



Applying Computer Vision to Signed Discourse: Effects of Form and Iconicity on the Signing Space

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IMPRS

Onur Keleş (Dept. of Linguistics, Boğaziçi University, onur.keles1@bogazici.edu.tr)
Kadir Gökğöz (Dept. of Linguistics, Boğaziçi University, kadir.gokgoz@bogazici.edu.tr)

FOCUS OF THE STUDY

The aim of this study is to examine the phonetic and iconic features of such expressions in signed narratives with computer vision. To this end, Experiment 1 examines the effect of RE forms on the amount of movement, hypothesizing that some forms occupy less signing space than others. As a follow-up study, Experiment 2 looks into the role of iconicity to explain the phonetics of RE forms.

RESOURCES

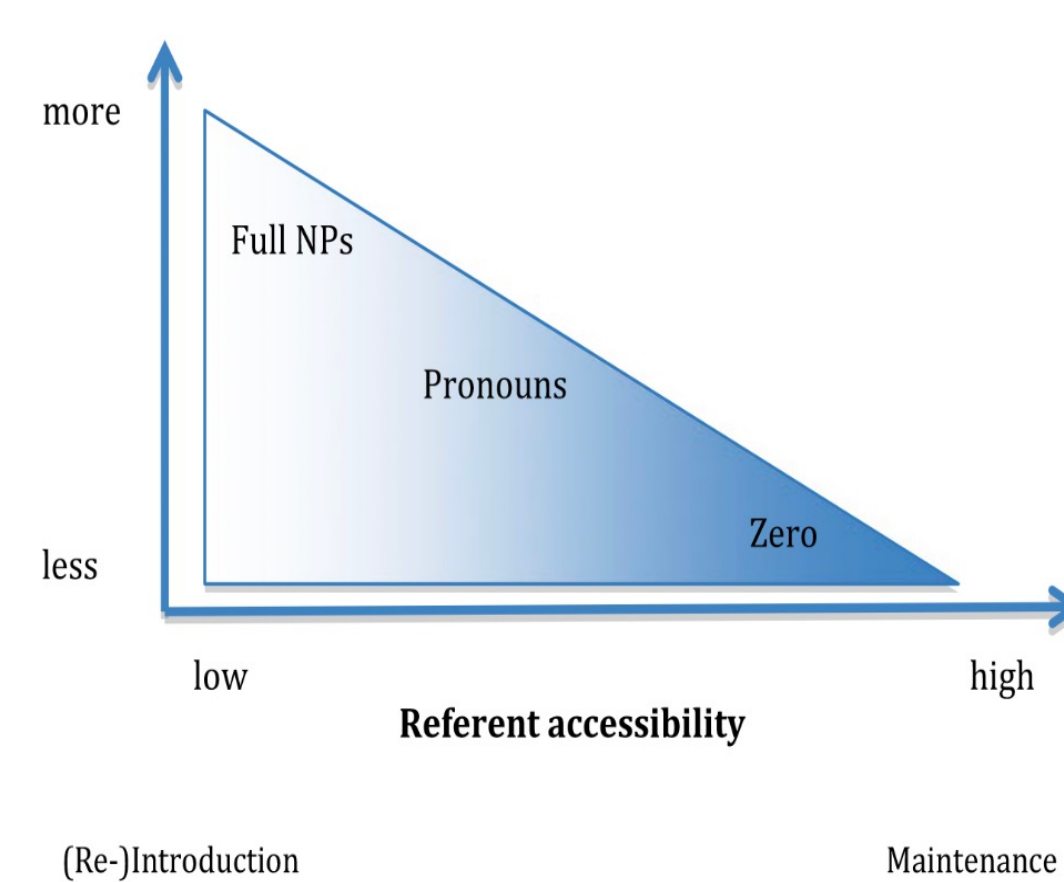


- Support that referring expressions with more iconicity (e.g., Constructed Action) are signed with greater movement and a larger sign space than others with less imagistic iconicity.
- Verbs were more iconic than nouns, like in other sign languages and they occupied a larger signing space than nouns.

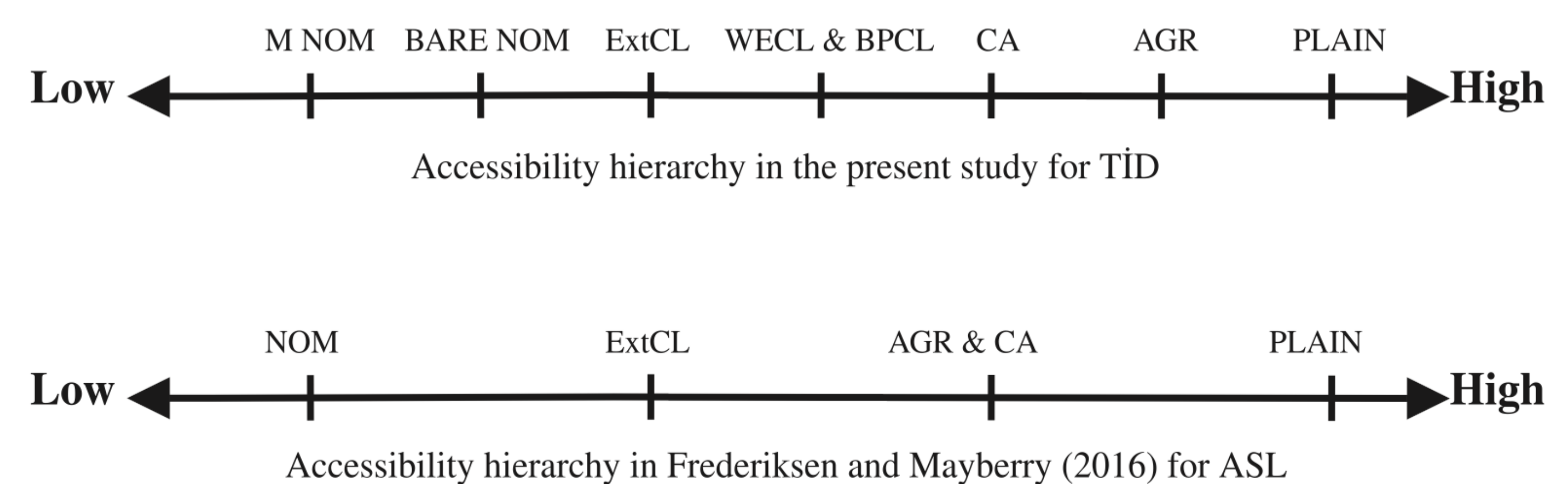
HIGHLIGHTS

INTRODUCTION

Background: Signers vary the form of referring expressions (REs), based on the accessibility of the referent (I). In Turkish Sign Language (TİD), Nominals and Tracing tools (i.e., size and shape specifiers) are used to introduce referents. For accessible referents, signers can use Verbal constructions (agreeing or non-agreeing) Classifiers, and Constructed Action (CA).



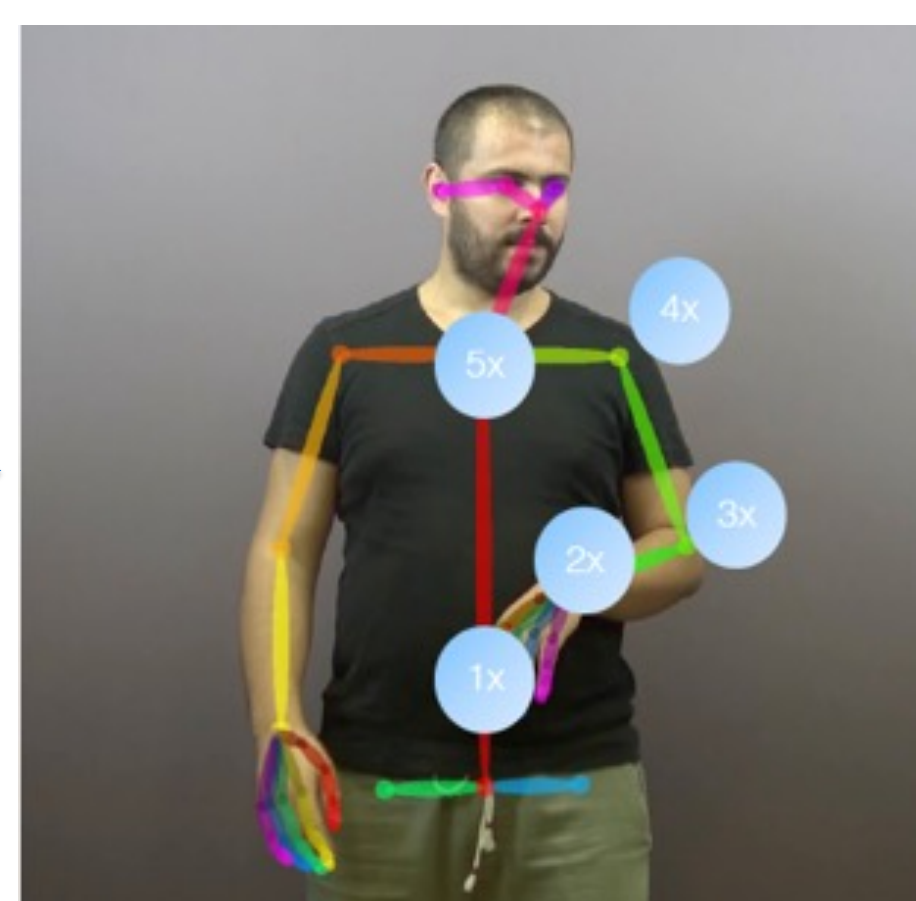
ACCESSIBILITY HIERARCHY



METHODOLOGY

Experiment 1. Stimuli: Narratives come from our previous cartoon re-tell task with 15 adult native signers (deaf-of-deaf), all right-handed, resulting in 4251 observations in total.

Calculating “weighted” movement: We took a set of screenshots from each movement in the videos and processed them with the OpenPose library (4) in Python by marking the torso, shoulder, elbow, wrist, and fingers and to calculate a value for the estimated energy spent on a movement within an expression, we assigned relative values to joints [1].



Experiment 2. 52 Turkish speaking participants (all non-signing and hearing) rated 50 referring expressions in TİD on a 5-point scale, based on the sign's visual resemblance to its meaning or imagistic iconicity on PennController for IBEX. Each sign was accompanied by its Turkish translation. 2 signs were given incorrect labels to ensure the accuracy of ratings.

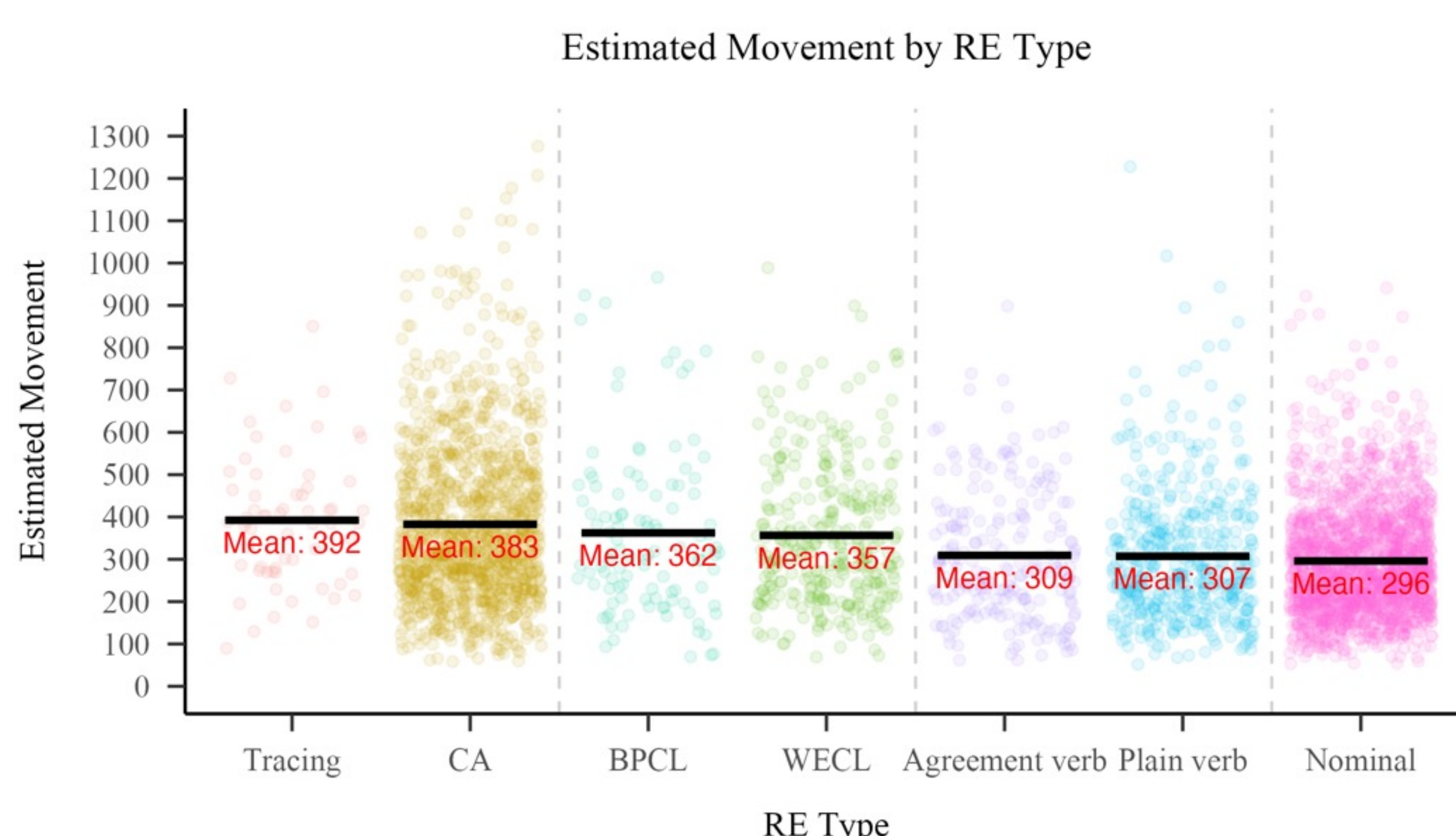
Stimuli: A balanced and representative subset of 200 REs was chosen from the first experiment and divided into four lists.

Formula for calculating estimated energy spent for each movement

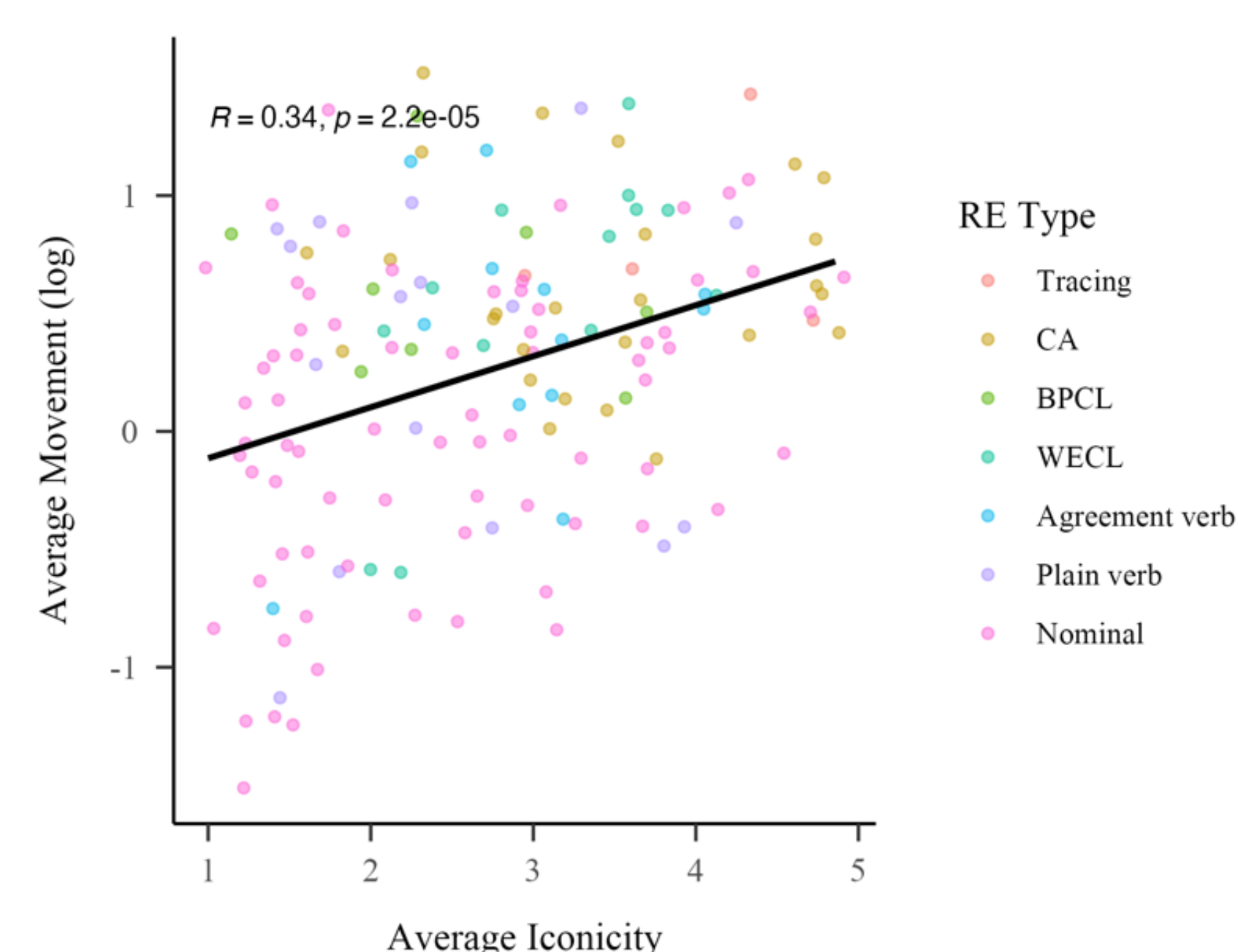
$$\text{Weighted Movement} = \sum_{i=1}^5 \left(\frac{\text{Movement of active joint/point}_i}{\text{Movement of entire sign}} \times \text{Relative value of joint/point}_i \right)$$

RESULTS

EXP 1: SIGN SPACE ANALYSIS. Signers' movements differed by RE-Type (Figure-1). For Estimated Movement, we fit a mixed effects regression model with RE-Type as a fixed effect and Participant and Frame as random effects using the lme4 package in R. Signers spent more energy on Tracing and CA compared to Classifiers, Verbs, and Nominals, respectively (all p 's < 0.01, except for Plain Verb).



EXP 2: ICONICITY RATINGS. We ran a regression model with Ratings as the dependent variable and RE Type as the predictor. Sign-naïve participants in general rated predicates more iconic than other forms: CA followed by Tracing, Agreement Verb, WECL, Plain Verb and BPCL, and Nominal as least iconic (all p 's < 0.01, except for WECL).



We used Spearman's correlation to investigate the relationship between iconicity and sign movement (Figure 2). With a positive correlation coefficient of 0.34, our results showed that as the sign iconicity ratings increase, the amount of movement also increases.

CONCLUSION

In the predicate domain, we found a division between CA & classifiers and agreement & plain verbs: The former two rely on real-world and space-related features (e.g., size, semantic number, and relative location), while the latter two use more abstract cues like referential-space and aspect-related movement. We conclude that a complete model of reference tracking across languages and modalities should allocate some consideration to the predicate domain in addition to the nominal domain and consider the nature of the reference tracking features and how they are externalized so that more accurate relations can be drawn between a form, what it semantically imports and the amount of energy one spends producing it.

REFERENCES

References. 1. Ferrara L, Anible B, Hodge G, Jantunen T, Leeson L, Mesch J, et al. A cross-linguistic comparison of reference across five signed languages. *Linguistic Typology*. 2022; 2. Ahlgren I, Bergman B. Reference in narratives. I Ahlgren, B Bergman & M. 1994; 3. Nuhbalaoglu D. Comprehension and production of referential expressions in German Sign Language and Turkish Sign Language: An empirical approach [Doctoral Dissertation]. Georg-August-Universität Göttingen; 2018. 4. Cao Z, Hidalgo G, Simon T, Wei SE, Sheikh Y. OpenPose: realtime multi-person 2D pose estimation using Part Affinity Fields. *IEEE transactions on pattern analysis and machine intelligence*. 2021;43(1):172–86. 5. Bürkner PC. Advanced Bayesian Multilevel Modeling with the R Package brms. *The R Journal* [Internet]. 2018 [cited 2020 Aug 12];10(1):395. 6. Perniss PM. Space and iconicity in German sign language (DGS). [SI]: MPI Series in Psycholinguistics; 2007. 7. Slonimska A, Özyürek A, Capirci O. Using depiction for efficient communication in LIS (Italian Sign Language). *Language and Cognition*. 2021. 8. Perlman M, Little H, Thompson B, Thompson RL. Iconicity in signed and spoken vocabulary: a comparison between American SignLanguage, British Sign Language, English, and Spanish. *Frontiers in psychology*. 2018.