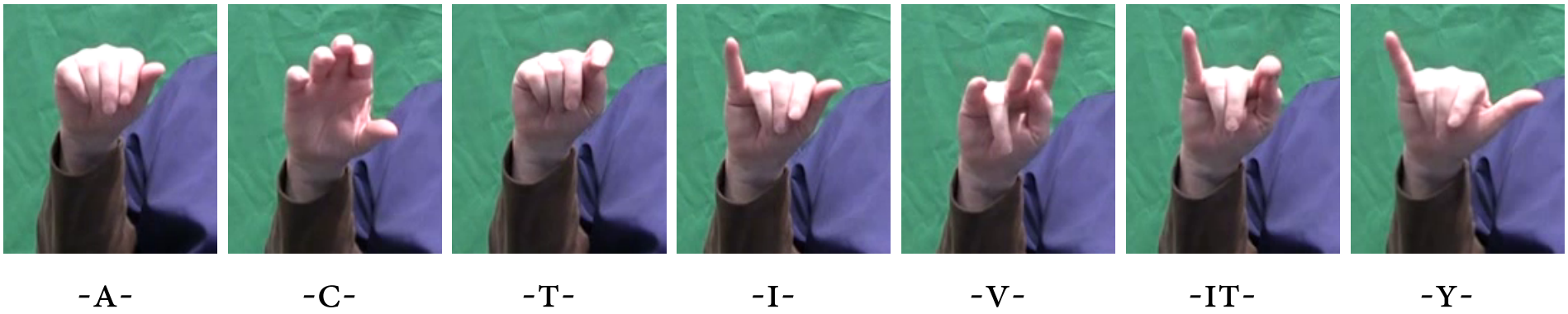
Articulator trajectories



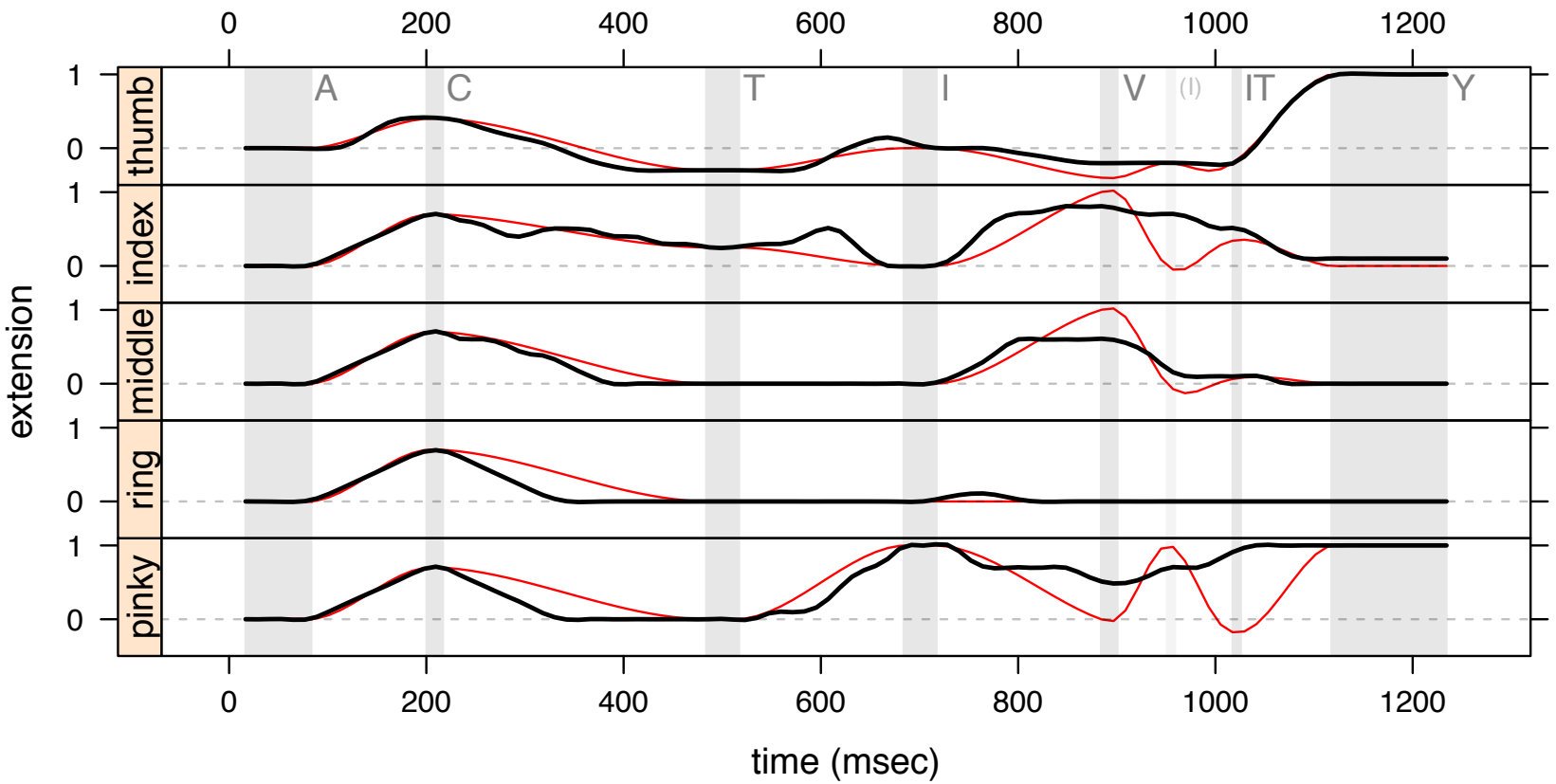
-A- -C- -T- -I- -V- -IT- -Y-



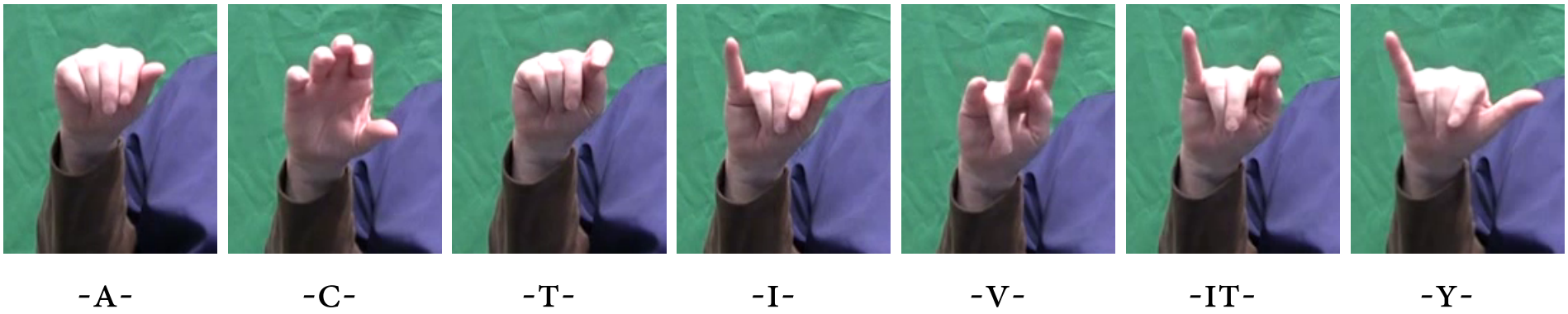
Articulator trajectories



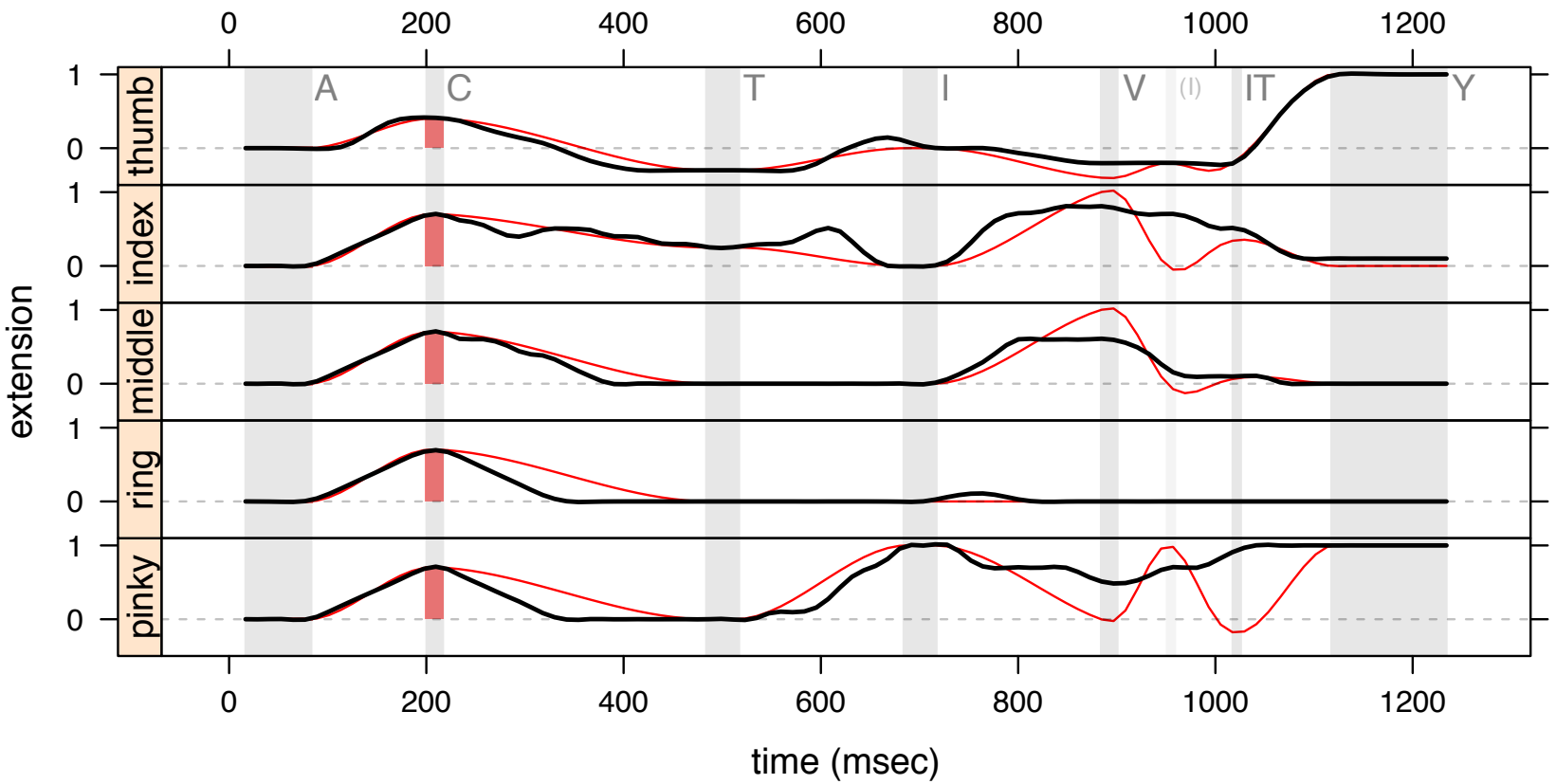
-A- -C- -T- -I- -V- -IT- -Y-



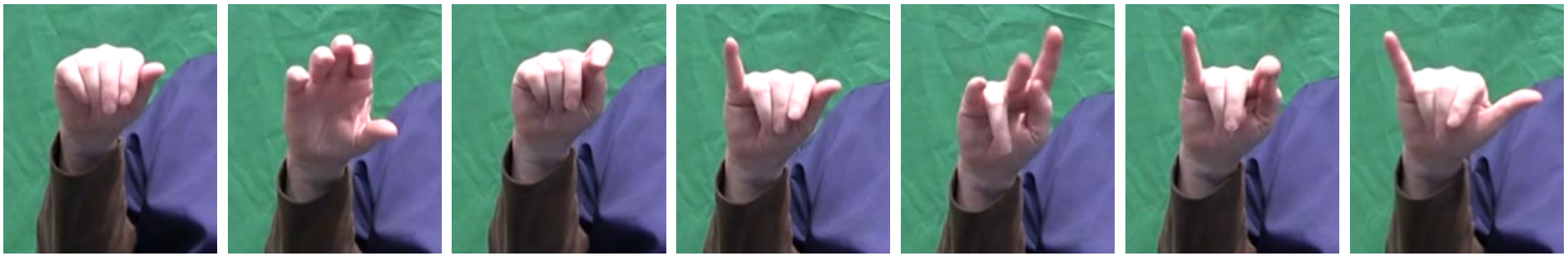
Articulator trajectories



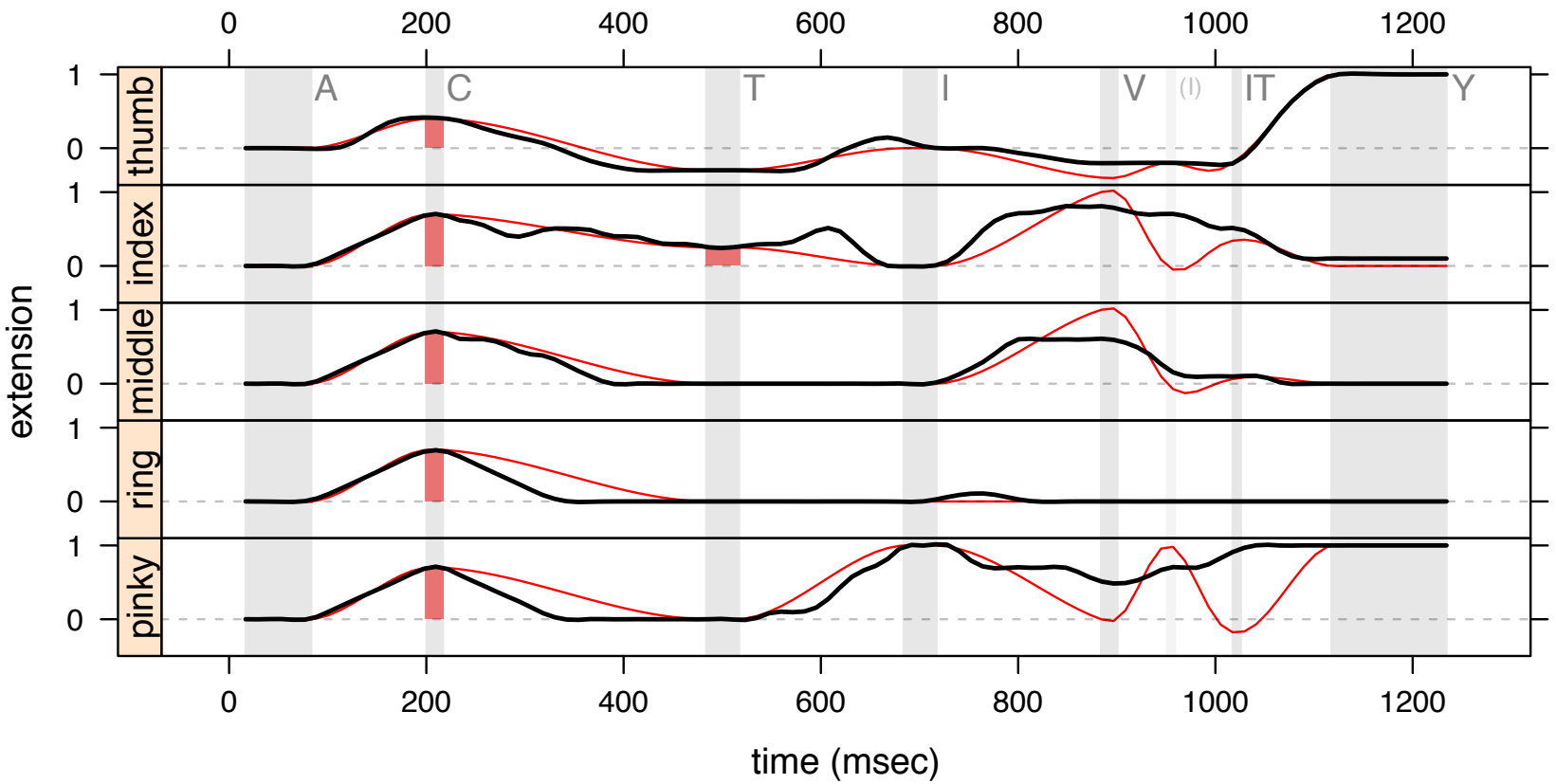
-A- -C- -T- -I- -V- -IT- -Y-



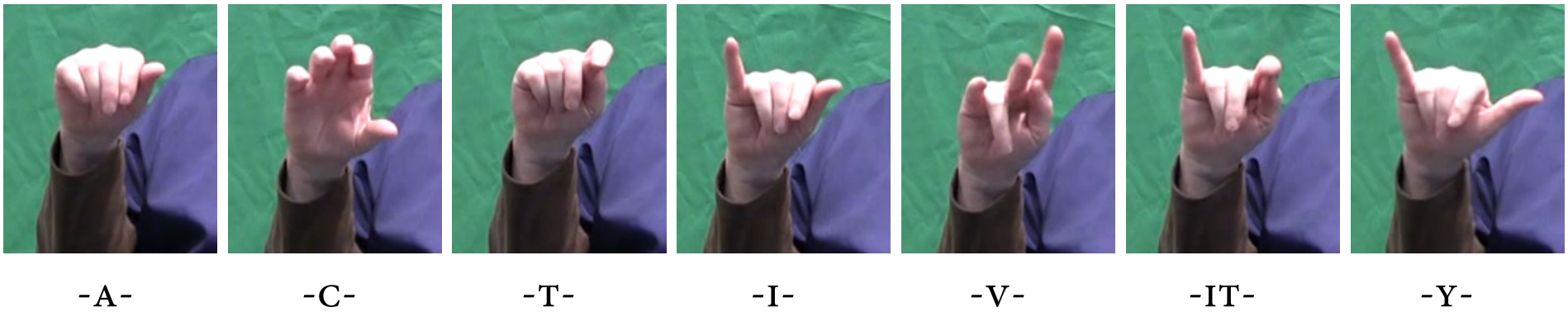
Articulator trajectories



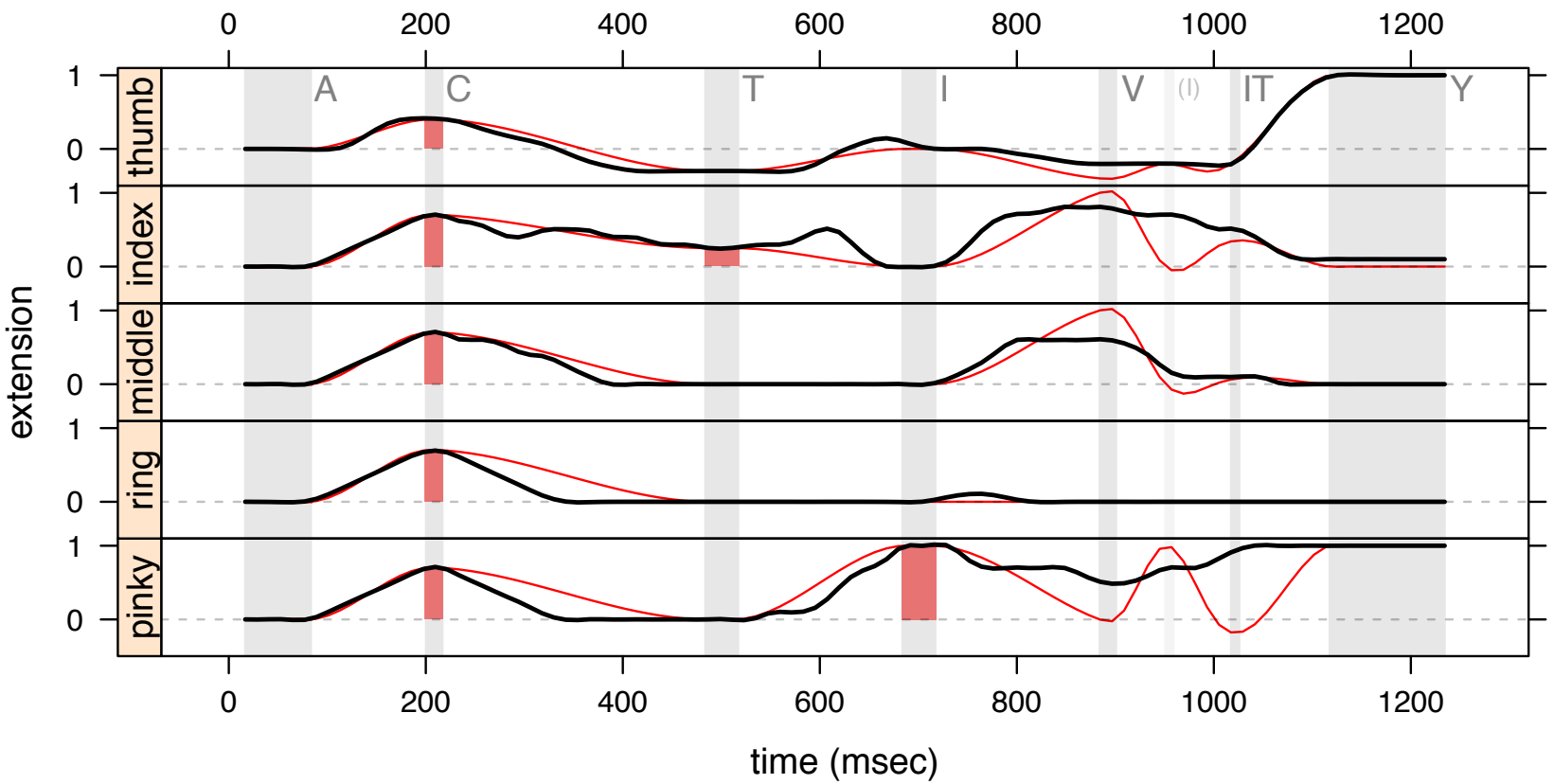
-A- -C- -T- -I- -V- -IT- -Y-



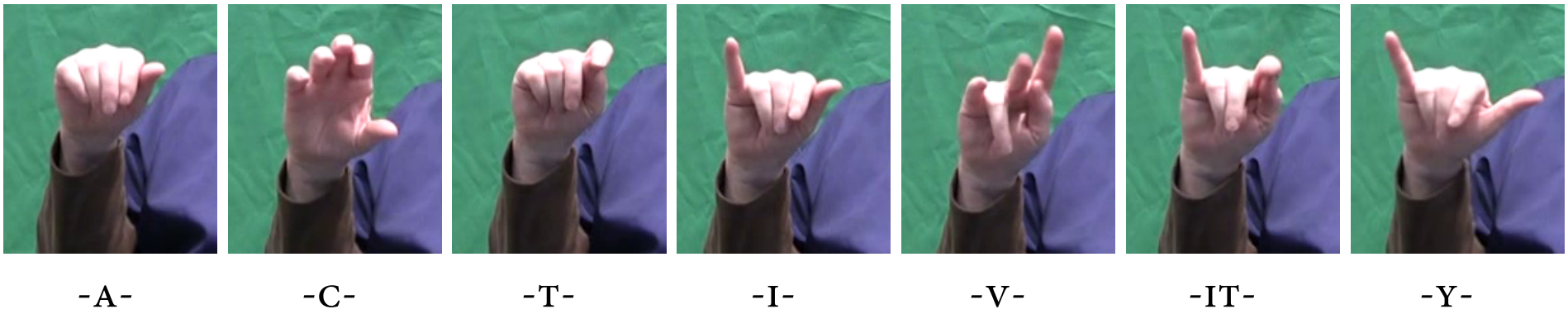
Articulator trajectories

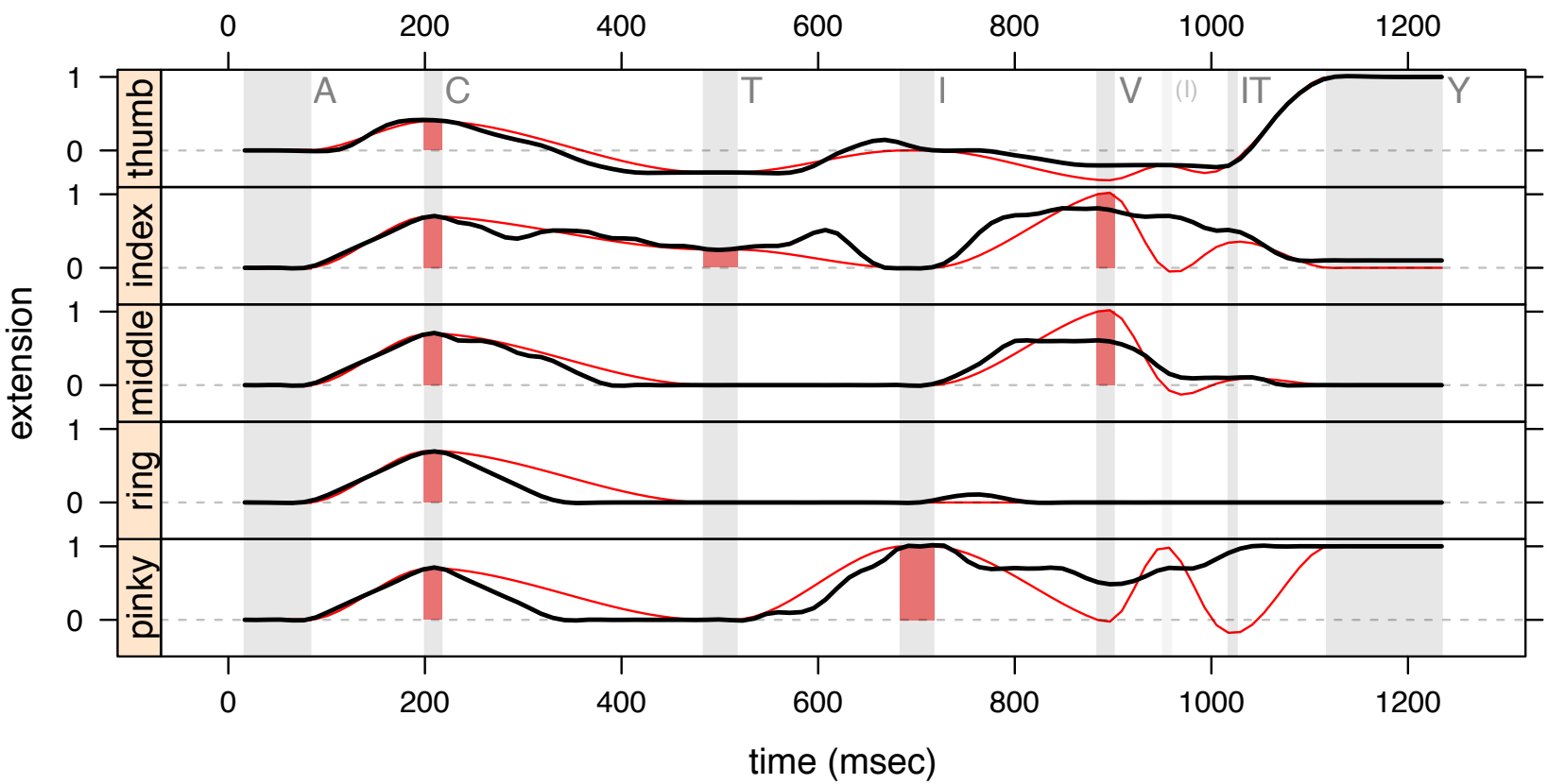


-A- -C- -T- -I- -V- -IT- -Y-

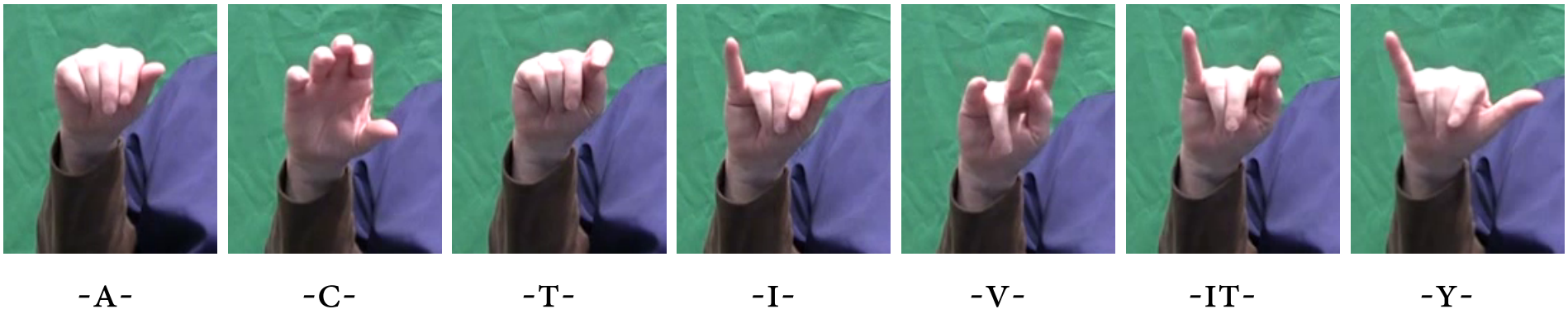


Articulator trajectories

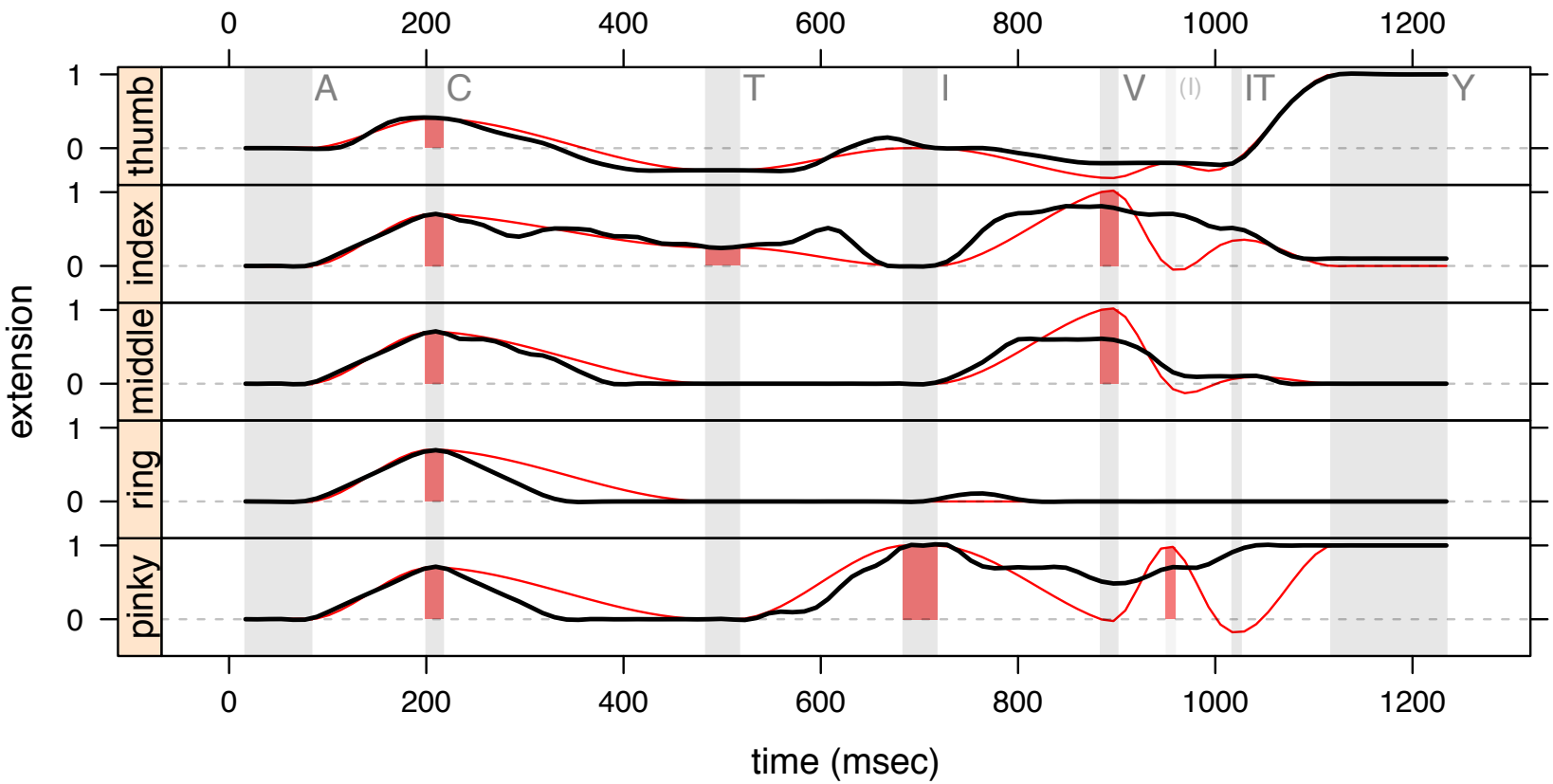




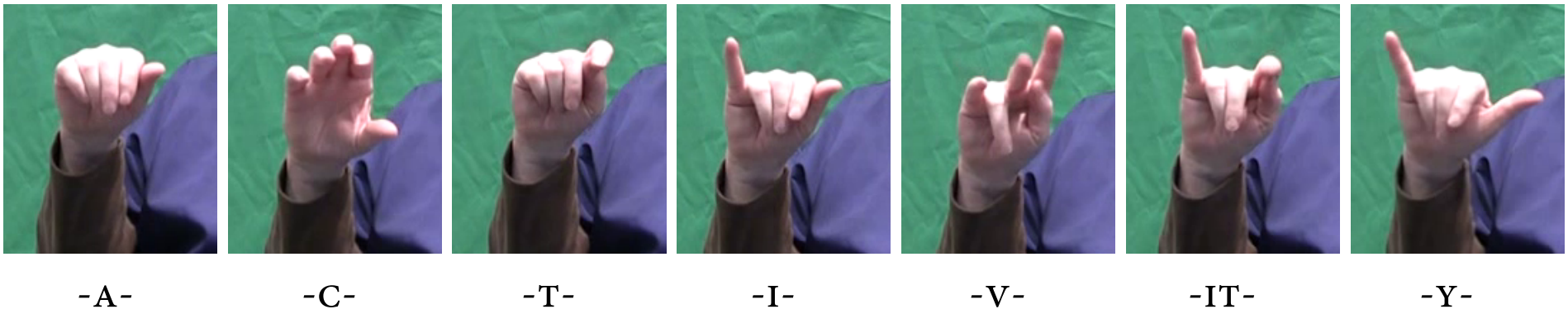
Articulator trajectories



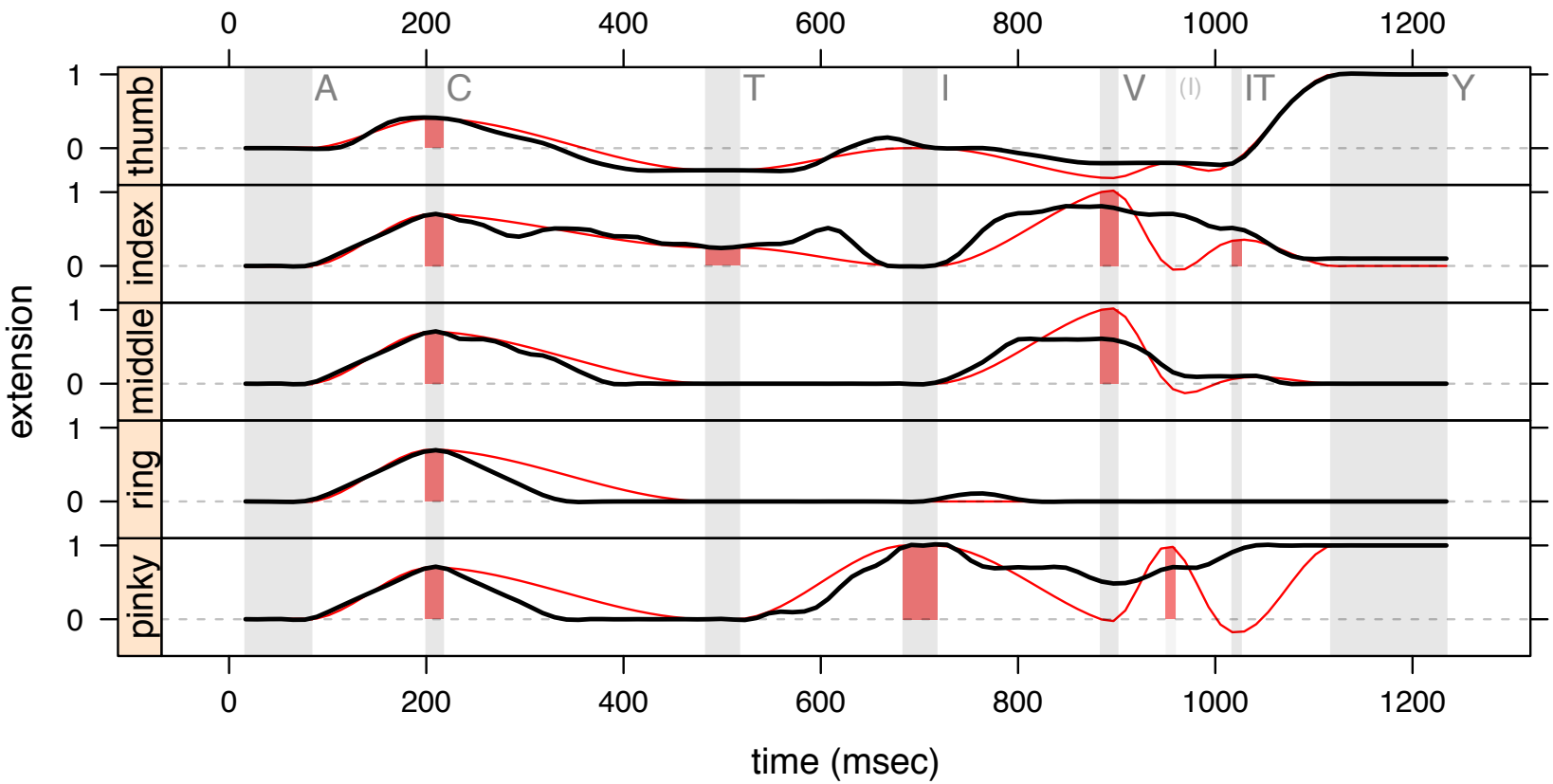
-A- -C- -T- -I- -V- -IT- -Y-



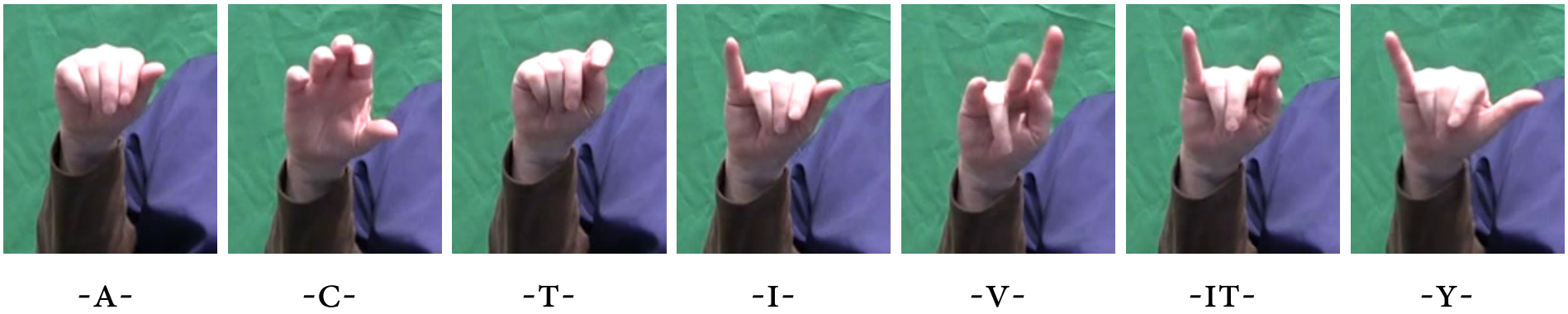
Articulator trajectories



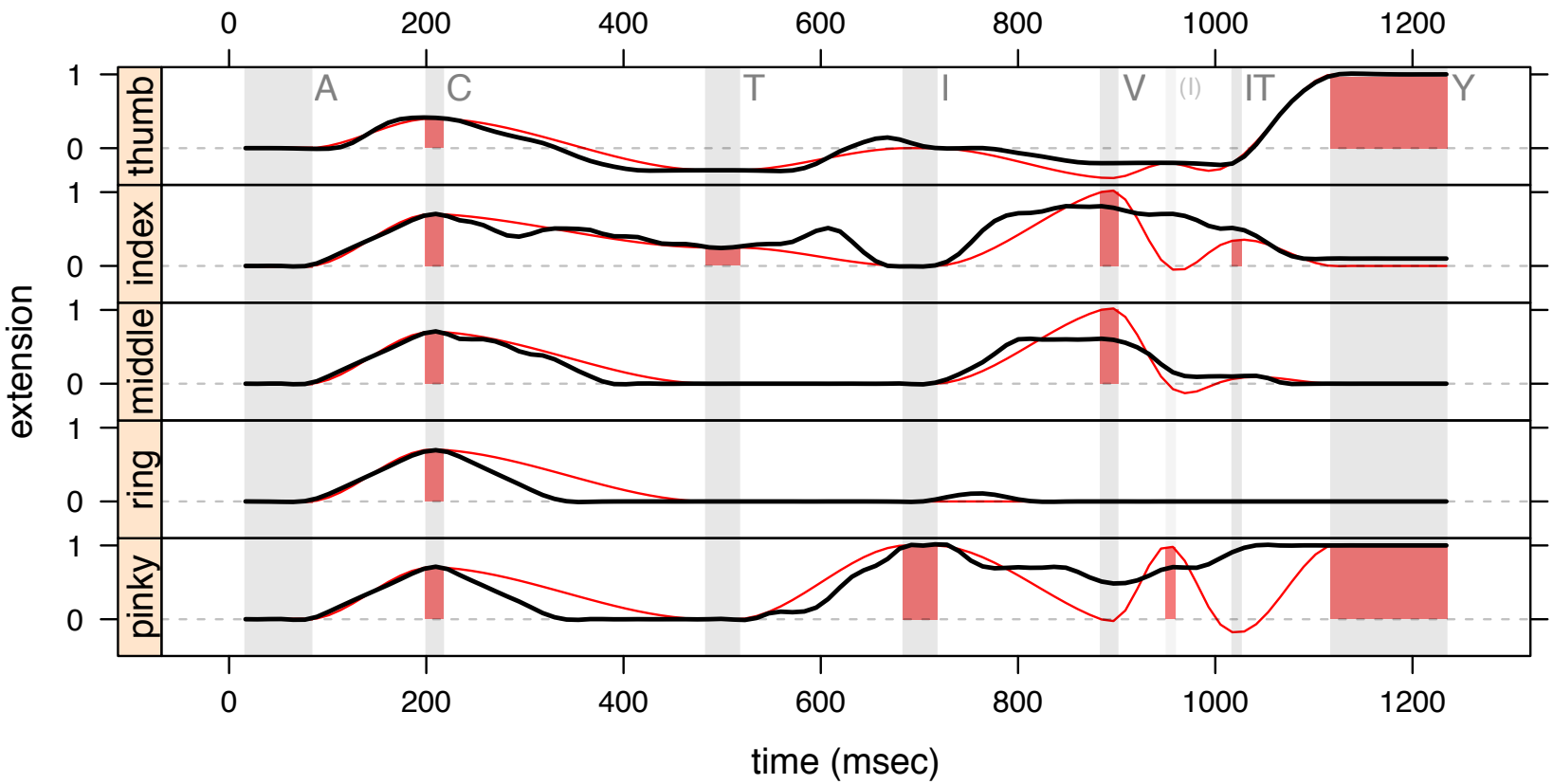
-A- -C- -T- -I- -V- -IT- -Y-



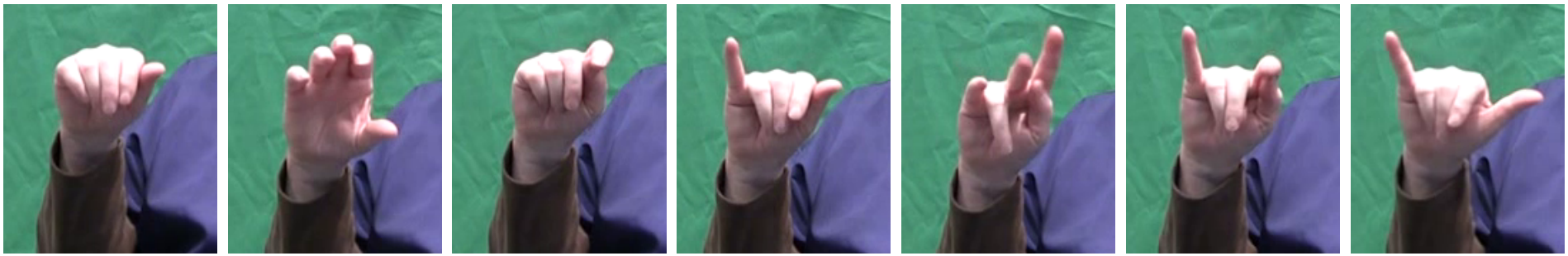
Articulator trajectories



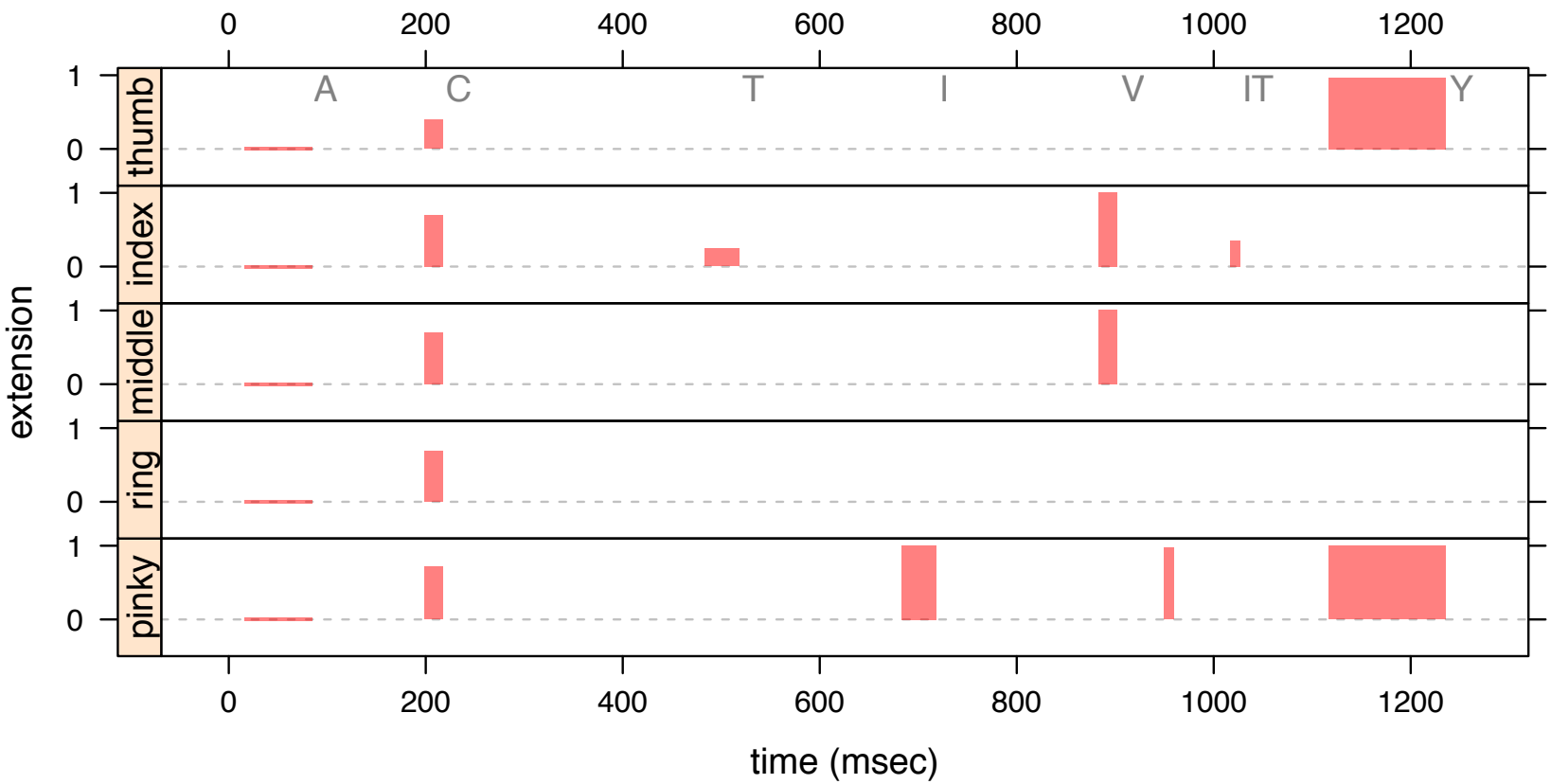
-A- -C- -T- -I- -V- -IT- -Y-



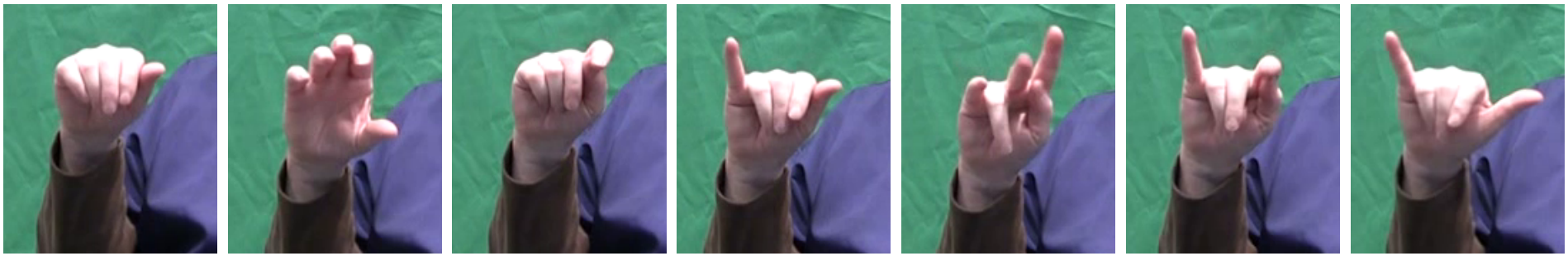
Articulator trajectories



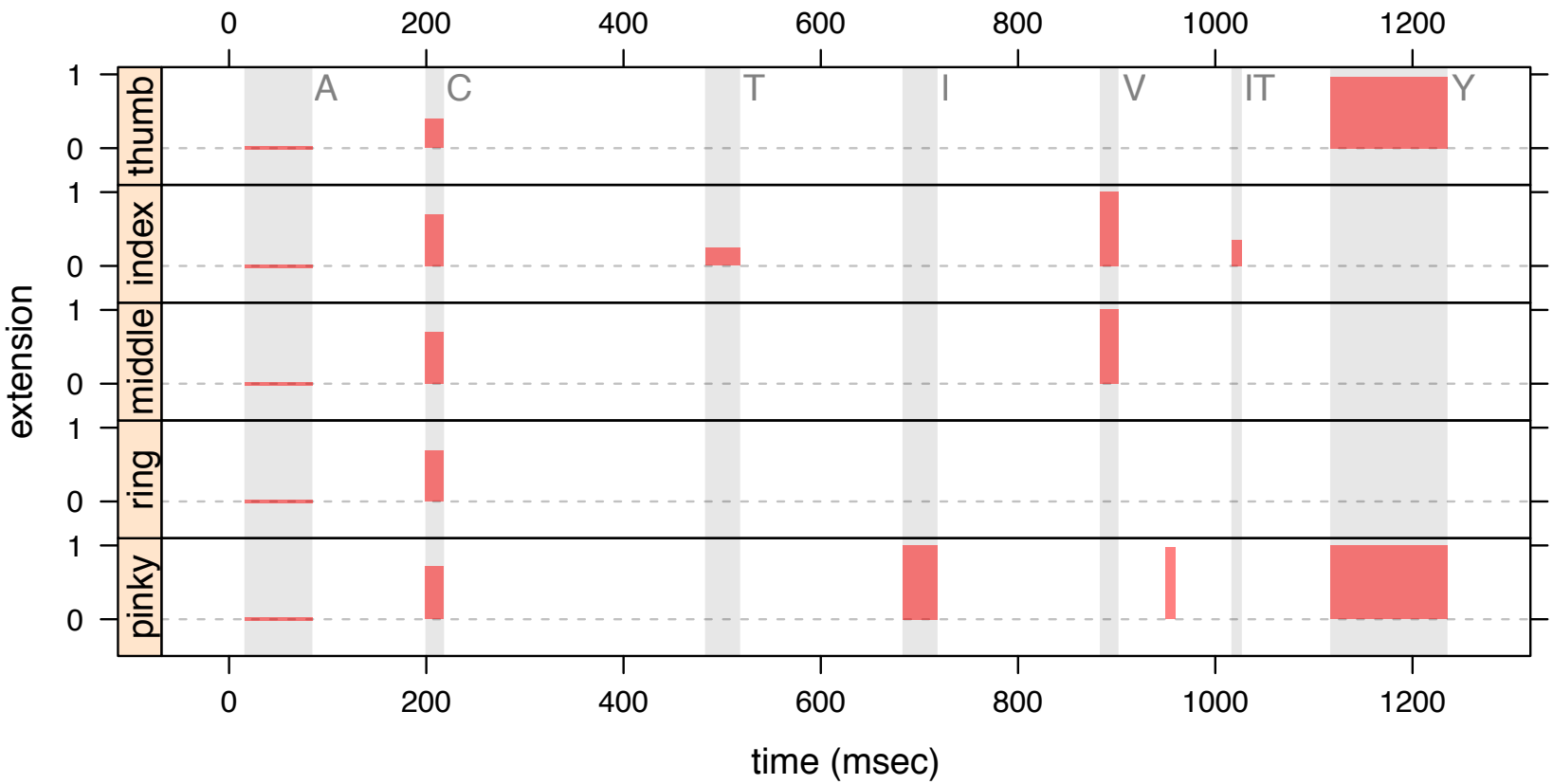
-A- -C- -T- -I- -V- -IT- -Y-



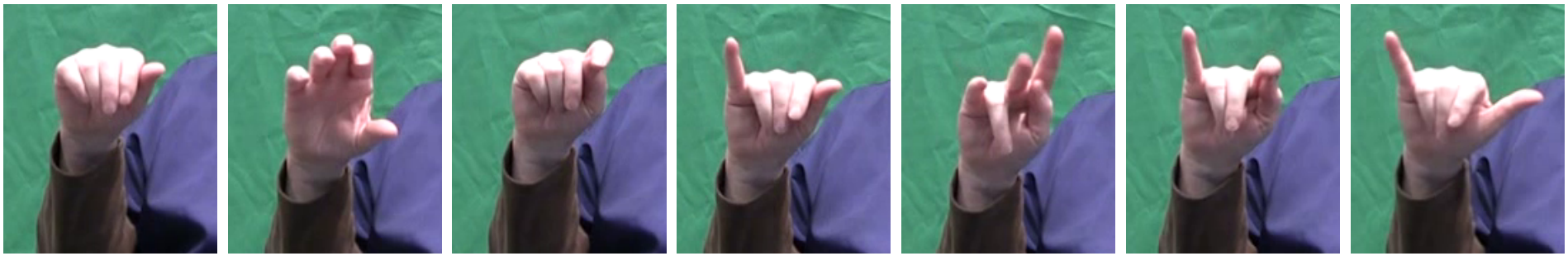
Articulator trajectories



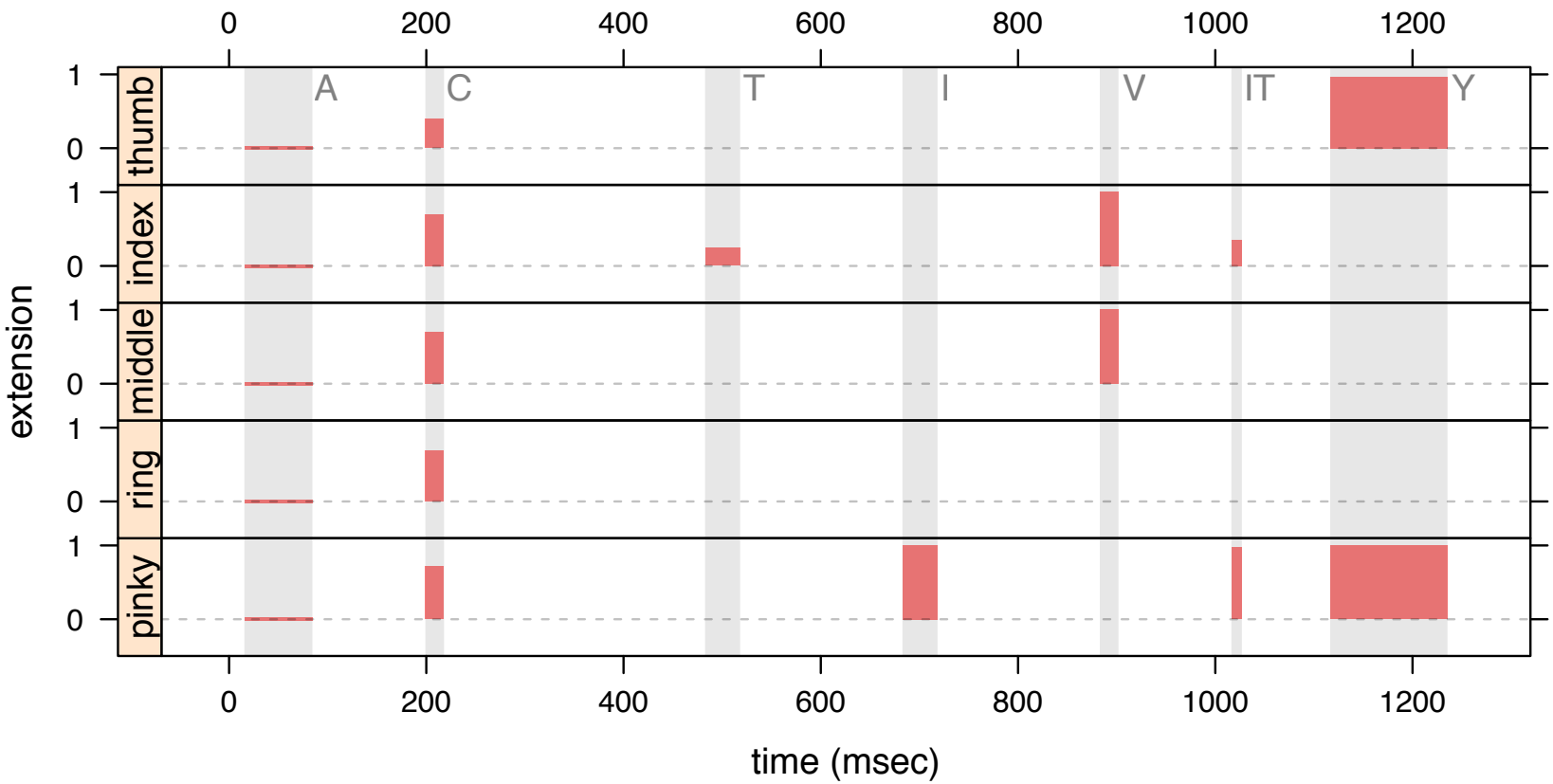
-A- -C- -T- -I- -V- -IT- -Y-



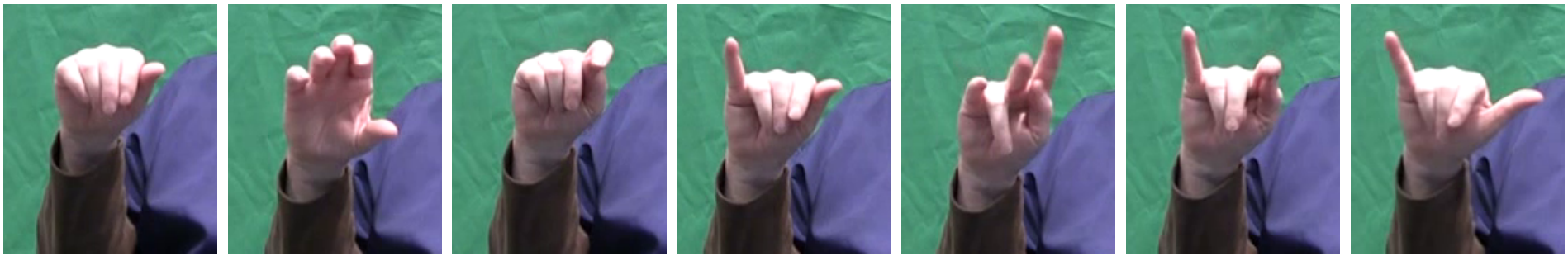
Articulator trajectories



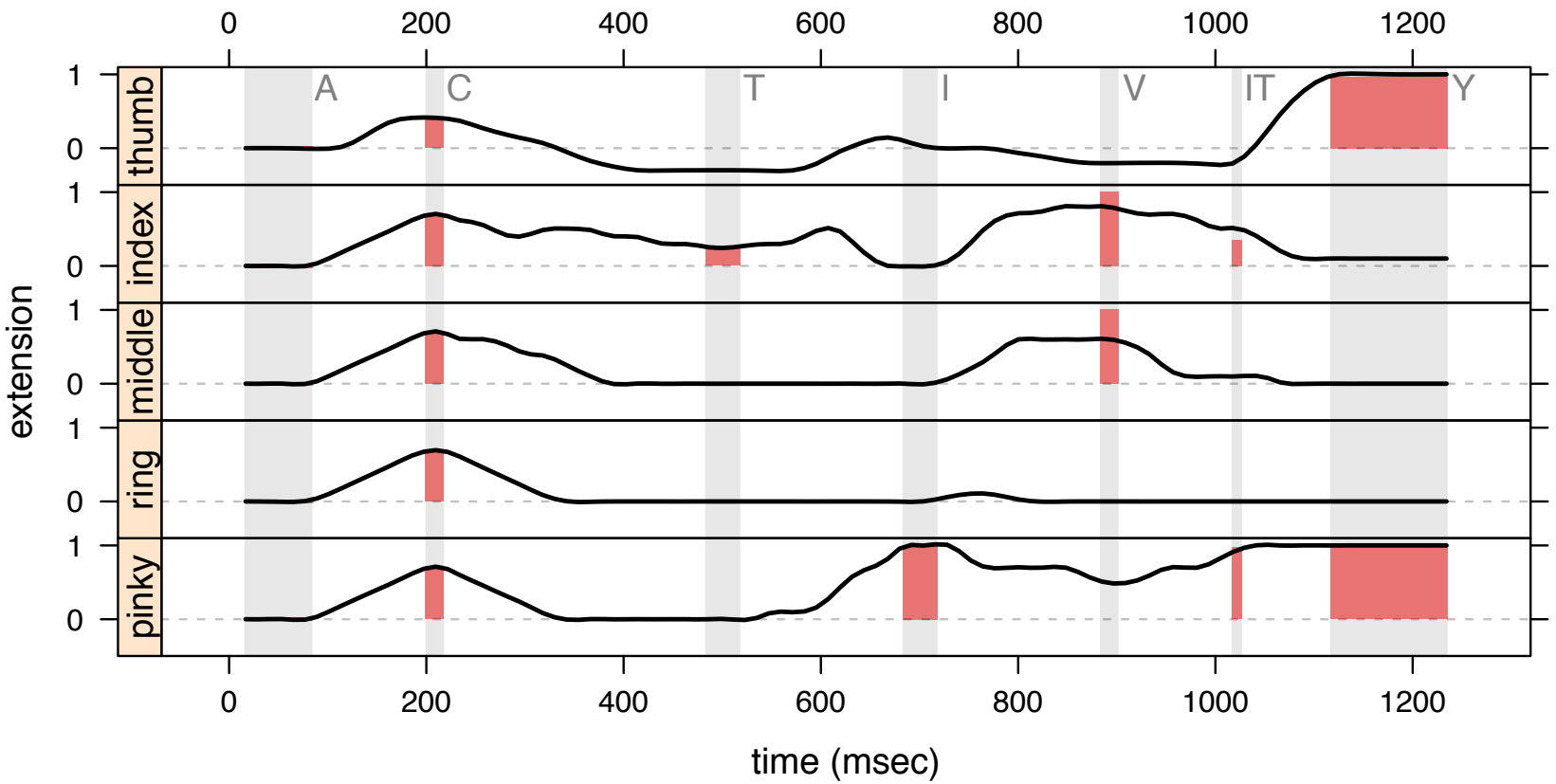
-A- -C- -T- -I- -V- -IT- -Y-



Articulator trajectories



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



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 (EG 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.

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

Main advisors

Jason Riggle and Diane Brentari

Other researchers

Susan Rizzo, Karen Livescu, Greg Shakhnarovich, Raquel Urtasun, Erin Dahlgren, and Katie Henry.

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