

Coarticulation in ASL Fingerspelling

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Background

There has been much work on coarticulation in speech, however fingerspelling has been explored less (Hoopes, 1998; Tyrone et al. 1999; Jerde et al. 2003).

Using a new data set of ASL fingerspelling, we have annotated pinky extension as a first step to look for coarticulation on a larger scale.

This study contributes to:

- › sign phonology generally (handshape contrasts)
- › articulatory theories of language production
- › segmentation in language generally

Questions

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?

Method

Apogee Identification

1. We recorded nearly 3 hours of 2 native ASL signers fingerspelling a total of 2,400 words and 7,317 apogees.
2. We coded the video by identifying the apogee of each letter that was fingerspelled. We defined apogee as the time when the velocity of the articulators approached zero. This usually corresponded with the most canonical handshape and provides us with a point to analyze variation in handshape between apogees.
3. We extracted still images, then hand coded pinky extension for each of these apogees.

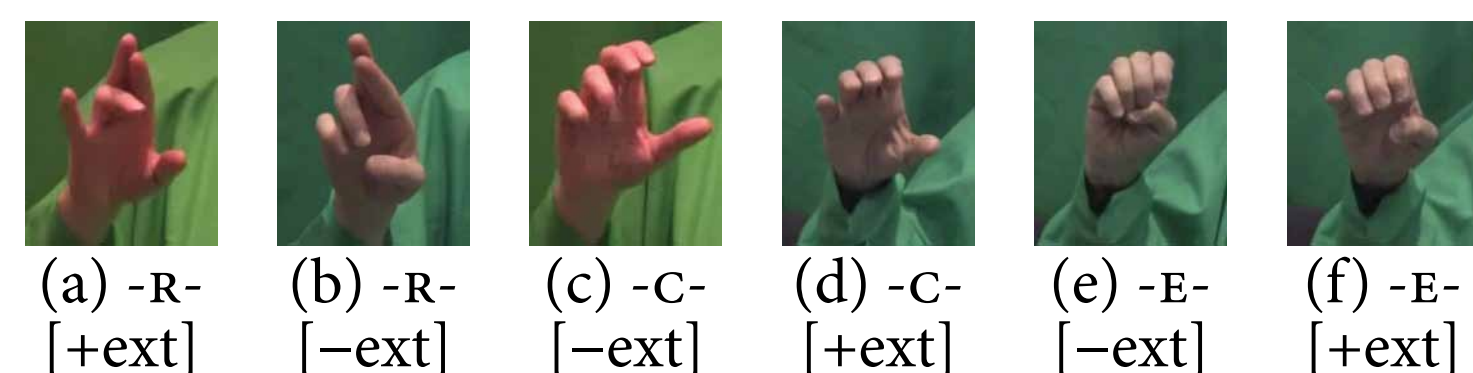


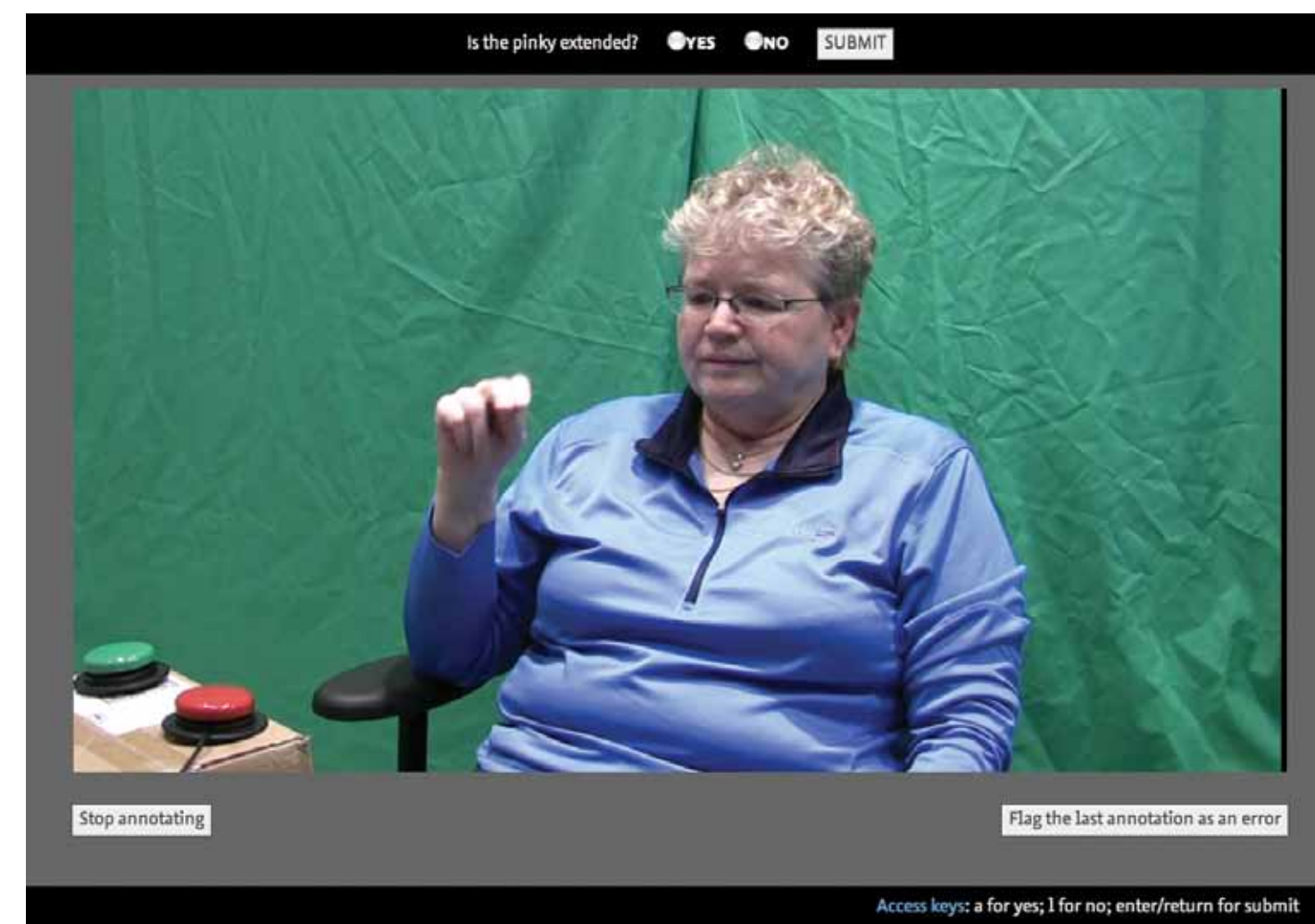
Figure 1: apogees from (a) C-H-R-I-S, (b) D-I-N-O-S-A-U-R, (c) Z-A-C-K, (d) E-X-P-E-C-T-A-T-I-O-N, (e) E-V-E-R-G-L-A-D-E-S, and (f) Z-D-R-O-Q-I-E

Extension Annotation

We defined a pinky as extended if:

- › The proximal interphalangeal joint (PIP) was extended significantly greater than 90 degrees (from the palmar plane).
- › The metacarpophalangeal joint (MCP) was extended at an angle perceptibly greater than 90 degrees.
- › The tip of the pinky was extended past the plane perpendicular to the palmar plane, at the base of the fingers (the MCP joint).

With this metric the canonical hand shapes for -B-, -F-, -I-, -J-, -Y-, and sometimes -C- would have extended pinkies, and the rest would not.



Results

Apogees that we expect to have pinky extension (-B-, -F-, -I-, -J-, -Y-, and sometimes -C-) by and large do. In the apogees that we don't expect to have pinky extension we see a surprising 295 apogees have pinky extension, which is nearly 5% of all apogees in this set.

	expected	unexpected
+pinky extension	1438	295
-pinky extension	49	5870

table 1: Counts for pinky extension: note that there are a large number of apogees with unexpected pinky extension.

Coarticulation involving the pinky, involves pinky extension being anticipated and preserved in surrounding apogees, rather than pinky extension being suppressed.

Significant in a multilevel logistic regression of pinky extension:

- › handshape of the preceding apogee
- › handshape of the following apogee
- › word type
- › following transition time
- › interaction of following handshape and following transition time

Increase the probability of pinky extension (in decreasing magnitude):

- › preceding apogee is an -I-, -J-, or -Y-
- › following apogee is an -I-, -J-, or -Y-
- › following apogee is a -B-, -C-, or -F-
- › the wordtype was English (name or noun)
- › the following transition was shorter
- › both the following transition was shorter, and the following apogee is a B-, -C-, -F-, -I-, -J-, or -Y-

Discussion

Neighboring apogees that are -I-, -J-, and -Y- condition pinky extension much more than -B-, -C-, and -F-, despite the fact that both groups of handshapes canonically have an extended pinky. The only systematic difference is that in -I-, -J-, and -Y- the pinky is extended without other fingers, where as in -B-, -C-, and -F- other fingers are also extended.

There are three extensors involved in finger (excluding thumb) extension (Greftegreff, 1993; Ann, 1993):

1. extensor indicis proprius (for the index finger)
2. extensor digiti minimi (for the pinky finger)
3. extensor digitorum communis (for all of the fingers)

When extended with other fingers there are two extensors acting on the pinky, but extended alone there is only a single one. **This results in slower, less controlled pinky extension when only the pinky is extended.**

References

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- Rob Hoopes. A preliminary examination of pinky extension: suggestions regarding its occurrence, constraints, and function. *Pinky extension and eye gaze: Language use in Deaf communities*, 3–17, 1998.
- Irene Greftegreff. A few notes on anatomy and distinctive features in NTS handshapes. Working papers in linguistics, (17):46–66, 1993.
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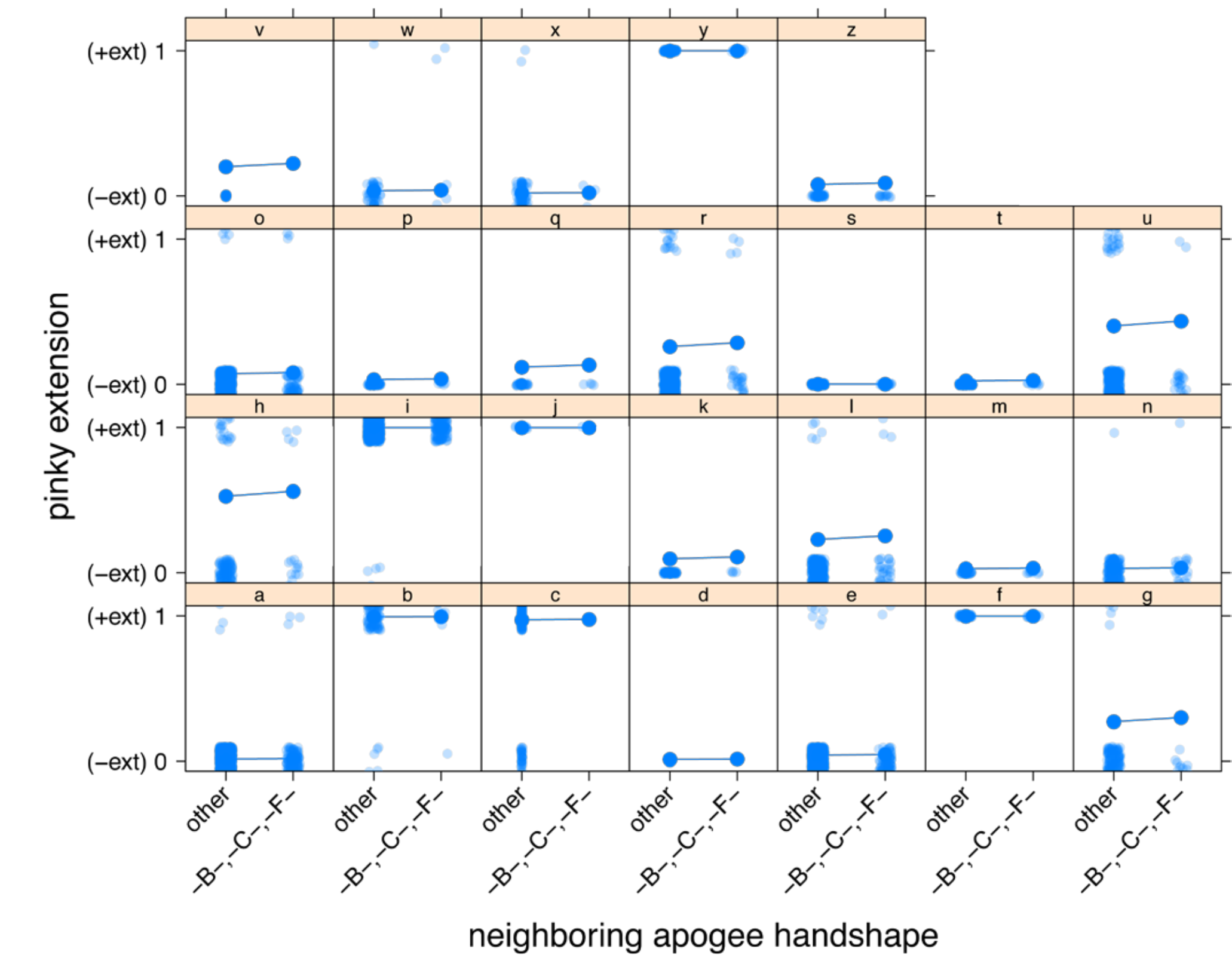
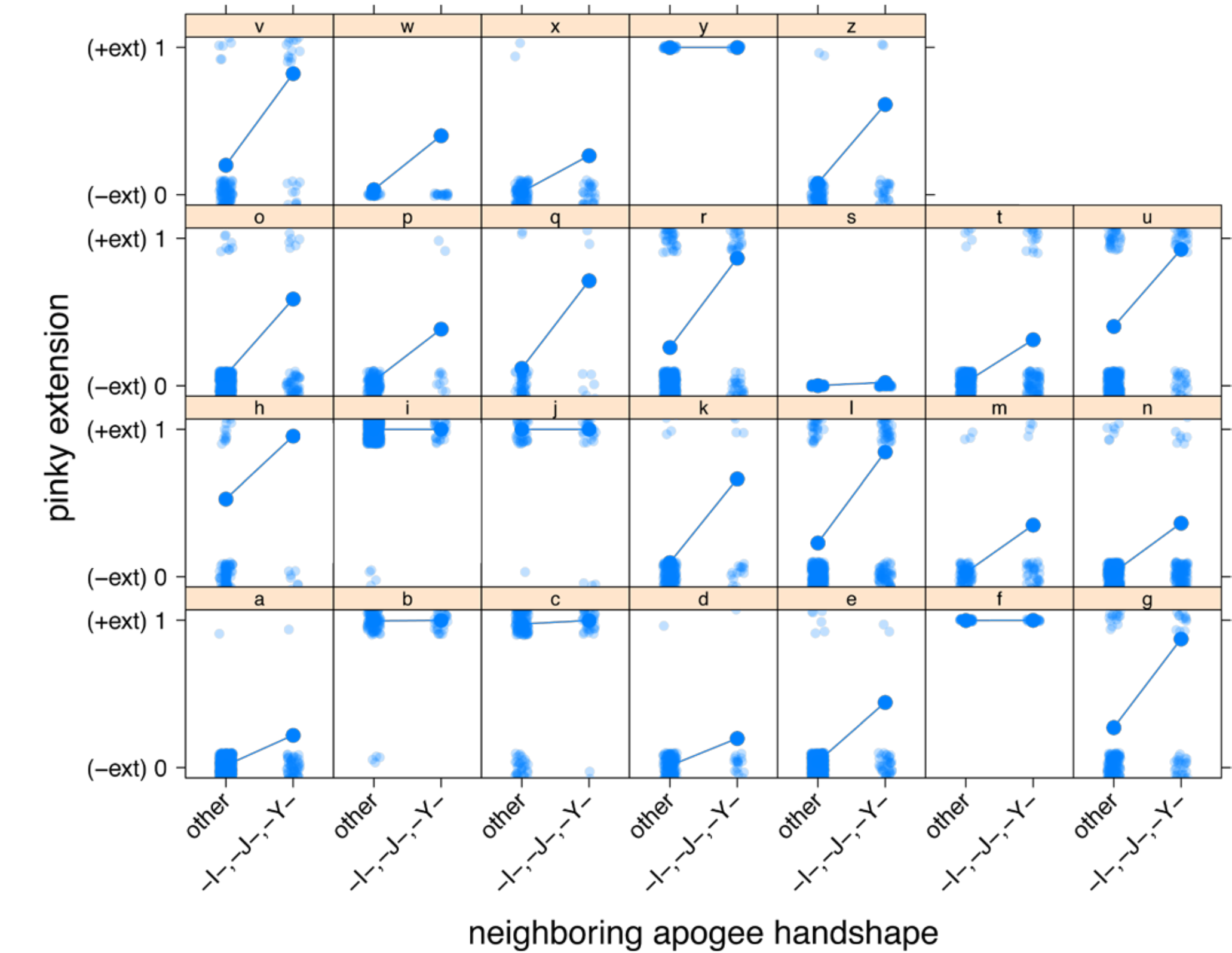


Figure 2: plots showing the effect of neighboring apogees on pinky extension

- › In the handshapes where we expect extension (-B-, -C-, -F-, -I-, -J-, and -Y-) nearly all apogees have pinky extension.
- › In other letters (particularly -E-, -G-, -H-, -K-, -L-, -Q-, -R-, -U-, -V- and -Z-) a neighboring -I-, -J-, or -Y- greatly increases the probability of pinky extension.
- › The lines represent model predictions.