Human Lexical Semantics are not Universal: Colexification Evidence from Western and Asian Signed Languages

Jenny Chen Lu[*1,2], **Rachel Skwersky**[*1], **Mahesh Srinivasan**[*1] **& Hugh Rabagliati**[*3]
[1]Department of Psychology, University of California, Berkeley, CA, USA
[2]Institute for Society and Genetics, UCLA, Los Angeles, CA, USA
[3]School of Philosophy, Psychology and Language Sciences, University of Edinburgh, Edinburgh, United Kingdom
[*]Both authors contributed equally to this work.

Abstract

Word meanings shift synchronically in the moment or diachronically over time. This paper addresses categorical shifts in meaning, focusing on metaphor and polysemy. For instance, belt could be used in the context of "*belt* on a dress" and then over time, it metaphorically extended to a geographic region in "*belt* of poverty." Prior work has documented systematic patterns of polysemy across unrelated spoken languages, suggesting universal lexical semantics. However, it is an open question whether these patterns generalize to sign languages. The present study sampled three unrelated sign languages (Japanese, German, and American Sign Languages) and compared their semantic patterns against 14 spoken languages across Western and Asian continents. Findings demonstrate that metaphorical polysemy is constrained by iconicity (e.g., *BEAM* cannot be colexified in sign languages). Our conceptual structures may not be universally fixed as we assume, and this work elucidates the mechanisms of grammaticalization unique to signed languages.

Keywords: concepts; polysemy; sign languages; lexical semantics; iconicity; cognitive diversity

Introduction

A fundamental feature of natural language is our ability to use a limited set of words to express a potentially infinite number of meanings. This communicative power is realized at the lexical level in part through the flexible use of a single word across multiple, related senses of meaning – a phenomenon known as polysemy (Bréal, 1897). This study of lexical semantics has been of great theoretical interest in cognitive science, linguistics, and philosophy, because these semantic networks reflect our interactions with the world and how we conceptually relate things within one domain to another, one world to another.

In spoken languages, polysemy has been observed to cluster in semantic patterns, with multiple words alternating between different senses in a predictable manner (Apresjan, 1974; Copestake & Briscoe, 1995; Lakoff & Johnson, 2003; Ostler & Atkins, 1992; Pustejovsky, 1991). For example, in English, multiple words can refer to a kind of animal or kind of meat (e.g., chicken, lamb, turkey), to a kind of material or product derived from that material (e.g., *glass, iron, tin*), and more (see Table 1).

Table 1: Examples of polysemy in English

Patterns and Examples
Animal for meat (chicken, lamb, fish) *The chicken drank some water.* *The chicken is tasty.*
Body part for object (arm, leg, hand) *John's arm was tired.* *The arm was reupholstered.*
Instrument for action (hammer, brush) *The hammer is heavy.* *She hammered the nail.*
Grinding (apple, chair, fly) *The apple was tasty.* *There is apple on the table.*
Visual Metaphor (beam, belt, column) *The beam supports the roof.* *A beam of light appeared.*
Material for artifact (tin, iron, china) *Watch out for broken glass.* *He filled the glass with water.*
Object for color (orange, violet, peach) *She ate an orange.* *She has an orange shirt.*

There are striking commonalities in how polysemy manifests across languages: some pairs of highly-related concepts frequently receive the same label across languages (Xu et al., 2020), and the same semantic relations (e.g., animal for meat, material for product) appear to underlie systematic patterns of polysemy across different languages (Srinivasan & Rabagliati, 2015). This evidence has led some to propose that there are universal conceptual constraints both on how language users have extended words to new meanings, as well as on the range of meanings that children expect words to alternate among; the application of these universal conceptual constraints over historical time could have created broad regularities in the polysemy of different languages synchronically (Ramiro et al., 2018; Srinivasan & Rabagliati, 2015; Xu et al.,

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2020; Youn et al., 2016).

However, these prior cross-linguistic studies have exclusively focused on spoken languages. This is potentially problematic for claims of universality, because sign languages, as we outline below, appear to be governed by somewhat different constraints on lexical semantic expression. In this paper, we provide a first examination of how polysemy is expressed across Western and Asian sign languages, and compare that to its occurrence in spoken languages. Language modality and its ability to encode semantic representations that vary in concreteness, sensory experience, imageability, as well as lexical classes (nouns, verbs) may give rise to distinct structures of polysemy.

Theoretical Motivation for Studying Polysemy in Sign Languages

In the sign language literature, polysemy has not been studied extensively and systematically with respect to these theoretical frameworks of cognitive universals and diversity. Rather, they have appeared in isolated case studies of a single word form and the semantic clusters around that form.

A Case of Colexification in Sign Languages. Some evidence has suggested that the polysemy found in spoken languages may manifest similarly in sign languages. For example, sensory perception verbs can be extended metaphorically to talk about cognition – such as using the word seeing to mean 'knowing' or 'thinking' in English (Sweetser, 1990) or hearing to mean 'understanding,' 'knowing,' 'thinking,' 'remembering' in several Australian languages (Evans & Wilkins, 2000). These kinds of extensions have also been found in ASL. Hou (2022) has examined the polysemous ASL sign that is glossed as LOOK-vision which has its origins as a verb of visual perception (e.g., perceptual experience of looking at something), but has been grammaticalized to LOOK-reaction – a stance verb to express the signer's attitude or perspective of an event (e.g., PRO.3 LOOK OH-I-SEE DEAF FINE; English translation: "He was like oh I see, you're deaf, got it."). This sign is produced with one hand with a V handshape with extended index and middle fingers pointing outwards, and is used to mean either 'looking' (perception verb) or 'looking-react' (meta-cognition verb).

The Role of Iconicity in Sign Language Semantics. On the other hand, some features of sign language – including unique grammatical constructions, such as depicting constructions and prevalence of iconicity – may constrain how polysemy emerges. Iconicity often shapes metaphorical and grammaticalization processes. If there is an extension that is infelicitous in sign languages, but allowed in spoken languages, this has been framed as a linguistic "constraint" in sign languages. Meir (2010) has discussed the "double-mapping constraint" (DMC) of metaphorical extensions in sign languages. According to DMC theory, both iconicity and metaphors are built on mappings of two domains: form and meaning of the word in iconicity and source domain and target domain in metaphors (Figure 1). Iconic signs that undergo metaphorical extension are subject to both mappings, but sometimes iconic signs block the metaphoric extension. Take *eat* in English, which can be metaphorically extended from consuming food to other objects, such as in the phrases, "the acid *ate* the iron key" or "the house *ate* up all my savings." In these examples, the meaning of eating food (literal) is extended to eating or consuming non-food resources, such as a key or savings (metaphorical). However, in Israeli Sign Language, where the sign is produced on the mouth with a grasping handshape, Meir (2010) claims that these metaphorical extensions are blocked due to the iconic nature of the source sign for EAT, which corresponds to the meaning of putting food into the mouth of the eater.

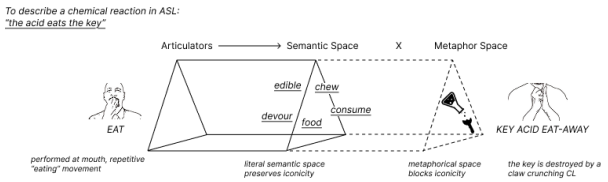

Figure 1: Double Mapping Constraint (DMC). This figure depicts two simultaneous mappings in language: *Literal*, a mapping of form to meaning and *Metaphorical*, a mapping from the source domain to target domain in which one conceptual domain is mapped to another. In the utterance, *the acid eats the key* (Meir, 2010), the manual articulators visualize the act of "eating" a non-edible object without violating the iconic property of the sign to eat, typically with the hand resembling the eating action at the mouth. The iconic sign, glossed EAT, cannot map onto the metaphor of "consumption of a non-edible object" because acid devours the key chemically. Conversely, in English, this metaphorical mapping is possible with the arbitrary word *eat* as there is no iconic interference.

Given that iconicity is prevalent in sign languages, this could predict widespread divergences between spoken and signed languages in the structure of polysemy. We anticipate that some of the extensions in spoken languages may not parallel how extensions work in sign languages. The competing iconic representations for related meanings (e.g., as in the example of EAT) can explain some of these patterns. Constraints on word sense extension could come from the iconicity of word forms in sign languages and this effect could be broader than just cases of metaphorical polysemy. Although we do not directly test the role of iconicity in meaning extensions, we present here a systematic evaluation of whether the polysemy found across spoken languages is also manifested in sign. This initial study will lay the foundation for future work testing the source of potential differences between spoken and signed languages.

Current Study

The present study characterizes polysemy in American Sign Language (ASL), German Sign Language (Deutsche Gebärdensprache, DGS), and Japanese Sign Language (日本手話, JSL) with reference to previously collected data on spoken languages (Hindi, Mandarin, Vietnamese, Hungarian, Indonesian, Italian, Korean, Russian, Cantonese, Japanese, Turkish, Farsi, Spanish, and English). ASL and German Sign Language have been historically influenced by Old LSF (Old French Sign Language), while JSL belongs to the Asian sign language family with contacts with Chinese Sign Language, Hong Kong Sign Language, and Taiwanese Sign Language; there has been no evidence of long-term contact between European and Asian sign languages based on historical records and computational phylogenetic methods(Abner et al., 2024).

Methods

Participants. A total of $N = 8$ Deaf bimodal-bilingual signers participated in this study; four participants were ASL-English fluent, two signers were DGS-German fluent, and two were JSL-Japanese fluent. German and Japanese participants had conversational fluency in English and ASL. Participants were instructed to answer the questions based on their knowledge of sign language, not the spoken or written language of their country. The respondents often initiated meta-linguistic discussions with the experimenter in ASL on why a particular sign would extend or not extend to other contexts, citing iconicity, cultural experiences, or language contact as reasons. We followed the same recruitment scheme asSrinivasan and Rabagliati (2015), testing at least two participants per sign language for the four-hour-long survey. Additionally, we collected data from two German speakers as the language was not included in the Srinivasan and Rabagliati (2015) study.

Procedure. We adapted the validated cross-linguistic survey from Srinivasan and Rabagliati (2015) into two guided zoom sessions appropriate for the signed modality. The experimenter–fluent in ASL and DGS–prompted responses for each trial, eliciting responses in sign language.

Materials & Stimuli. The survey tested 25 patterns of English polysemy (Table 1 only shows 7 out of 25 categories tested). Due to the varying prevalence of each pattern, the cross-linguistic survey tested 4 to 14 examples within each category, amounting to 197 trials for each participant.

For each pattern, we included a set of questions to probe whether the sign language in question had a translation-equivalent for a particular English word following that pattern that could participate in the alternation. For example, we were interested in whether the sign for CHICKEN, in its animal context, could also be used to refer to chicken meat. For each target word, we asked 3 questions about their meaning and use. Finally, at the end of each pattern, we asked participants if they could think of any other words in the sign language that could participate in the semantic alternation, beyond the ones we had queried.

Linguistic Coding of Production. We combed through video footage to code linguistic production, using a coding schema developed for sign language semantics analyses. See Table 2 for a description of production strategies that signers used in cases of non-extension (e.g., compounding, fingerspelling, classifier construction, alternative lexical sign to the first original production). Each trial received a binary judgment (0 = not natural, 1 = natural) based on participant responses. Interrater reliability was calculated for 20% of the data, which was coded by another ASL-fluent researcher. For ASL, reliability was Kappa = .846, 0.887 for DGS, and 1 for JSL.

Table 2: Morphosyntactic strategies across ASL, DGS, and JSL participant data

Production Strategy
Lexical Sign 1 The same lexical sign (1) is used in both contexts. *Example:* 1. CHICKEN (1) / 2. CHICKEN (1) *Polysemous?* Yes
Compound Production Sign (1) is combined with a classifier or depicting construction in the second context. *Example:* 1. CHICKEN (1) / 2. CHICKEN (1) + SCARED *Polysemous?* No
Fingerspelling The word is fingerspelled from a foreign lexicon (e.g., English, Japanese, German). *Example:* 1. CHICKEN (1) / 2. C-H-I-C-K-E-N (fs) *Polysemous?* No
Lexical Sign 2 / Classifier Different lexical signs are used: sign (1) vs. sign (2), or classifier constructions are employed. Production is NOT polysemous. *Example:* 1. CHICKEN (1) / 2. CHICKEN (1_Person_CL + SCARED facial expression) *Polysemous?* No
Unclear Unclear how to express the second context or notes it would not occur in daily language. *Example:* N/A *Polysemous?* No

Results

We report the data on 1) whether the same colexification patterns are present across sign languages and how they compare with spoken languages and whether the sets of senses that instantiate these patterns are similar across sign languages. 2) We present some qualitative and quantitative analysis on the sign linguistic strategies that signers used to describe the dif-

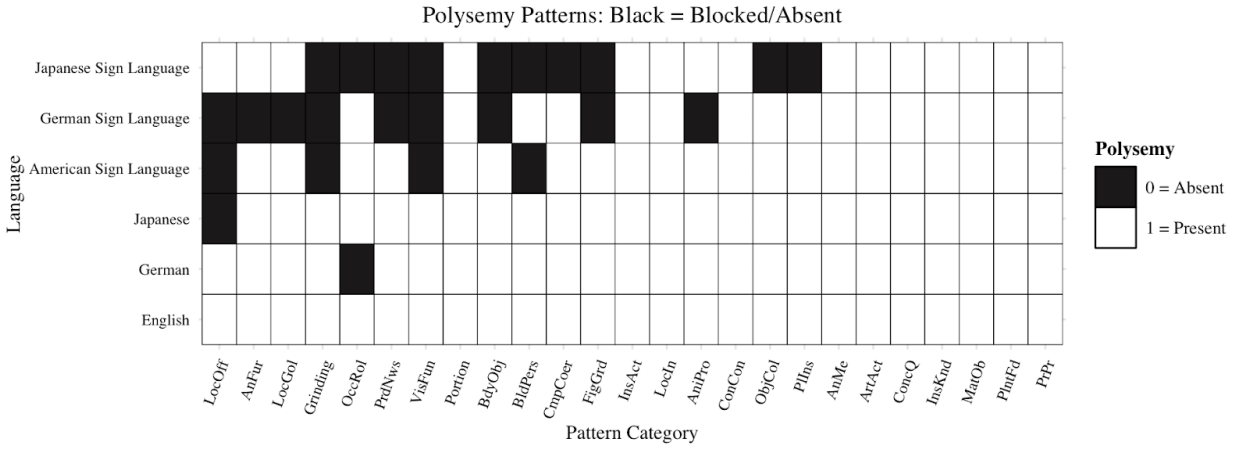

Figure 2: Polysemy patterns in Spoken and Signed languages

ferent senses in situations of non-extension.

Figure 2 focuses on three signed languages (ASL, DGS, and JSL) and respective spoken language counterparts, which are in close daily contact (English, German, and Japanese). For each semantic pattern, we coded whether a pattern was attested (1) or absent (0) in each sign language, based on their language production. Figure 2 displays these data as a heatmap, with white cells representing the presence of polysemy across a significant number of trials and black cells indicating an absence of polysemy. Our data reveals that polysemy patterns that were identified as systematic in Srinivasan and Rabagliati's cross-linguistic analysis of spoken language were systematically more absent in signed languages.

Then, we document alternative linguistic strategies that signers used in cases of infelicitous extension. Participants often resorted to alternate linguistic strategies for production, such as compounding, classifier/depicting constructions, fingerspelling, or a combination of these, see Table 2.

Universal Polysemy Patterns. Of the 25 patterns tested, 11 appeared in all six languages regardless of modality. The attested patterns were consistently metonymies, where a word stands in for a highly-related concept. English examples include "John played a *Mozart*" or "Emily poured a *glass*." The cross-linguistic presence of these polysemies may reflect similar conceptual structures across modalities.

Unique Modality-Specific Patterns. For some semantic categories, we identified systematic divergences, according to modality, especially for *Grinding* and *Visual Metaphor* (see Table 1). These categories were systematically absent from all three signed languages, but present in all three spoken languages. Four additional patterns (*Body Part for Object; Building for Person; Figure for Ground; Publisher for Product*) showed moderate blocking in the sign languages.

Within Sign Language Variation. Individual sign languages demonstrated variation: DGS blocked 9/25 patterns, JSL blocked 10/25 patterns, and ASL blocked 4/25 patterns. This variation indicates modality is one factor among many, including typology, language contact, and historical development. It is possible that ASL is more strongly influenced by English through cross-modal borrowing, to a greater extent than JSL-Japanese and DGS-German.

Sign Language Production Data. How do signers encode the alternative, secondary meaning when they judge that a sign in one sense is unnatural in the other sense? Figure 3 explores in depth the linguistic strategies that signers are resorting to when they are judging that sign is not attested in the second context as opposed to the first context. The patterns across the three sign languages are similar in their distributions but with slight variations, especially with respect to compound production and fingerspelling; there was a main effect of the type of strategy used ($\chi^2(4) = 11.32$, $p < .05$; posthoc tests show that Lexical sign 1 or Lexical sign 2/Classifier 2 are more likely to be used than fingerspelling, $p < .05$ for both contrasts). Occasionally, some signs are qualified as polysemy, where the same sign is used across all semantic contexts (Lexical sign 1 strategy 28.6% for ASL, 31.8% for DGS, and 24.4% for JSL). An entirely different sign may be used to represent the secondary meaning from the first meaning (Lexical sign 2 or a classifier construction 2; 38.3% of the time for ASL; 42.2% for DGS; and 44.3% for JSL), making it unattested. For example, in English, the word beam refers to either a wooden support structure or ray of light. All signers produced two distinct signs for these meanings (see Figure 4). Compound productions were also another strategy for all three groups (ASL: 13.2%; DGS: 12%; JSL: 22.5%). There are also hints of language contact, such as borrowing from the foreign lexicon (e.g., English, Japanese, and German). At times, signers are resorting to fingerspelling as an alternative strategy for encoding word meaning (ASL: 18%; DGS: 11.7%; JSL: 0.6%). The Unclear category includes strategies that we could not categorize. Based on model comparisons between the null and full models, there was no significant main effect of Language Group on the types of strategies they chose to use, proportionwise. However, there was a significant interaction between

Language Group and Strategy Type $\chi^2(8) = 23.14$, $p < .005$, where the distributions of language production strategies varied across the three sign languages.

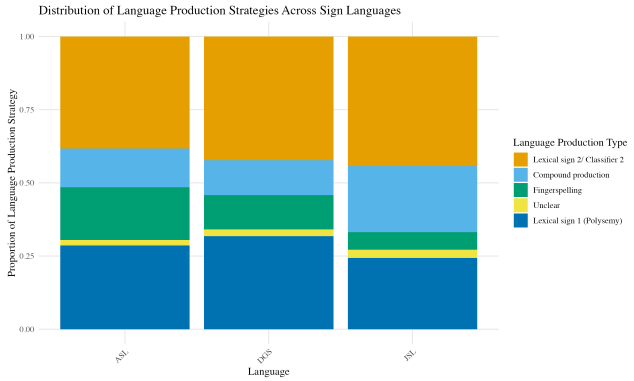

Figure 3: Linguistic strategies that ASL, DGS, and JSL signers use in the alternative meaning contexts. Using a production strategy other than Lexical Sign 1 for each trial was coded as not polysemous and received further classification.

Context 1: ceiling beam | Context 2: light beam

Figure 4: Example productions in sign. The JSL participant provides their natural translation of the two contexts for beam. They produced two different classifiers, which would result in a linguistic coding of 0, polysemy absent. See the English spoken language example in Table 1.

Context 1: hammer (noun) | Context 2: hammer (verb)

Figure 5: ASL signs for hammer (object) and hammer (action). The same handling handshapes and movements are used for object hammer and action hammer. This qualifies as polysemy.

Discussion

This study explored the expression of polysemy across three unrelated signed languages, and compared it to its expression in spoken languages. Prior cross-linguistic work by Srinivasan and Rabagliati (2015) had suggested – in spoken languages alone – that many patterns of polysemy may be universal across languages, with a small number of other patterns showing more extensive cross-linguistic variation, such that languages tend to express polysemy in very similar ways. These sign language data suggest that this claim requires significant revision. In particular, while we did find that many patterns of polysemy were also universally present in signed languages, we also found that patterns of polysemy were much more frequently absent in these signed languages than in previously investigated spoken languages. While many patterns of polysemy were present in signed languages, many other patterns were not present when Srinivasan and Rabagliati would have predicted them to be.

While we saw categories that were attested in sign languages (OccRol in DGS and LocOff in JSL) that were not permitted in the respective spoken languages German and Japanese, we cannot strongly motivate the claim that polysemy blocking is one-directional, with spoken languages permitting more flexible semantic extension than sign languages. Our survey instruments relied on attested categories in spoken English, which limited our ability to elicit signed-modality-specific semantic categories. In the future, exploring new methodological frameworks that rely on the generative production of signs sharing the same form may elucidate some of the universal sign-only colexification patterns.

The Role of Iconicity in Shaping Semantics

Iconicity has been put forth as a potential factor that influences the potential of meaning extension or colexification. The double mapping constraint (DMC) theory predicts that words that are iconic of their senses in Context 1 may be less likely to be extended to mean something else, especially if the source and target domains no longer align in their features in Context 2. Indeed, the data provide some preliminary support for this theory. For example, the English word *beam* can mean either light beam that shines from a flashlight or a wooden beam on the ceiling. In contrast, in ASL, DGS, and JSL, these meanings – light beam and beam structure – are encoded with distinct phonological forms through the use of depicting constructions.

However, the iconicity constraint may only apply in cases where the source and target meanings both have high potential for iconic mappings and competing iconic representations. If there are no competing representations, an iconic sign may be more naturally extended. These mechanisms may account for some of the patterns, such as the Object-Color pattern, where in JSL, the iconic sign for PEACH (two slightly bent B handshapes making contact with each other to resemble PEACH) is naturally extended for color, which is an abstract concept and does not have a clear iconic representation. Indeed, color signs tend to be rated low in iconicity in ASL and BSL (Thompson et al., 2020). Future follow-up studies can evaluate and quantify 1) the iconic potential of source and target meanings and make predictions about whether an extension is likely in a specific case, 2) test spoken languages with high potential for iconicity in the forms of mimetic devices

(e.g., ideophones in African and Asian languages), and 3) examine the interface of spoken and written languages. These studies would also solve the confounding factors of modality (visual vs. auditory) and iconicity in predicting colexification.

Implications for Theories of Conceptual Structure and Grammaticalization

Theory of Conceptual Structure. Our study lays the foundation for forming new theories on conceptual structure and grammaticalization processes. First, these structural representations of concepts – which arise from iconic constraints of sign languages – may re-shape people's natural conceptual associations. Signers may initially have the same natural conceptual associations as speakers, however, because their language does not allow these senses to cohere, their conceptual structures become reshaped in the process of using and acquiring sign language.

Alternatively, signers may naturally have different conceptual networks to begin with due to their embodied and visual experiences. Word meaning dynamically emerges based on our physical, social, and linguistic context, including shared experiential history and is not derived from a pre-existing conceptual structure (Casasanto & Lupyan, 2015). For example, signers may extract information about their environment in a way that privileges specific visual statistical patterns (e.g., categorizing all of the 'thin' shaped objects together, 'container' like objects together). These conceptual categories may be reinforced through the exposure to depicting constructions (which happen to morphologically categorize these shapes with handshape). To test these two theoretical proposals on conceptual structure, future research could investigate whether child learners show changes in their semantic structures over time (linguistically and non-linguistically) as they acquire a sign verses a spoken language or track historical changes in sign language lexicons, raising the question of whether sign language lexicons historically resembled spoken languages.

Semantic Drift and Grammaticalization Processes. This descriptive work also sets the foundation for understanding mechanisms of language variation and change. Polysemy is a key characteristic of grammaticalization, especially in sign languages, where there is a historical lineage of meaning change underlying one sign form. In ASL, pointing signs have been grammaticalized from being purely demonstrative to other grammatical markers, including locative, demonstrative pronouns, personal pronouns, relative pronouns, and agreement markers in signed languages (Pfau & Steinbach, 2006). These pointing signs are going up to higher levels of abstraction from purely exophoric, indexical references in the immediate environment to more endophoric and anaphoric references. Under the same underlying grammaticalization scheme, Sampson and Mayberry (2022) have documented an ASL sign that is glossed as SELF, showing its evolution from a deictic term into a copula. By expanding the scope of methodologies to capture other word classes, such as the pronominal, would be a fruitful line of work.

Future Work on Semantic Modeling

Word meanings undergo change throughout time – through processes of semantic drift or grammaticalization, and their developmental processes may unfold in distinct trajectories across spoken and signed languages. For example, words like *glass, tin,* and *iron* were used to denote specific materials in old English, but then later were extended to mean artifacts made from those materials, including drinking glass, hour glass, eye glasses, tin container, clothes iron, and golfing iron (Harper, 2001). However, due to technological and cultural evolutions, some of these words have semantically drifted away from the original source meaning – specifically, adopting some artifact meaning from their material meaning. For instance, one could refer to *eyeglasses* even when the glasses are actually made out of plastic not glass. However, there seems to be constraints on how semantic drifts occur – for instance, a cup made out of brass cannot be called *glass* (Srinivasan et al., 2019).

These specific examples do not apply to at least ASL as these material and artifact senses are not polysemous, and the sign for EYEGLASSES is simply an iconic shape representation of the shape of eyeglasses (e.g., G handshapes on the eyes), and does not have any semantic reference to the material glass (which would be differentiated sign, with a X handshape on the chin for material glass; or a C handshape to represent cup glass). How iconicity, modality, and language contact shape the developmental pathway of semantic drift in sign languages is an uncharted territory of research.

Future research can leverage computational modeling, such as vector space models (VSMs) to calculate the correlations between semantic and phonological similarities within sign and spoken language lexicons (Martinez del Rio et al., 2022; Thompson et al., 2020). Calculations could be formed to predict how a certain word form would be shifted semantically over time. Based on the current study, we predict specific constraints on how new meanings are extrapolated and extended. We hypothesize that these shifts are not randomly distributed, but could be tracked and estimated across languages and modalities.

Conclusion

Sign languages fundamentally differ from spoken languages in their colexification patterns. These findings have implications for theories on conceptual structure – these differences in the lexicons may also reflect differences in how signers and speakers think about relations between concepts in the world and their everyday embodied experiences.

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No AI was used for writing, *R* coding, and data analyses – all were human produced. Claude was used to format references and images.

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