Measuring phonological complexity in sign languages

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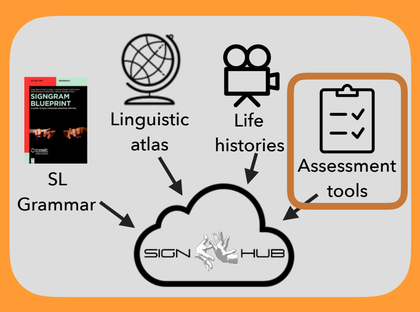
The Sign-Hub project



Short-term / Scientific goal: assess the impact of delayed language exposure.

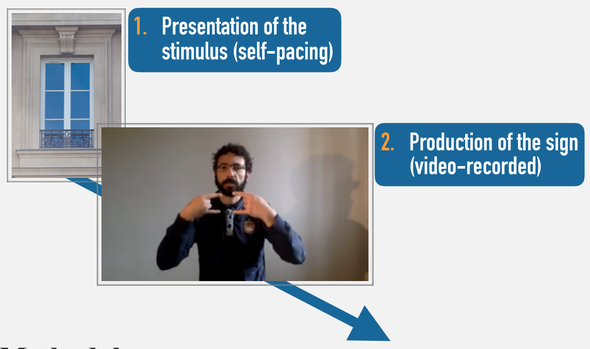
Long-term / Application: provide a basis for clinical assessment.

Battery of tests: lexical and syntactic tests.

LSF LIS LSC LSE ISL

Introduction

Assessing phonology: the production test in LSF and LIS.



Methodology:

- **Target signs:** non iconic, non transparent
- **Validation:** 20 hearing non-signers, exclusion if guessing >2
  - LSF: 112 signs, 4 excluded
  - LIS: 103 signs, 9 excluded

Setting the baselines:

- **Native** signers are a minority among signers
- Most Deaf people get to SL late or very late

➡ 3 Deaf populations per SL

15 natives | 15 early exposed (4yo-8yo) | 15 late exposed (9yo-13yo)

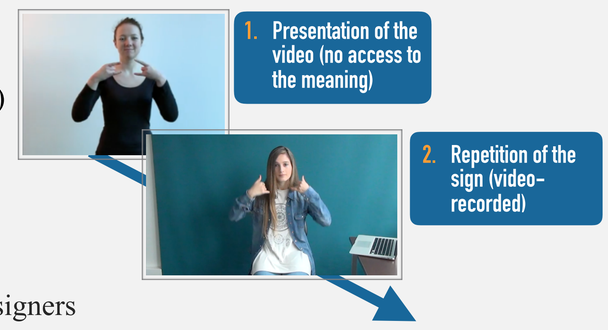
Factors:

- The frequency of each sign
- The **phonological complexity** of each sign, but:
  - No phonological description
  - No information on acquisition pattern or order
  - No recognition into speech/sign errors or other recognizable facts

Challenge: how to measure phonological complexity of signs without any knowledge of the phonology of the SL?

Non-linguistic measure

Repetition task for non-signers (video-recorded)



Materials:

- LSF:
  - 108 signs
  - 20 hearing non-signers
- LIS:
  - 94 signs
  - 17 hearing non-signers

Coding:

- 2 interns with basic competence in LSF/LIS + 2 SL researchers
- Fluency + Accuracy (Handshape (HS), Location (Loc), Orientation (Or), Movement (Mov))

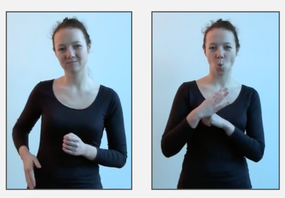
	Window
Fluency	1
HS	0
Loc	1
Or	1
Mov	1
TOTAL	4 / 5

Scoring:

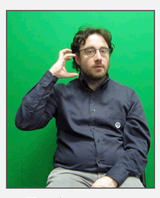
- Binary value for each component (correct = 1; wrong = 0)
- Overall accuracy: sum of the accuracy value for each component
- Degree of accuracy mapped onto a complexity scale (5 = least complex, 0 = most complex)

Results:

- Overall mean:
  - LSF: 4.282
  - LIS: 4.579


- Easiest: HAM (5)

- Most complex: HEDGEHOG (3.15)


- Easiest: RADIO (5)


- Most complex: HEDGEHOG (3.82)

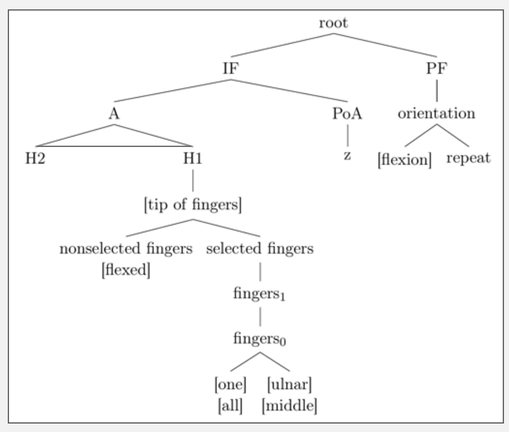
- Distribution of errors:
  - HS > Mov ≫ Or > Loc
- Mixed-model analysis:
  - Random effects: item & subject
  - Fixed effect: age
  - Main effect of age ($p < .05$)

Linguistic measure

Complexity scale: adapting the ***Prosodic Model*** (Brentari 1998)

Materials:

- LSF: 50 items annotated (/108), 3 excluded
- LIS: 30 items annotated (/94), 3 excluded



Coding:

- Tree structure for each sign

	Window
HS	16
Loc	2
Mov	4
TOTAL	22

Scoring:

- Level of complexity: number of nodes and positively specified features
- Lower values = less complex; higher values = more complex signs
- Total set of nodes and features: 116 (HS = 67, Loc = 22, Mov = 27)

Results:

- LSF


- Easiest: MATCH (14)


- Most complex: PEN (38)

- LIS


- Easiest: MOM (20)


- Most complex: PENCIL_SHARPENER (34)

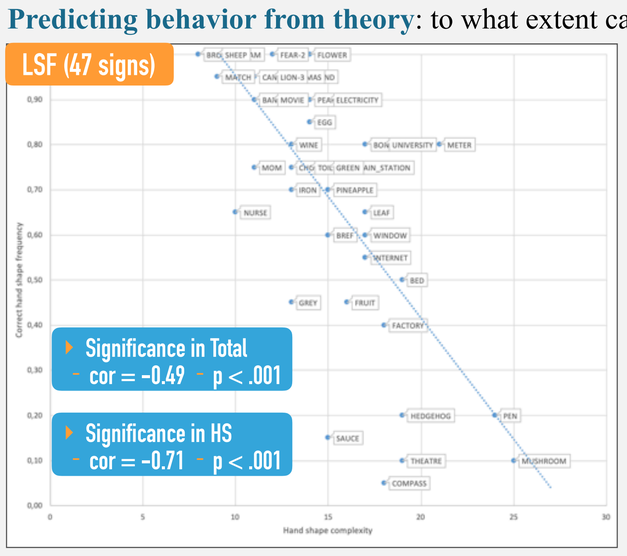
VIDEOS

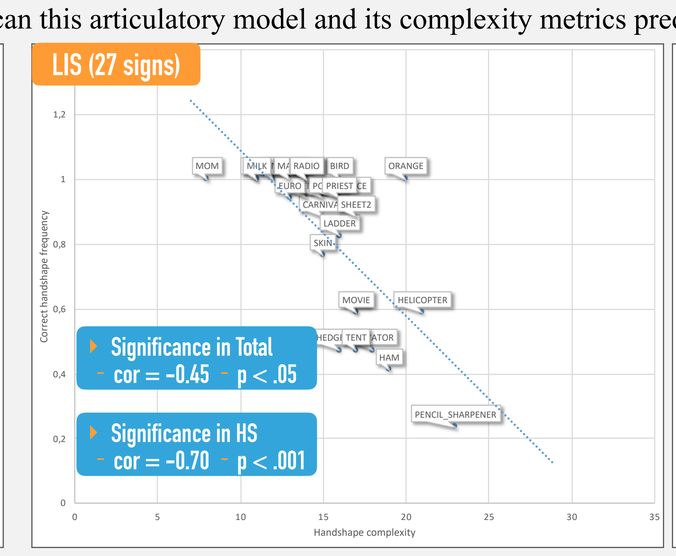
Correlation between data-driven & theory-driven complexity scores

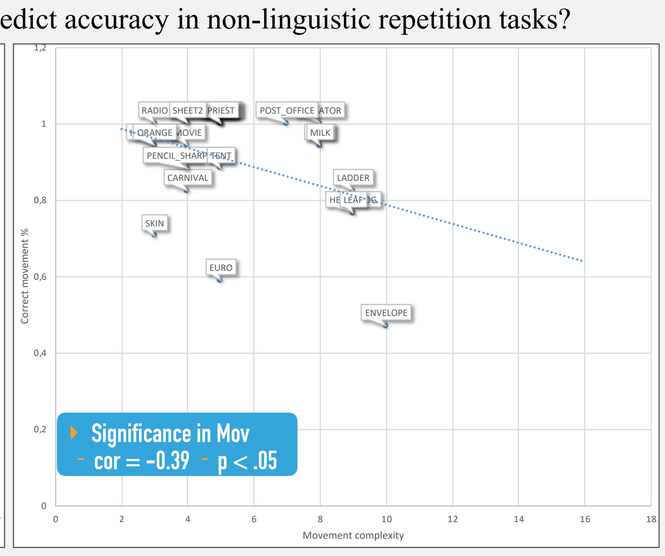
Predicting behavior from theory: to what extent can this articulatory model and its complexity metrics predict accuracy in non-linguistic repetition tasks?

A priori possibilities:

1. No relation (H0)
2. Full correlation for all phonemic classes
3. Correlation with some phonemic classes
4. Mixture of 2 and 3







Linear regression:

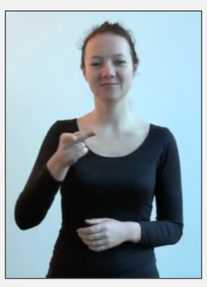
- No interaction

✓ HS: main effect

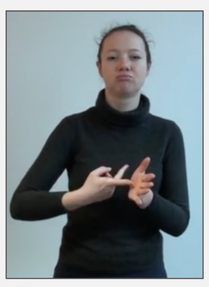
✳ Mov: main effect

Discussion

Some clear divergences in HS: cases where the predictions of the phonological model did not fit what was observed in the non-linguistic performance.


SAUCE

- Repeated **worse** than predicted by the model.
  - Data-driven HS: 0.15/1
  - Theory-driven HS: 15/25


COMPASS

- Repeated **worse** than predicted by the model.
  - Data-driven HS: 0.05/1
  - Theory-driven HS: 18/25


METER

- Repeated **better** than predicted by the model.
  - Data-driven HS: 0.8/1
  - Theory-driven HS: 21/25

Possible sources of mismatch:

1. Perceptual salience
2. Mismatch with gestural repertoire: [stacked]

1. Inhibition of movement
2. Different HS between the two hands
3. HS change not intuitive
4. Mismatch: [stacked]

1. No inhibition of movement
2. H2 open hand not complex
3. Activation of some iconic meaning

Conclusion

- LSF & LIS: HS is the most complex parameter and predicts complexity in a non-linguistic repetition task.
- LIS: Mov is also a factor of sign complexity.
  - ➡ Signs complexity might be due to only one parameter at a time.
- The non-linguistic measure is partially predicted by the phonological model.
  - ➡ This suggests a partial overlap between the phonology of signs and articulatory constraints applying on gestures.

Reference

Brentari, D. (1998). *A prosodic model of sign language phonology*. Mit Press.

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SIGN HUB

For further information about the project please visit our website at www.sign-hub.eu