Pragmatics predicts phonetic reduction in signed narratives

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FOCUS OF THE STUDY

Question: Does referential predictability (i.e., discourse context and cognitive accessibility) predict phonetic reduction in Turkish Sign Language (TİD) narratives?

Aim: Extend Zipf's linguistic efficiency claims [1] to the visual-spatial modality by examining TİD, an established sign language.

Predictions: TİD signers will reduce their nominal referring expressions (REs) when tracking high-accessible referents (i.e., repeated or predictable referents) versus low-accessible referents (i.e., first mentions or topic shifts).

BACKGROUND

Frameworks for studying linguistic efficiency and economy:

Cognitive frameworks:
- Zipf's principle of least effort [1]
- Gricean maxim of quantity [2]
- Relevance theory [3]

Discourse frameworks:
- Ariel's Cognitive Accessibility [4]
- Gundel's Givenness Hierarchy [5]
- Givon's Topic Continuity [6]

Previous studies [7,8] reported reduction in phonetic form for predictable or repeated references in signed discourse, although they did not use a graded referential accessibility scale.

POSTER, CODE, DATA

METHODOLOGY

1 Production Task

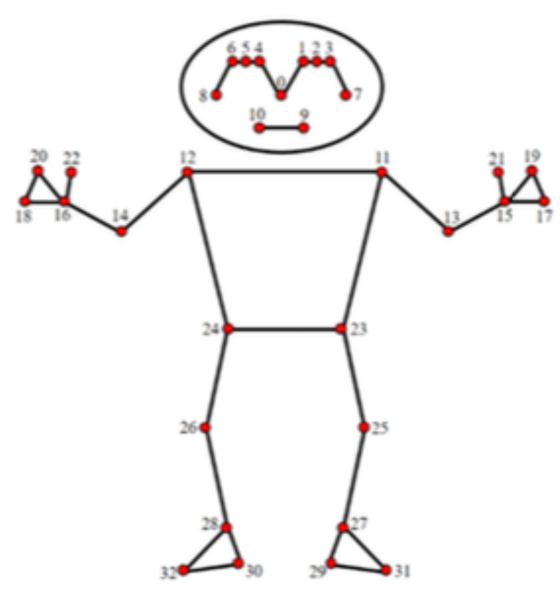
- Participants ($N = 29$) watched and retold 10 silent *Tom & Jerry* clips.
- Annotations for *discourse status (*Introduction, Maintenance, Re-introduction) and *RE type* (nominal, classifier, constructed action, verbal)

2 Phonetic Analysis

Used MediaPipe [9] to extract 33 3D joint coordinates (x, y, z) of two nominal REs (MOUSE and CAT):

- Duration of each RE:
- Hand Distance (sum of Euclidean distances *(D)* between hand positions in consecutive frames).
- Signing Space Use (Euclidean distance between wrists & middle shoulder).

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$



MOUSE

CAT

3 Hand Distance and Signing Space Calculations

$$D_{\text{HAND}} = \sqrt{(X_{\text{HAND}}(t) - X_{\text{HAND}}(t-1))^2 + (Y_{\text{HAND}}(t) - Y_{\text{HAND}}(t-1))^2 + (Z_{\text{HAND}}(t) - Z_{\text{HAND}}(t-1))^2}$$

$$D_{\text{SHOULDER\_WRIST}} = \sqrt{(X_{\text{WRIST}} - X_{\text{MID\_SHOULDER}})^2 + (Y_{\text{WRIST}} - Y_{\text{MID\_SHOULDER}})^2 + (Z_{\text{WRIST}} - Z_{\text{MID\_SHOULDER}})^2}$$

$$\Delta D_{\text{SHOULDER\_WRIST}} = |D_{\text{SHOULDER\_WRIST}}(t) - D_{\text{SHOULDER\_WRIST}}(t-1)|$$

Transformations: (i) Median filtering, (ii) Body-size normalization, (iii) Duration-normalization, (iv) Landmark visibility

4 Calculating Referential Accessibility Scores

Following [4, 10], we calculated each RE's score (-2 to 5) based on:

- Distance to previous mention and Unity (Base: 0, 1, 2, 3)
- Topicality (0, +1, +2)
- Competition with other referents (0, -1, -2)

RESULTS

Reduction Effects By Discourse Status

Mixed-effects modeling: Fixed effects: Discourse, Random Effects: Participant & Stimuli

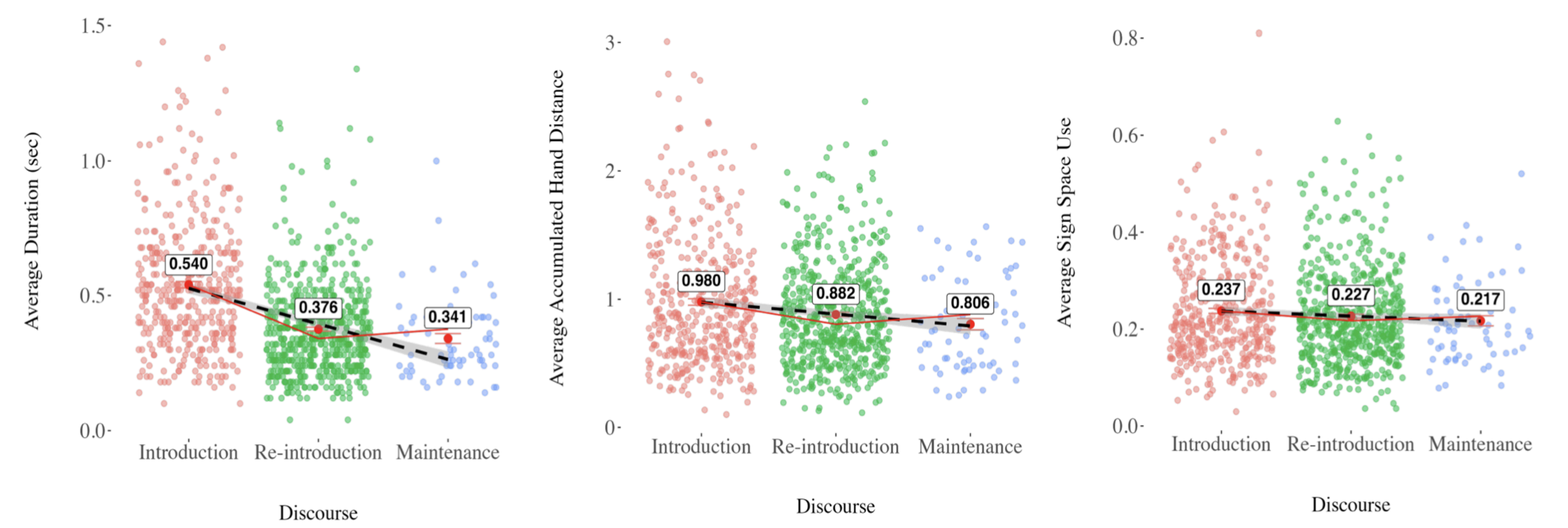
Duration Reduction: REs shortened as discourse predictability increased

- Introduction ($\beta = .29$) > Re-introduction > Maintenance ($\beta = -0.18$, $ps < .001$)

Kinematic Reduction: Less movement for old vs. new referents

- Hand Distance: Reduced ($\beta = .29$, $p < .001$)
- Signing Space Use: Slight reduction ($\beta = .06$, $p < .001$)
- Maintenance not significant ($p = .10$ for hand; $p = .40$ for space)

(a) Duration (non-kinematic) (b) Hand Distance (kinematic) (c) Signing Space Use (kinematic)

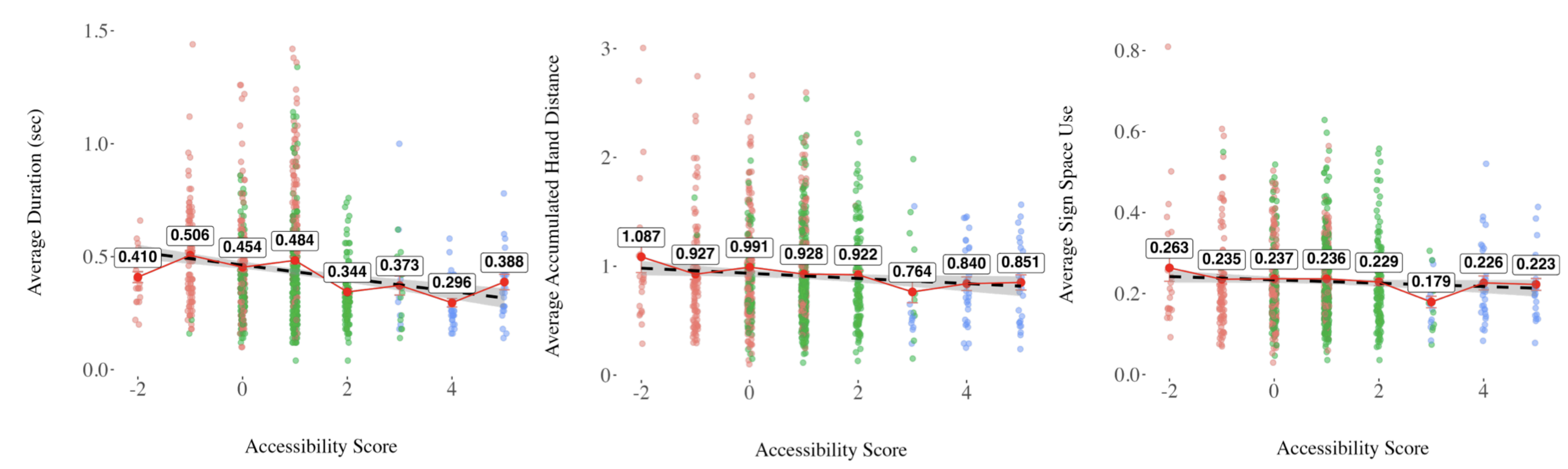


Reduction Effects By Referential Accessibility

Mixed-effects modeling: Fixed effects: Accessibility, Random Effects: Participant & Stimuli

- Higher Accessibility → Reduced Articulation
  - Duration: Shortened ($\beta = -0.07$, $p < .005$)
  - Hand Distance: Decreased ($\beta = -0.03$, $p < .005$)
  - Signing Space: Became narrower ($\beta = -0.03$, $p < .005$)
- Nonlinear Patterns:
  - Duration: Sensitive to both maintenance and re-introduction ($\beta_{Cubic} = .06$, $p < .005$)
  - Hand Distance & Space: Sensitive to old vs. new ($\beta_{Quadratic} = .17$, $p < .04$, hand; $p < .01$, space)

(a) Duration (non-kinematic) (b) Hand Distance (kinematic) (c) Signing Space Use (kinematic)



DISCUSSION & CONCLUSION

Summary:
- Signers phonetically reduced predictable REs (e.g., those with higher accessibility).
- Duration was sensitive to three discourse contexts (introduction, maintenance, re-introduction).
- Kinematic measures (hand distance, signing space) showed a more binary distinction (new vs. old).

Conclusion:
- Accessibility predicts phonetic reduction: Signers economize effort based on predictability.
- Duration might be a stronger discourse marker than kinematic measures.
- Findings align with theories of linguistic efficiency [1] and cohesion [4].
- Duration in older sign languages like TİD may encode referential predictability more nuancedly than in younger ones (e.g., ISL) [7].

REFERENCES

[1] Zipf 1949; [2] Grice 1975; [3] Sperber and Wilson 1986; [4] Ariel 1990; [5] Givon 1983; [6] Gundel, Hedberg, and Zacharski 1993; [7] Stamp et al. 2024; [8] Hoetjes, Krahmer, and Swerts 2014; [9] Lugaresi et al. 2019

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