

Layering manifests when multiple phonological and paralinguistic elements co-occur [1]. Deconstructing layered expressions in signed discourse presents a formidable challenge for sign language researchers. Unlike spoken languages, which rely on the oral tract as the sole articulator, sign languages engage multiple articulators simultaneously, including the hands, head, body, and face. Nonmanual features (NMS), which do not involve the hands, serve both affective and grammatical functions. The face, with 43 striated muscles, utilizes various articulators like the eyebrows, mouth, and nose. A meticulous examination of each articulatory component affords an array of insights into the linguistic dexterity of signers [6-10].

Signers intrinsically utilize layering [2-5] as a metastrategy. In phase one of this study, a preliminary analysis of internet corpora (grammatical & emotional pairings) revealed layered patterns of NMS. To understand this further, the second phase mirrors previous research methods and target constructions with modifications [5]. All instructions and interactions are conducted in American Sign Language (ASL), and targets are elicited through visual stimuli rather than written sentences. Our adaptations aim to avoid intrusion from spoken languages while encouraging naturalistic responses. This study limits itself to three emotions (neutral, anger, & surprise) and three syntactic structures (polar questions, interrogatives, & statements) [Table 1].

Participants were all self-described as deaf with acquiring ASL from birth. Each was presented with three illustrations and instructed to describe the third target illustration [Fig. 1]. Participants reproduced their descriptions, targeting specific pairs of a syntactic structure and an affective facial expression (e.g., polar question + surprise affect). Each illustration generated nine constructions, resulting in a total of ninety constructions manually coded via the Facial Action Coding System to identify facial muscle activation [11].

Similar constructions found during phase one's preliminary analysis also occurred during phase two's elicited target construction, revealing patterns of eyebrow competition. These indicate three metastrategies signers employ to maintain clarity and functionality: *separation*, *addition*, &/or *competition*. Firstly, signers **separated** affective NMS into a sequence, introducing them before &/or after grammatical information. In this study, participants also expressed distinct, separate signs after or before to emphasize emotional targets (e.g., SHOCK, SURPRISE, NOT EXPECT, INCREDIBLE, PISSED-OFF & SICK-OF) [Fig. 2].

Secondly, signers supplemented the emotional quality by **adding** affective features, e.g., jaw drop [Fig. 2-4] and rapid blinking [Fig. 5d]. Such additions emphasized the affective quality while the eyebrow activation facilitated a grammatical function. The findings from this study support such observations. Darting of the eyes was present when the surprise affect was paired with various constructions. Also, body leans enhanced positive [Fig. 4a-d] and negative [Fig. 5a-d] reactions. Participants further emphasized the grammatical structure with optionally adding manual question markers (e.g., ASK, WHY...WHY).

Thirdly, eyebrow activation demonstrated **competing** simultaneous functions mentioned in previous research [3; 12]. In Fig. 4-5, anger requires lowered eyebrows, while the question also requires a furrow. In the interrogative + anger competition, the frontalis muscle raises the eyebrows' inner corners and narrows eye aperture to further the emotional affect. [Fig. 5a-d].

While the timing of affective NMS may vary [2], this study showcases additional NMS that further supports the utilization of metastrategies by signers when pairing affective and grammatical NMS. This research enhances our understanding of how signers layer multiple articulators to execute metastrategies during eyebrow competition in ASL. Future phases of this project will employ comparisons with other methodologies, such as fEEG, facial landmark detection software, depth-sensing cameras, and machine learning.

		Construction Type		
		Statement	Polar	Interrogative
Emotion	Neutral	None	Raised brows	Lowered brows
	Surprise	Raised brows	Raised brows	Raised & lowered brows
	Anger	Lowered brows	Raised & lowered brows	Lowered brows

Table 1. Eyebrow behaviors expected based on nine construction pairs (in gray), Each set of nine were elicited from visual stimuli, see Fig. 1.

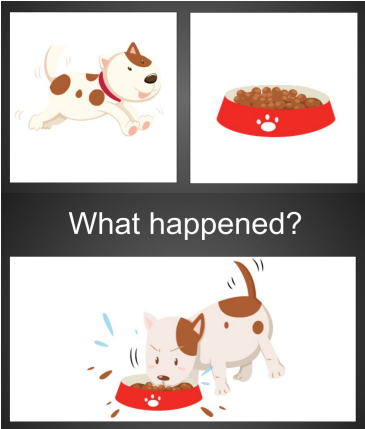


Fig. 1 Example illustrations for target “The dog is eating.”

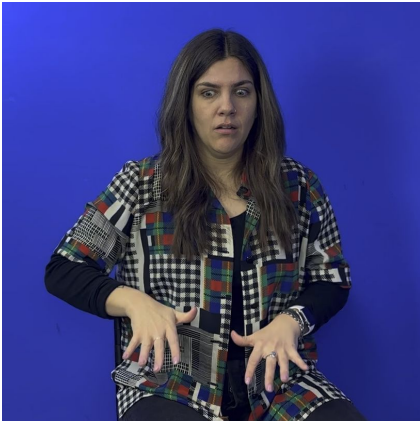


Fig. 2 Separation: Sign SHOCK with corresponding NMS



Fig. 3 Addition: NMS widened eye aperture and jaw drop



Fig. 4-5 Same interrogative construction ‘who build that house’ with differing NMS per affective target.

Selected References

1. Wilbur, R. B. (2013). Phonological and prosodic layering of nonmanuals in American Sign Language. In *The signs of language revisited* (pp. 196-220). Psychology Press. 2. Baker-Shenk, C. L. (1985). The facial behavior of deaf signers: Evidence of a complex language. *American Annals of the Deaf*, 130(4), 297-304. 3. Weast, T. (2011). American Sign Language tone and intonation: A phonetic analysis of eyebrow properties. *Formational units in sign languages*, 203-228. 4. Schnepf, J., Wolfe, R., McDonald, J., & Toro, J. (2013). Generating co-occurring facial nonmanual signals in synthesized American sign language. 5. Kimmelman, V., Imashev, A., Mukushev, M., & Sandygulova, A. (2020). Eyebrow position in grammatical and emotional expressions in Kazakh-Russian Sign Language: A quantitative study. *PloS one*, 15(6), e0233731. 6. Johnson, R. E., & Liddell, S. K. (2011). Toward a phonetic representation of hand configuration: The fingers. *Sign Language Studies*, 12(1), 5-45. 7. Johnson, R. E., & Liddell, S. K. (2011). Toward a phonetic representation of signs: Sequentiality and contrast. *Sign Language Studies*, 11(2), 241-274. 8. Johnson, R. E., & Liddell, S. K. (2012). Toward a phonetic representation of hand configuration: The thumb. *Sign Language Studies*, 12(2), 316-333. 9. Johnson, R. E., & Liddell, S. K. (2021). Toward a phonetic description of hand placement on bearings. *Sign Language Studies*, 22(1), 131-180. 10. Stokoe, W. C., Casterline, D. C., & Croneberg, C. G. (1965). *A dictionary of American sign language on linguistic principles*. [Washington, D.C.], Gallaudet Press. 11. Ekman, P., & Heider, K. G. (1988). The universality of a contempt expression: A replication. *Motivation and emotion*, 12(3), 303-308. 12. Reilly, J. S., & Bellugi, U. (1996). Competition on the face: affect and language in ASL motherese. *Journal of Child Language*, 23(1), 219-239. <https://doi.org/10.1017/S0305000900010163>