

Including Non-Manual Markers in Studies of American Sign Language Dialogue

Jillian "Jam" Stebbins¹, Amber Hamilton², Emily Nover¹, Stephanie Patterson¹, Allison Fitch¹, Patrick Boudreault³, Raja Kushalnagar³, Cecilia O. Alm¹

¹Rochester Institute of Technology

² Rochester Institute of Technology/National Technical Institute for the Deaf

³Gallaudet University

js2680@rit.edu, aih5790@rit.edu, en7367@rit.edu, slp9101@rit.edu, ahfgsh@rit.edu, patrick.boudreault@gallaudet.edu, raja.kushalnagar@gallaudet.edu, coagla@rit.edu

Abstract

Language technology resources are limited for signed languages. In order to improve these technologies, large amounts of labeled language data stored in annotated corpora are necessary. Many existing annotated corpora in American Sign Language (ASL) do not include non-manual markers (NMMs), i.e., language features that do not involve the hands. This work underscores the importance of including NMMs in sign language research by describing their plurifunctional nature in signed conversation, specifying their link to sign language prosody, examining the current state of ASL corpus research, and recommending a systematized method of annotation which captures the critical but complex variations in NMM production in ASL.

1 Introduction

American Sign Language (ASL) is a natural, visual language with articulatory and perceptual features distinct from those of spoken languages (Valli et al., 2011). While signed languages primarily utilize the same neurological and linguistic systems as other natural languages (Newman et al., 2015), the visual modality impacts many aspects of language production and comprehension and allows a unique opportunity for cross-linguistic comparison. At the same time, it introduces distinct considerations for the development of language processing technologies. For the roughly 500,000 deaf and hard-of-hearing ASL users in the United States (Mitchell and Young, 2022), technologies such as Automatic Sign Recognition and Text-to-Sign lag behind Automatic Speech Recognition and Text-to-Speech (Bragg et al., 2019).

Improving language technology for ASL and other signed languages requires specialized methodologies designed for the visual modality, as well as engagement with the Deaf community by understanding technology users' actual needs and

supporting Deaf and hard-of-hearing researchers in leading roles (Boudreault et al., 2024). ASL technologies developed by hearing non-signers typically have cultural and linguistic blind spots, leading to calls from the Deaf community to not only collaborate with, but center the perspectives of Deaf and hard-of-hearing researchers (Desai et al., 2024; Bragg et al., 2019). In addition, the development of sign language processing technologies often requires different techniques than those used for speech processing; these methodologies may be as straightforward as utilizing video rather than audio to capture language samples, or as complex as adopting alternate models for utterance segmentation (Moryossef et al., 2023). In this opinion paper, we bring attention to one set of ASL linguistic features that have been critically understudied in the computational linguistics literature: non-manual markers (NMMs).

1.1 Non-Manual Markers (NMMs)

The articulators most often studied in signed languages are the hands (Hochgesang, 2022). Manual features such as the shape, movement, and orientation of a signers' hands contribute heavily to word identification and grammar, and are typically seen as producing the lexico-morphological signs. However, non-manuals, or language features that do not utilize a signer's hands, are also critical for producing and comprehending signed language (Crasborn and Van der Kooij, 2013). These features, including head, face, and body movement, may influence an utterance's lexical content or provide suprasegmental cues or contextual information.

NMMs in signed languages are plurifunctional (Bauer et al., 2026), meaning any given feature may serve multiple purposes. These functions may be structural or affective. Affective functions of non-manuals include some facial expressions which are used in both spoken and signed languages (Benitez-Quiroz et al., 2016). However, in signed languages,

NMMs also serve as language-specific features that can be used to disambiguate morphemes, convey syntax, and structure information. For example, raised eyebrows in ASL may demonstrate surprise or shock, but are more commonly used to determine phrase boundaries, indicate topicalization or question type, or function as an emphatic prosodic cue (Gonzalez, 2011). One NMM may be used for multiple functions on a very short time scale, often within one utterance (Oomen and Roelofsen, 2023). Due to their suprasegmental functions, NMMs are often associated with prosody in sign (Sandler, 2010). For instance, a signer may use eyebrow movement to indicate intonational phrases (Dachkovsky and Sandler, 2009), or use body shift to convey focus or emphasis (Wilbur, 2020).

While NMMs are critical for producing and understanding ASL in dialogic contexts, they are difficult to incorporate into language technologies like computer vision for sign detection or even DeepMind’s new sign-language-to-text (SL2T) technology (DeepMind, 2026). If the same feature, for instance, body tilt, is used both to demonstrate contrast between options and to indicate that a signer is relaying information from another party (role shifting), the ability of tools like OpenFace (Baltrusaitis et al., 2018) or MediaPipe (Lugaresi et al., 2019) to detect when that feature is present does not allow for a full depiction of how body tilt functions in the utterance, or what the meaning of that utterance is. Research involving sign language and the development of sign language technologies requires more nuance than these tools currently provide. For further examples, computational models might not be able to fully parse an ASL question if eyebrow movement is not included, or distinguish the sign NOT-YET from LATE if mouth and head movement are ignored. The limitations of existing technologies in registering and reproducing NMMs in signed languages (Zhang et al., 2025) creates a resource gap in technologies such as sign language recognition (SLR), sign language generation (SLG), and affective computing for signers (Bragg et al., 2019).

2 Defining Prosody

2.1 Multimodal Prosody

In general, prosody relates to the suprasegmental features of language, which are patterns that help with producing and understanding dialogic context. Prosody can also be described as conveying

informational structure (Zora et al., 2025); that is, prosodic cues do not necessarily impact morphology or syntax but nevertheless change the meaning of an utterance. Analyzing prosody typically involves examining duration, energy, and intonation (Haralambous, 2024), and all of these aspects are critical to fully relay any conversational message.

In spoken languages, prosodic cues appear primarily through features such as pitch, volume, speed, and pauses (Sandler, 2010). To indicate a yes or no question (i.e., to structure information) in English, for example, a speaker usually raises their pitch at the end of an utterance. However, prosody itself is not tied to any specific modality. Prosodic cues appear in all languages (and some nonlinguistic communication systems, as discussed in Applebaum et al., 2014) to allow dialogue partners to interpret what is actually meant by a statement. This is the case whether the prosodic cue or the language itself is spoken, signed, or tactile.

While most research on prosody is conducted on sound-based prosodic phenomena such as speech focus (Zora et al., 2025), prosody is not strictly tied to sound even in spoken languages (Prieto et al., 2024). Behaviors such as nodding (Frid et al., 2019) or holding the palms up (Lepeut and Shaw, 2025) may have some prosodic function in spoken languages, indicating focus, pausing, or other suprasegmental information. For visual languages like ASL, these same features are plurifunctional, so may be lexico-morphemic, prosodic, or affective depending on the utterance and its context.

2.2 Prosody in Sign

Prosodic cues are critical in dialogic interactions, and can indicate communicative intent, emotional or affective state, utterance boundaries, and other global contextual information. In ASL, energy and intonation are expressed not by changes in loudness and pitch, but through other articulators (Dachkovsky and Sandler, 2009). For example, frustration or anger (i.e., high energy) may be expressed by making a signed utterance larger. Many of these prosodic cues are non-manual: eyebrow, mouth, head, and body movement are all linked to prosody in signed languages (Crasborn and Van der Kooij, 2013).

Because signed languages are primarily in the visual modality, non-manual articulators serve more purposes than the same cues in spoken languages. Due to this previously discussed plurifunctionality, some aspects of ASL prosody may be difficult to

distinguish from syntax or even nonlinguistic gesture (Kita and Emmorey, 2023). Features identified as prosodic cues, such as eyebrow raises, often also serve other functions (i.e., conveying grammatical structure or affect) depending on the context of the utterance. This is a complexity that language processing technologies are currently less equipped to process (Orr et al., 2024).

However, there is evidence that first-language signers are able to accurately parse intonational phrases in ASL using as few as three prosodic cues (Gonzalez, 2011). They are also sensitive to a more selective array of cues (in the prior study, pauses, holds, and eyebrows) when parsing ASL clauses than signers of other languages, second-language signers, and non-signers, who all utilized a wider variety of prosodic cues to make the same determinations (Gonzalez, 2011). Other research has shown that, when signing speed is increased, certain NMMs change more drastically than others in both number of appearances and duration (Wilbur, 2009). Therefore, it is likely that native signers produce and attend to specific patterns of prosodic cues based on the function of an utterance. If language technologies gain the ability to identify and analyze the same cues as signers, improvements will be made in recognizing, processing, and producing ASL utterances.

3 Annotated Corpora in ASL

3.1 Existing Annotation Tools and Corpora

For computational models to learn how language is used in different contexts (e.g., by different speakers and in different locations) and to represent these differences accurately, especially for languages with fewer speakers or resources, the annotated corpora that provide the data needed for these models should be high-quality and reliable (Jurafsky and Martin, 2026). Annotated ASL corpora with clear structure can become benchmarks that train and evaluate novel systems, in addition to contributing to model improvements for tools trained on other ASL resources such as SL2T (DeepMind, 2026). For NMM annotations, human annotators should make consistent judgments about subtle face, head, and body movements that may be difficult to distinguish from one another.

Applications like OpenFace (Baltrusaitis et al., 2018), MediaPipe (Lugaresi et al., 2019), and OpenPose (Cao et al., 2021) have more general computer vision use than sign language analysis.

Although these tools can demonstrate limited utility for automatically analyzing NMMs (Kuznetsova et al., 2021), they are not designed specifically for sign language applications and are missing key features that are necessary for processing sign language, such as the needed movement tracking for the tongue. This highlights the necessity of continuing to engage human annotators in the process of developing an improved annotation scheme. Existing automated tools, many of which utilize Action Units (AUs) from the Facial Action Coding System (Ekman and Friesen, 1978) to describe the motion of muscles in the face, do not necessarily help the annotation process for multiple reasons. First, facial AUs are designed and often used for emotion recognition within affective computing (Baltrusaitis et al., 2018). While there is some overlap between affective and structural non-manuals in signed languages (Benitez-Quiroz et al., 2016), it is not complete. Facial AUs may not capture the nuances of syntactical and prosodic NMMs. For example, ASL utilizes several mouth and tongue morphemes which a human annotator can distinguish, but current facial AU annotation schemata or automatic pose estimation tools lack such coverage (Zadeh et al., 2016). In addition, these schemata and software are primarily designed for and trained on non-signers, meaning that they may harbor inconsistencies and likely do not capture cultural differences in signers’ non-manual production, including for affective expression. Accordingly, a standardized annotation system is important for ensuring consistency for both human annotators and future automatic annotation models, and for enabling cross-corpus comparisons and reliable model training.

Despite rapid improvements in the past few years, current annotations of ASL corpus data still focus on manual over non-manual cues. Many citation-form corpora, which have isolated dictionary-style tokens of individual signs, do not include contextual non-manual information. For example, ASL SignBank is an annotation tool meant to be used by fluent ASL researchers to make videos in ASL machine-readable (Hochgesang et al., 2019). It has over 3,000 sign-gloss pairs and is the gold-standard for a citation-form ASL corpus. Videos in SignBank are intentionally “unmarked” (Hochgesang, 2022), meaning that there are no NMMs involved, in order to maintain the dataset as a baseline for individual manual signs. While this is beneficial for standardization, it is

not sufficient to use corpora like this for developing language processing technologies that capture real-world NMMs use. The team behind SignBank has cautioned against using it for machine learning-based development due to this and other reasons (Hochgesang, 2026).

Continuous-form corpora, on the other hand, cover naturalistic signing in full and often include NMMs, even if they are not yet annotated as such. These corpora are used for different purposes than citation-form corpora and can include more contextual information. For example, one of the richest datasets is How2Sign, which includes multiple modalities, such as gloss, pose, and depth information (Duarte et al., 2021). However, How2Sign currently lacks NMM annotations. Other datasets serve specific purposes such as Sign Language Recognition (SLR) or Sign Language Translation (SLT), but there are no standardized annotation conventions for NMMs between these corpora. The current systematized conventions for annotating ASL, SLAASH (Hochgesang, 2022), focus predominantly on manual features, without many distinctions for NMMs (and specifically excludes from analysis ASL mouthings such as MM or PUFF-CHEEK) (Hochgesang and Lillo-Martin, 2020). The inclusion of more detailed NMM annotations into existing or novel ASL corpora will allow these datasets to become more complete and nuanced representations of signed languages.

3.2 Importance of Including NMMs in Annotated ASL Corpora

Because NMMs serve so many functions in signed languages, including as prosodic cues, omitting them from a conversation may obfuscate its meaning at any level of analysis. At the utterance level, for instance, signers consistently use NMMs to indicate permission, an explanation, a command, or advice (Brentari et al., 2018). However, not all ASL prosodic cues are non-manual and while NMMs serve many prosodic functions, they also have syntactic, morphological, and affective functions.

Some of the variation in NMM use is mostly standard across signers; for example, the phonological difference between NOT-YET and LATE depends on mouth and head movement, and most signers will sign the difference the same way. PUFF-CHEEK, for another example, is a mouth morpheme that may serve an adjectival function, impacting the lexical content of an utterance. NMMs that serve prosodic or affective functions are less

standardized, and the same utterance might vary with NMM use from one signer to another (Valli et al., 2011), or from the same signer between contexts (Gonzalez, 2011). The variability of prosodic NMMs makes them more complex to annotate, but properly understanding them is a critical component of sign language comprehension. This complexity underscores the necessity of expanding NMM annotations when developing corpora used for training computational models of ASL.

There is still much to learn about NMMs, particularly their role in prosody, and current language technologies for ASL would benefit from novel and expanded corpus resources. For instance, automatic annotation systems for sign language struggle to catch specific features of NMMs, such as nose folding, forehead wrinkles, and tongue/teeth use (Hrúz et al., 2011). Annotation is further complicated whenever a signer’s hands block NMMs from being visible on the face (Hrúz et al., 2011). In addition, NMMs add semantic richness to sign languages (Quesada et al., 2016; Orr et al., 2024), and existing facial action unit and facial gesture recognition tools built for emotion identification do not perform adequately on NMM-relevant tasks without additional human effort (Kuznetsova et al., 2021). Capturing NMMs reliably will require both more data and ASL-native human annotators; corpora developed this way can then support further ASL prosody research and NMM-aware models.

4 Discussion and Recommendations

The shortage of high-quality, annotated ASL data at scale remains a challenge for the development of accurate and relevant ASL processing technologies. Current corpus annotations are focused primarily on the manual articulators (Hochgesang, 2022), and current annotation tools are focused on features that are more relevant to affective computing than language processing applications. It is crucial to ensure annotation schemata are expanded to adequately capture the language-specific features of ASL, including NMMs.

An expanded annotation scheme for NMMs in ASL is necessary to model the behavior of different NMMs and their relationships to each other using quantitative representations. In addition, any computational models developed for the purpose of improving language technology will rely heavily on standardized annotations of large corpora. We note the importance of the creation of a common,

detailed template to annotate NMMs, especially those with links to ASL prosody. This scheme can be utilized to annotate existing or novel continuous-form corpora and improve the ability of language technologies to parse NMMs in ASL.

We argue that there should be additional nuance in these NMM annotations, such as including adjectival mouth morphemes, syntactic and affective eyebrow raises, and prosodic head and body tilt. Detailed annotations for NMMs will improve the utility of sign language data, especially for naturalistic dialogue between two or more signers.

4.1 Future Work

This paper is part of an ongoing project which has begun to collect a corpus of spontaneously-produced continuous signing from fluent signers. The corpus will utilize an expanded annotation scheme focusing on NMMs, which will be useful for computational models that process ASL, such as automatic annotation of other corpora. Future work should examine the implications of more detailed NMM annotations for machine learning-based models that train on annotated sign language data. The ability to model relationships between NMMs could potentially improve the performance of sign language technologies. Further, future work requires additional research on the distinction between different functions of prosodic NMMs in ASL, as a more robust and detailed protocol for the documentation and differentiation of NMMs will allow for better analysis and the use of NLP techniques in parsing and predicting NMMs in ASL.

5 Conclusion

This opinion paper asserts the importance of including NMMs in research related to ASL, especially due to their links to sign prosody. We discuss the state of ASL corpus research and advocate for a standardized method of annotating NMMs in projects designed to develop and improve language technologies. Our goal is to encourage corpus resource creation that can better capture the language-specific features of ASL so that emerging sign language technologies will have improved accuracy, allowing ASL tools to better serve Deaf and hard-of-hearing users. To support the conclusions found, the ongoing project relies on a strong base of knowledge from the Deaf sign language research community. Future works proposed are also relevant to researchers across many fields from

linguistics to psychology to computer science, and especially for those who work on ASR, TTS, SLR, SLG, and other language technologies.

6 Limitations

This set of recommendations, while solidly based in the ASL linguistics and sign technology literatures, is only intended to support the study of NMMs in ASL. Other signed languages have different language-specific features and, while spoken languages may also have visual prosody, the conclusions drawn above do not generalize to languages other than ASL or types of prosody that are conveyed through articulators other than NMMs (i.e., the hands or vocal tract). Despite the fact that human annotations of NMMs are critical for the continued development of language technologies, there is a limit to the features that can be reliably coded. Some NMMs, such as blinking, squinting, and nose wrinkling, are subtle and difficult for human annotators to identify consistently. In addition, the function of some NMMs may be very difficult to classify in any given utterance, even for highly fluent or native annotators. This is a further challenge to the development of a broadly standardized annotation methodology. Finally, while ASL technologies necessitate improvement, this does not necessarily mean that it is impossible to do so without NNM annotations.

7 Ethical Considerations

While this work is an opinion paper and does not include data from human subjects participants, ethical considerations remain. Any project discussing sign language is positioned against the backdrop of a history of suppression of signed languages and the current realities of language deprivation for many deaf and hard-of-hearing children (Hall et al., 2017). This harm is, in part, the result of hearing academics who have operated under ableist frameworks without input from Deaf individuals—those who actually use the language (Hill and Hall, 2025). To reduce threats of adding to this harm, the ongoing project is being conducted by a team of Deaf and hearing researchers who operate in a bilingual (ASL/English) research space, and who developed the project collaboratively. Data collection sessions for the ongoing corpus project always involve at least one Deaf researcher, and all researchers interfacing with participants are users of ASL.

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