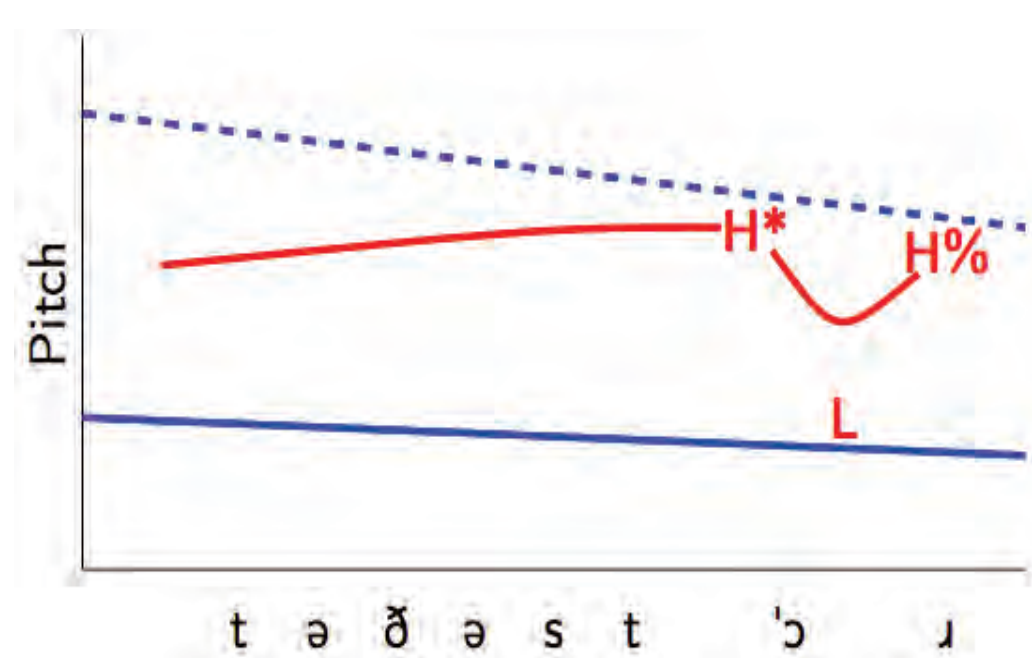# ASL sign lowering as target undershoot: A corpus study

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Undershoot: when an articulator doesn't get all the way to its target before moving away toward another target.

E.g., in intonation, a low tone might be undershot if it's squeezed too tightly between two high tones.

Usual explanation: overlapping gestures pull the articulator in conflicting direction.
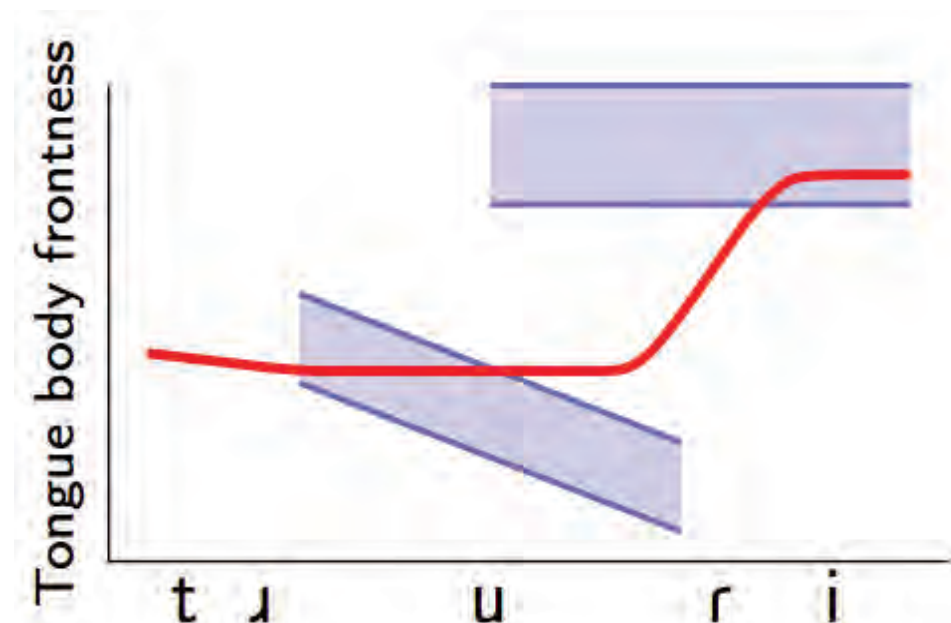
E.g., tongue body at the end of the /u/ in Trudy, pulled backward by the /u/ gesture but never fully reaches its target since it's also pulled forward by the /i/ gesture that's already started.

Is ASL sign lowering a case of undershoot?

One token of the sign THINK, canonically formed on the forehead.

Two research traditions have explored lowering of forehead signs:

1. Phoneticians

continuous measurements with optical tracking (Mauk et al. 2008, Mauk and Tyrone 2008, Tyrone and Mauk 2010)

Things influencing the degree of sign lowering are the same as those for spoken language undershoot: signing rate, location of neighbouring signs, position at a phrase edge.

2. Variationist sociolinguists

forced by logistic regression analysis to treat lowering as a categorical (yes or no) rule. (Lucas et al. 2002, Schembri et al 2009)

In addition to social factors, the frequency of lowering is influenced by lexical frequency, lexical category (noun/verb), location of neighbouring signs, and position at a phrase edge — also all factors for spoken language undershoot.

QUESTIONS

Are the phoneticians and the variationists measuring different phenomena or the same phenomenon, just with different assumptions about gradience/categoricalness?

And do findings about forehead signs generalize to other locations on the face and neck?

The current study

Six signers, all right-handed native ASL users from the Winnipeg Deaf community, recorded in 2000, in informal conversation with a Deaf interviewer.

We identified all signs canonically made at the head, face, or neck — unlike earlier studies, not just the forehead. For all those that occurred more than once:
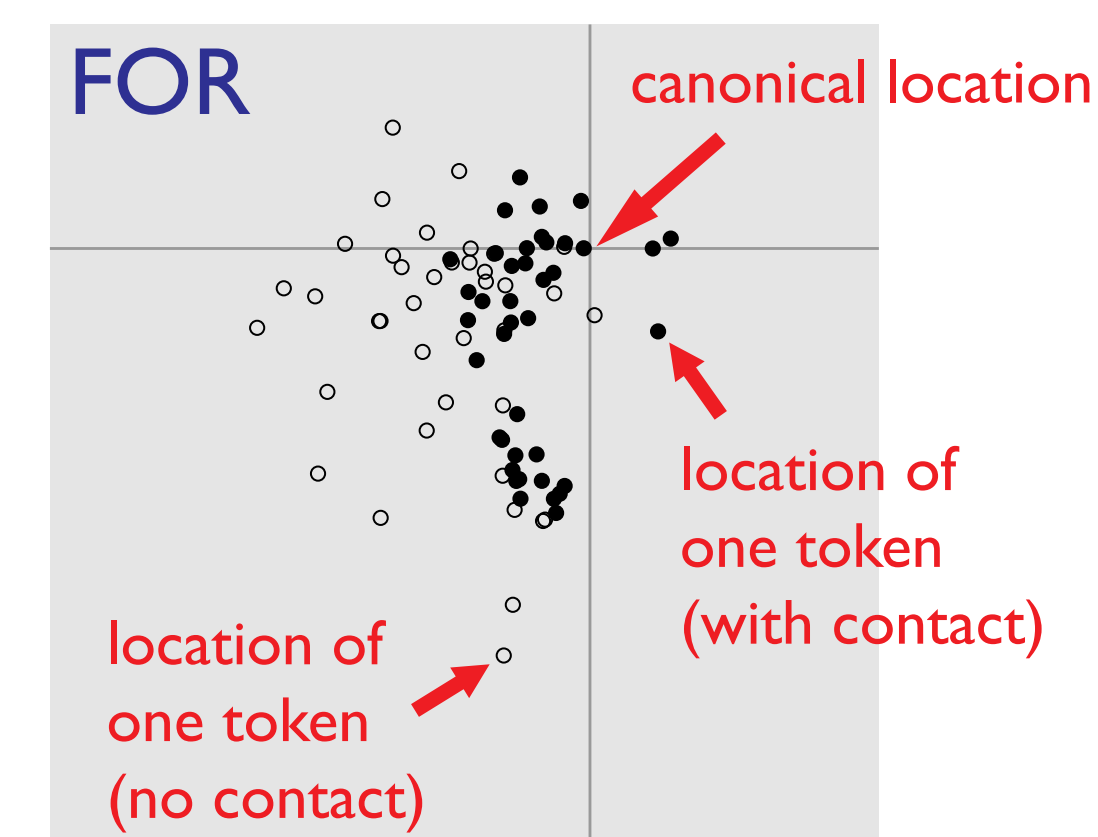• decided on "canonical location" — that of the most conservative version of the sign still actually used in Winnipeg.
• obtained subjective frequency judgments from native signers.

3075 tokens representing 229 types/lexemes.

For each token of those signs:
• identified the frame of the video with the closest approach of the "active articulator" (AA, a part of the hand) to the "passive articulator" (PA).
• recorded the position (in pixels) of the AA, the PA, the eyes, nose tip, and chin tip.
• rotated the coordinate system around the PA (0,0) by the negative of the angle between the eyes.
• reflected the AA coordinates for signs made with the left hand (3%) across the y-axis.

How we diagram the farthest points reached for tokens of a sign. (All these diagrams are drawn to the same scale.)

FOR — canonical location — location of one token (with contact) — location of one token (no contact)

Some hypotheses:
1. Verbs will show more lowering than nouns.
2. More frequent signs will show more lowering than less frequent signs.
3. A gradient decrease in the amount of lowering:
     forehead > eye > nose/ear > mouth > chin > neck
     since signs formed lower on the head are easier to articulate

RESULTS

Verbs are significantly more lowered than nouns. (Other lexical categories are intermediate.) Verbs are simply more variable/less fussy.
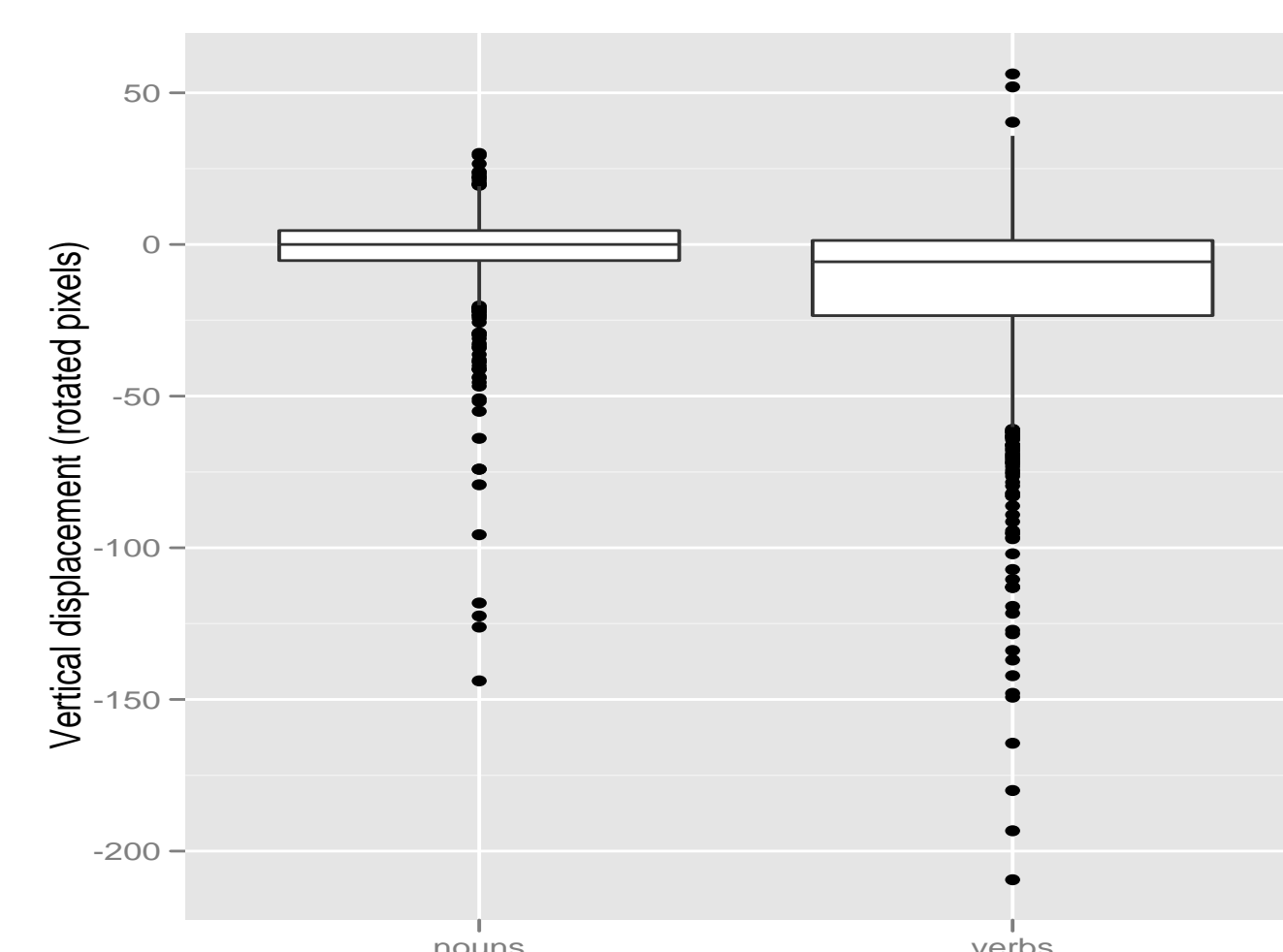

Significant effect of lexical frequency on amount of lowering.
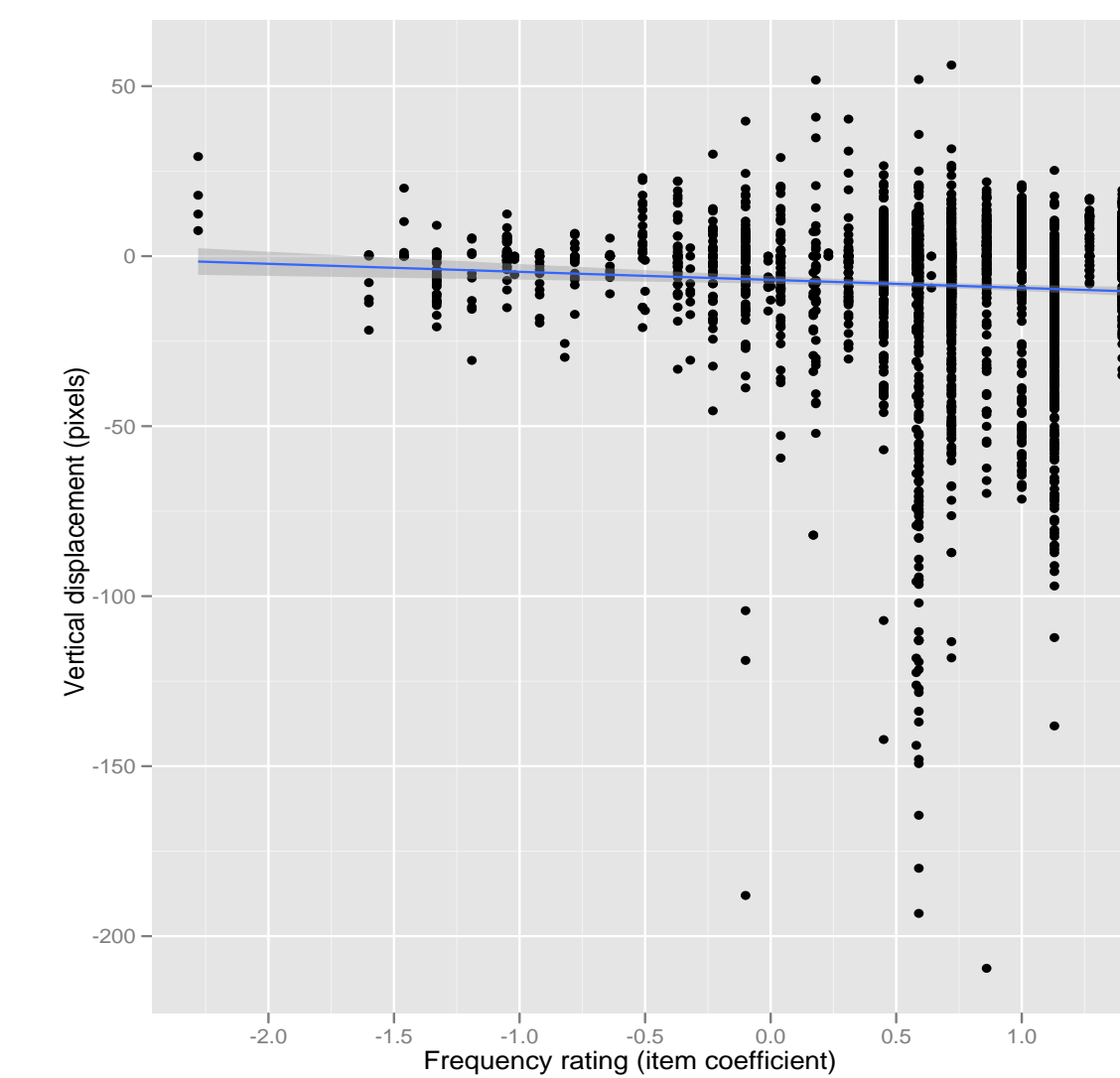
Patterns of lowering in forehead signs don't generalize nicely to lower locations on the head. Forehead signs lower more extremely, even in absolute terms. The degree of lowering doesn't diminish gradually for signs lower on the face.

eye level
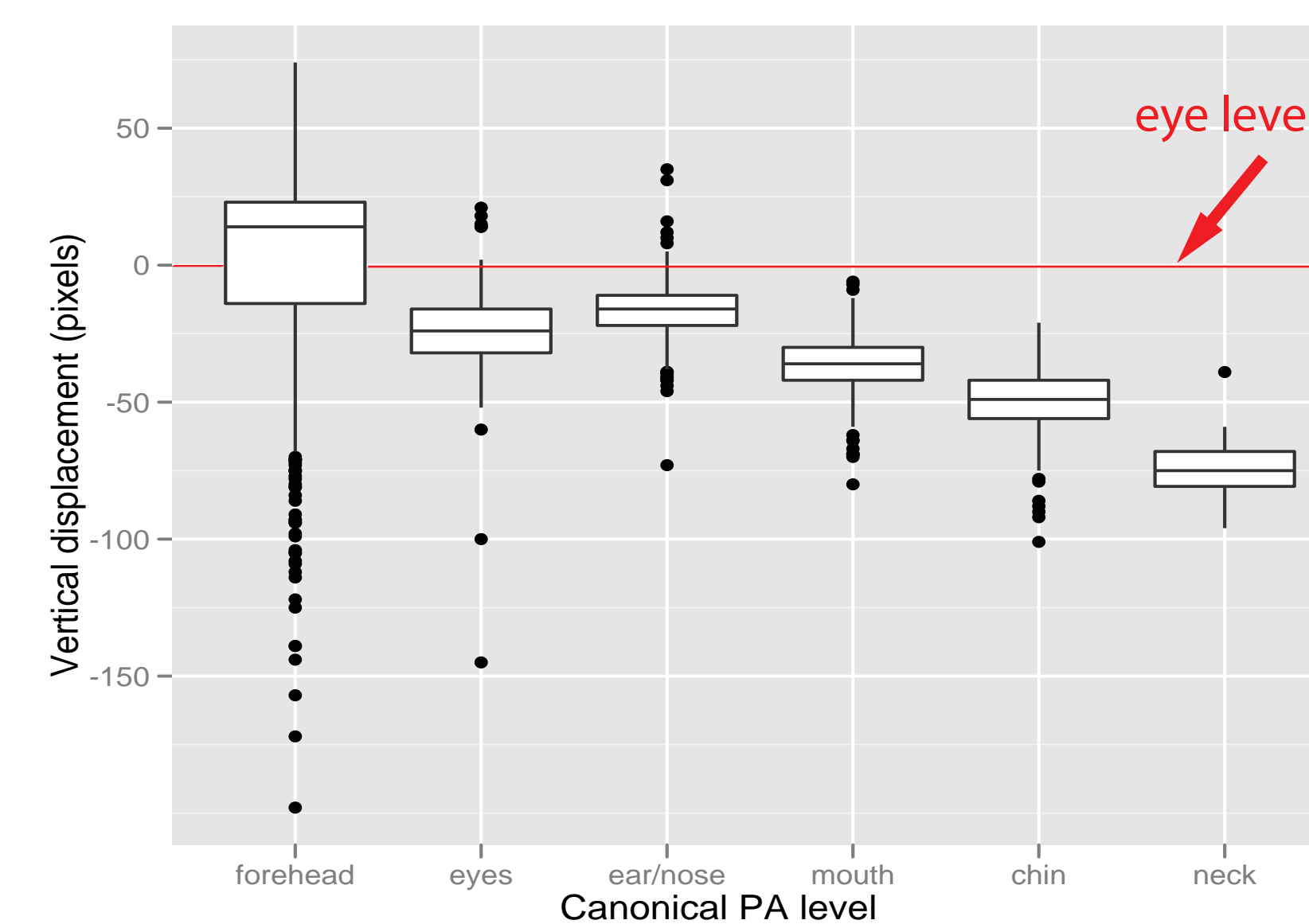
Minimal pairs of forehead and non-forehead signs are qualitatively different. (Same pattern for MAN/WOMAN and BROTHER/SISTER.)
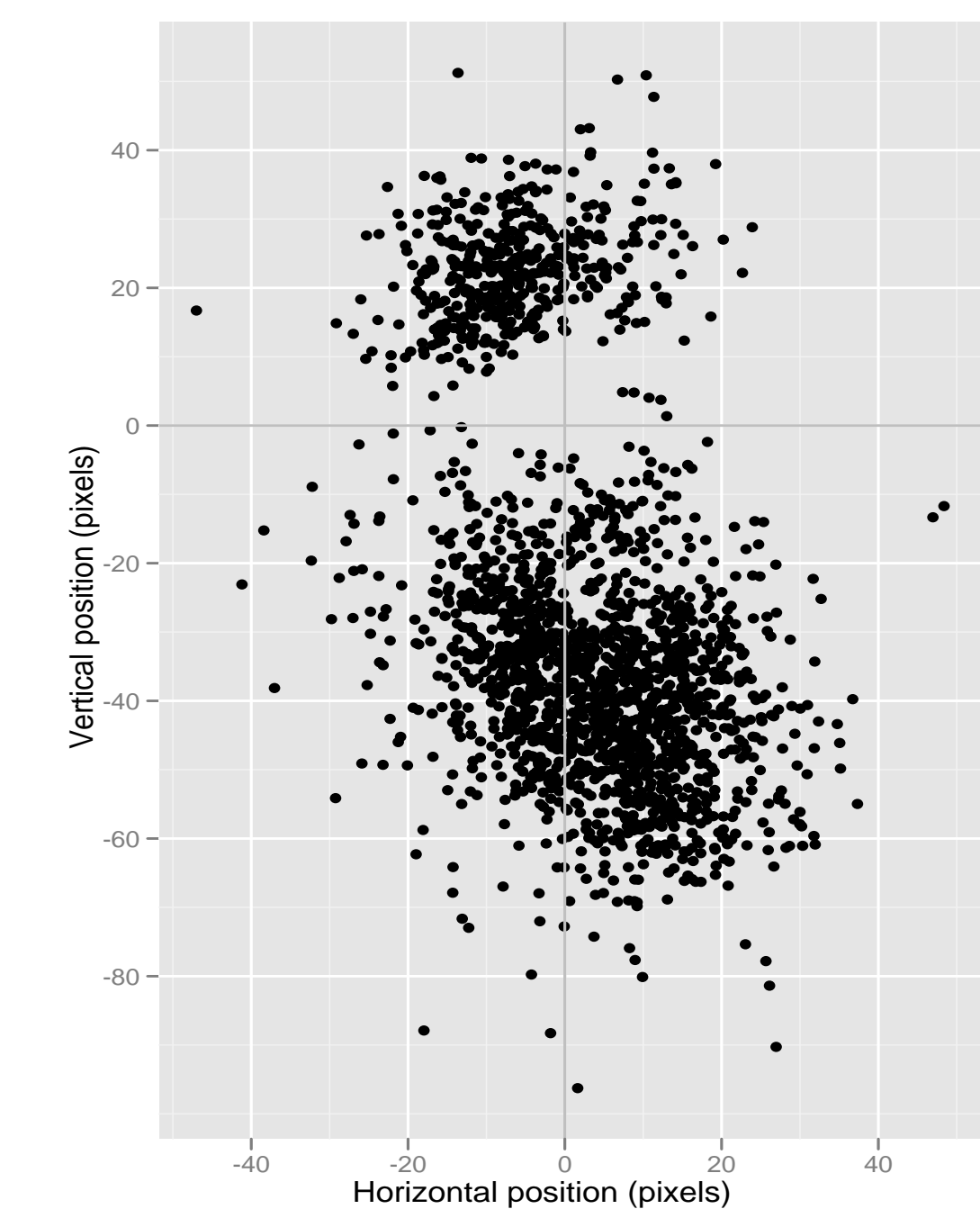
FATHER   MOTHER
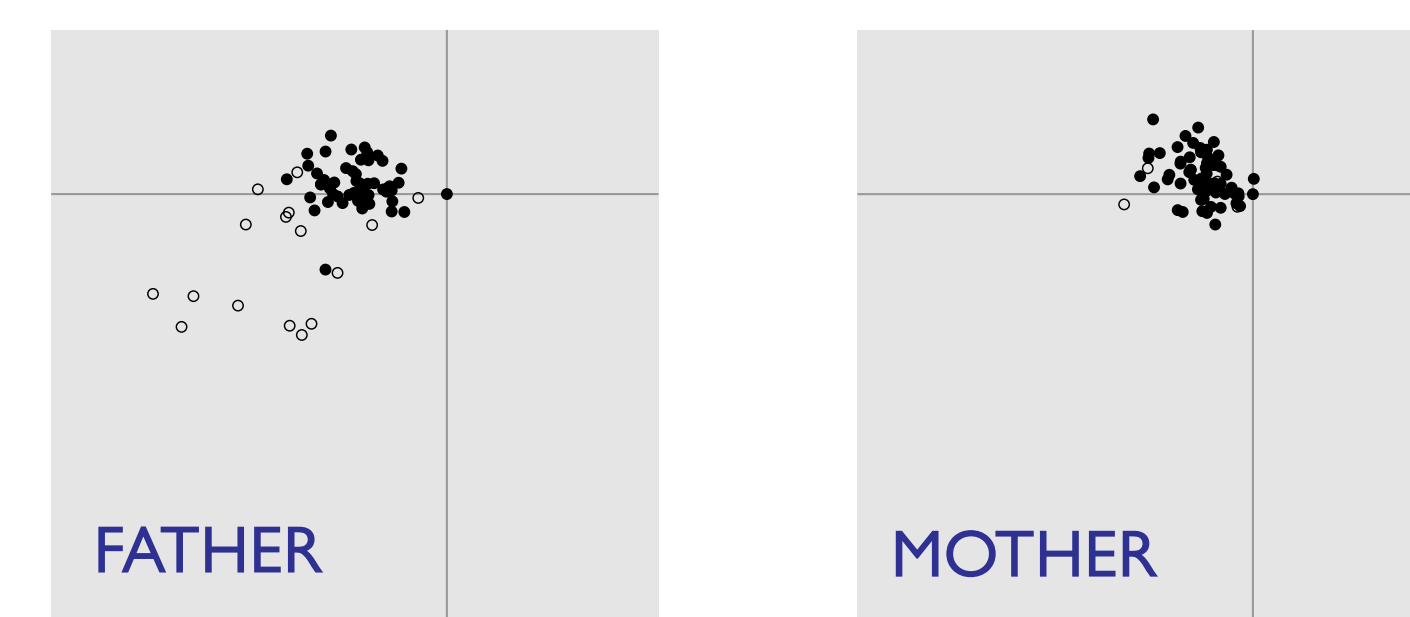
So the explanation for greater forehead sign lowering can't be purely mechanical.

Is sign lowering categorical?
A few signs clearly seem to have two variants (each with its own trail of undershot tokens), most others not quite so obviously. So sign lowering can't be just a categorical rule.

KNOW   DON'T-KNOW
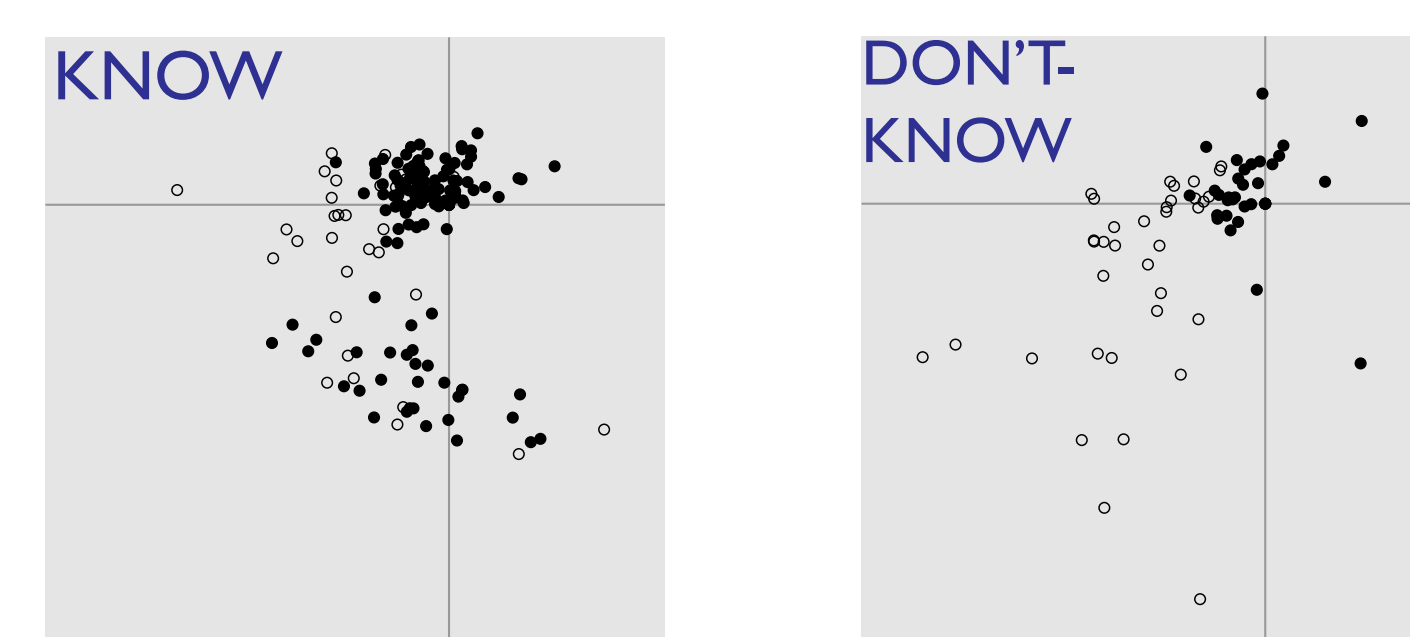
So undershoot is involved, but...

The location of all sign tokens in the corpus that actually make contact, relative to the right eye.

Signers systematically avoid poking themselves in the eye – even when undershooting.

So: Undershoot can't be merely an automatic side-effect of two overlapping gestures fighting it out.

Instead, there must be sophisticated forward modelling going on that predicts the somatosensory consequences of various gestural alignments, in time to avoid those that would be painful.

Undershoot is carefully planned and controlled.

Cf. Emmorey et al. (2009): Signers' self-monitoring must be due mostly to somatosensory (not visual) feedback.

It's unlikely that all variation in sign lowering will be explainable by general factors like lexical frequency. We'll need some sign-specific phonetics built into lexical representation (e.g., with distributions or exemplars).

REASON   WHY

Possible division of labour:

• "phonology": selecting a passive articulator target from a (complex) lexical distribution — can appear categorical.

• "phonetics": undershooting that target due to fast articulation, gestural overlap, etc. — gradient.

Articulatory reduction might be a form of physical "laziness", but mentally it takes at least as much work as clear speech or signing.

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