BAIR
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# Pressures for Communicative Efficiency in American Sign Language


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# Efficiency shapes human language

Efficiency: successful communication with **minimal effort** by sender + receiver

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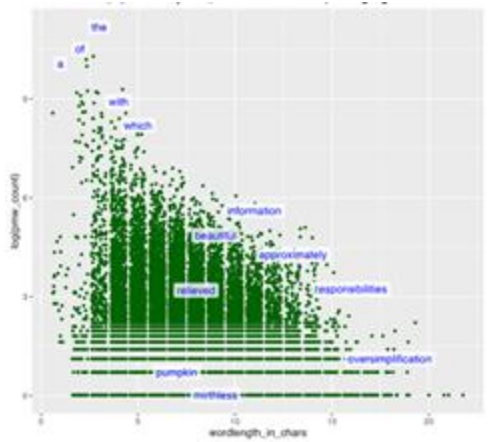
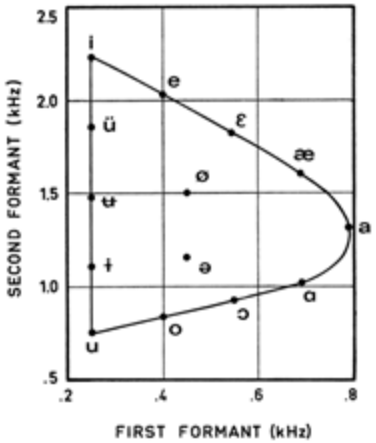



Frequent/informative words are shorter
(Zipf, 1935; Piantadosi et al., 2011)




Vowel space maximizes perceptual contrast
(Liljencrants & Lindblom, 1972)

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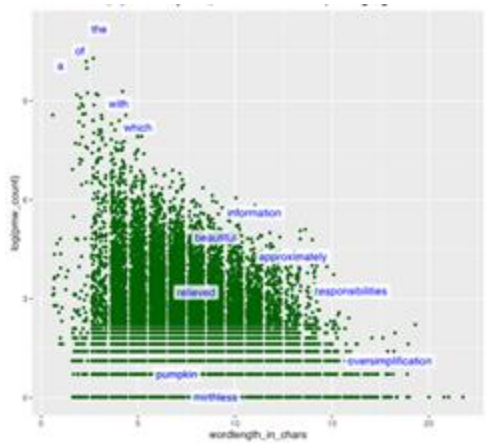


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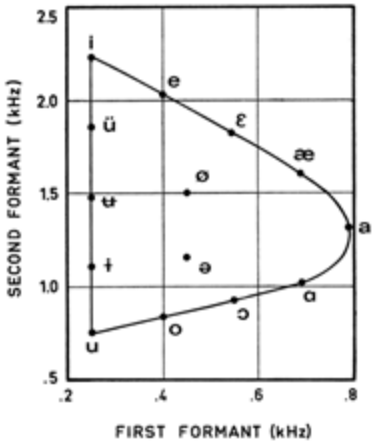


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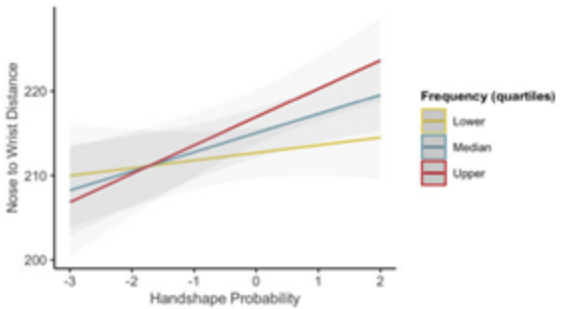


Infrequent ASL signs are produced closer to face
(Caselli et al., 2022)

# Research questions

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RQ2. If so, do we find communicative efficiency mostly in **native signs**, or also in signs **borrowed from English**?

→ Compare handshape frequency and production effort

# Data

ASL Fingerspelling Recognition Corpus

- 100k+ fingerspelled phrases, no character-level labels
- Heuristic algorithm + manual post-correction
  - 1062 letters extracted

did you have a good time

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ASL-LEX (Caselli et al., 2017)

- ASL lexicon including handshape categories, sign frequency, native/initialized/fingerspelled loan sign categories

# Effort metrics

Articulatory effort:

- Finger independence

$$FI(\text{hand}) = \sum_{\mathcal{J}} \sum_{\alpha,\alpha' \in \mathcal{J} | \alpha \neq \alpha'} D(\alpha, \alpha')/N$$

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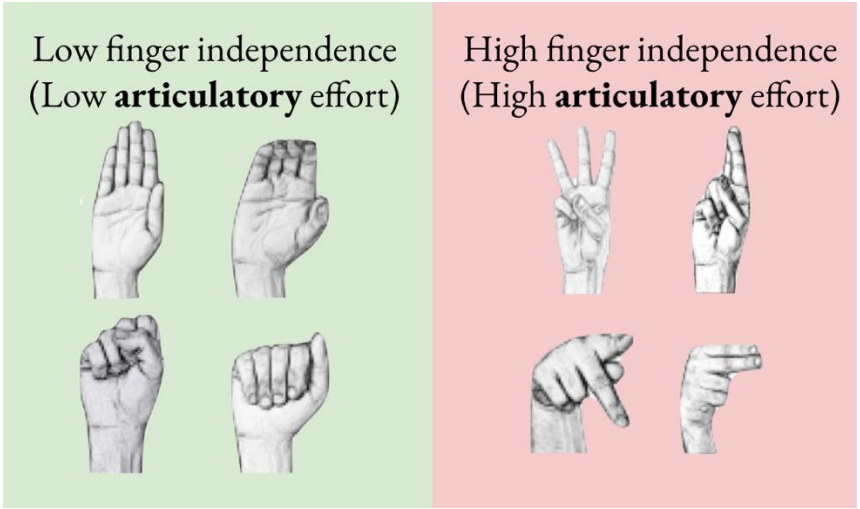


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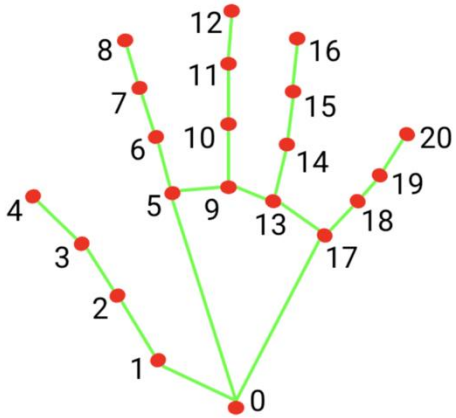

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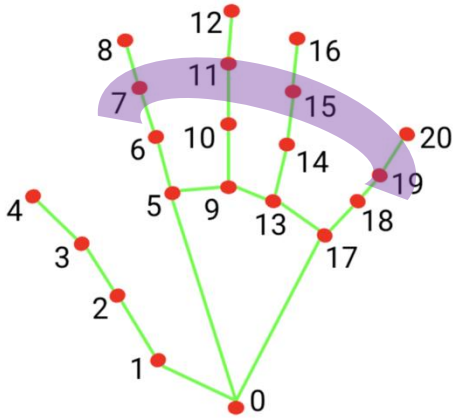

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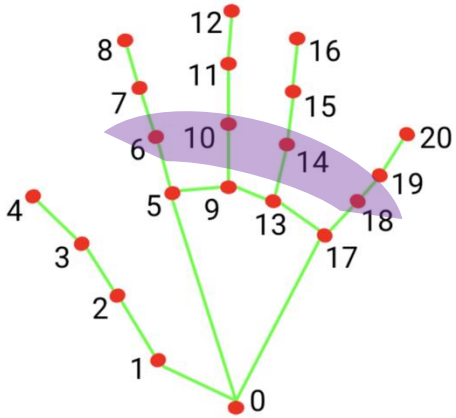

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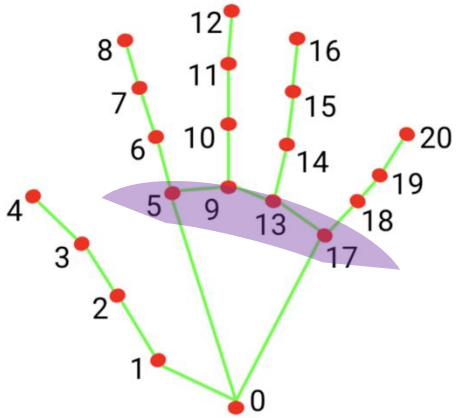
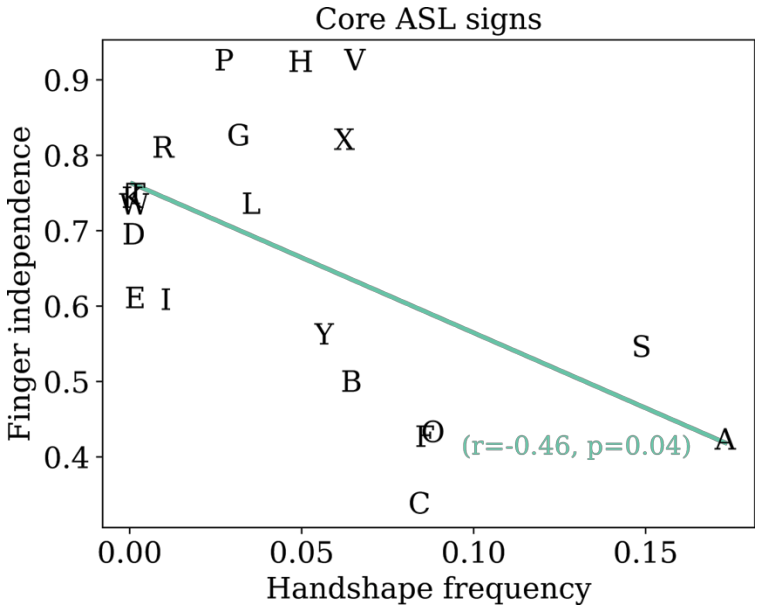


# Results

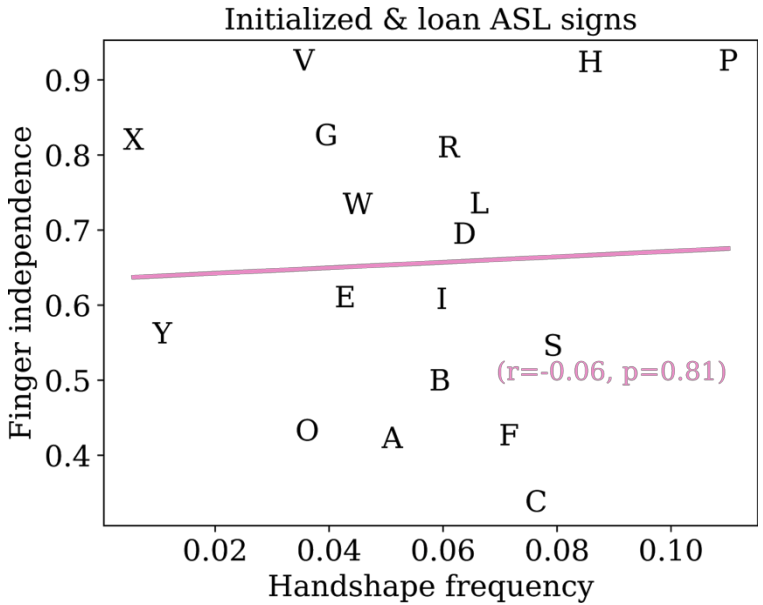
Handshape frequency vs. articulatory effort：native ASL signs




Pearson’s r=-0.46,p=0.04
→strong correlation

# Results

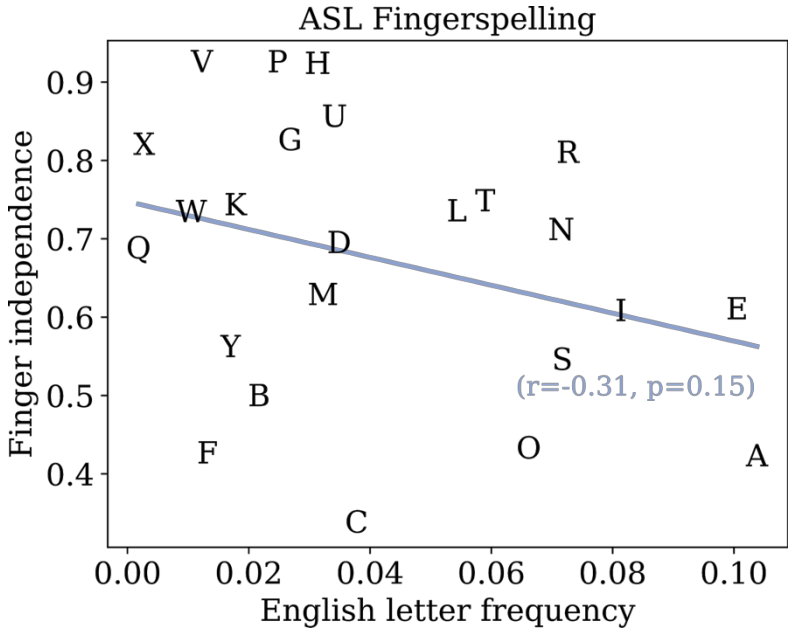
Handshape frequency vs. articulatory effort：borrowed ASL signs (initialized / fingerspelled loan signs)




Pearson’s r=-0.06,p=0.81
→no correlation

# Results

English letter frequency vs. articulatory effort (fingerspelling)




Pearson's r=-0.31,p=0.15
→no correlation

# Takeaways

RQ1. Do FS handshapes reflect pressures for **communicative efficiency**?

Yes!

RQ2. If so, do we find communicative efficiency mostly in **native signs**, or also in signs **borrowed from English**? Only in native signs!

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- Frequent words undergo faster language change (Bybee, 2015; Caselli et al., 2022)

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**Why?**

- ASL fingerspelling is invented by hearing educators (Padden and Gunsauls, 2003)
- Frequent words undergo faster language change (Bybee, 2015; Caselli et al., 2022)
- Foreign components obey fewer phonological rules (Brentari and Padden, 2001)

# Summary

- Compare the frequency and production effort of ASL handshapes
- Developed automatic metrics to quantify production effort
- We observe communicative efficiency in only handshapes of native signs, not signs borrowed from English