The Role of Motor Feedback in Second Language Sign Learning

Sign languages are natural human languages whose comprehension and production follow similar principles to spoken languages (Emmorey, 2002; MacSweeney et al., 2008). Unlike speech, however, they are produced in the visual–manual modality, where direct self-monitoring is limited: signers cannot always see their own signing space and thus rely heavily on somatosensory and proprioceptive feedback for articulation (Emmorey et al., 2009). Previous work suggests that motor systems contribute to both comprehension and learning, but their role appears to vary with linguistic experience and task demands. For example, late L1 and L2 signers show egocentric motor simulation effects during comprehension (Corina & Gutierrez, 2016; Watkins & Thompson, 2017), while native signers rely more on abstract linguistic representations. Similarly, motor involvement in speech is heightened under perceptually difficult conditions such as accented or noisy input (Adank et al., 2013; Hickok et al., 2011).

In learning contexts, producing gestures or signs enhances recall, particularly when learners rely on motor rather than visual feedback (Garcia-Gamez & Macizo, 2019; Morett, 2015; Morett et al., 2024). However, existing studies have rarely examined how somatosensory feedback supports both comprehension and production in new sign learners.

We address this gap by experimentally manipulating motor feedback during Hong Kong Sign Language (HKSL) learning. Hearing nonsigners will learn 48 low-iconicity signs (Ortega & Morgan, 2015; Ortega et al., 2019; Karadöller et al., 2024), balanced for phonological complexity, under four conditions: (1) normal practice, (2) motor-only feedback (eyes closed; cf. Morett et al., 2024), (3) altered feedback (using robotic gloves to distort proprioceptive signals; cf. Solomon et al., 2016), and (4) no motor feedback. Learning outcomes will be assessed through comprehension (forced-choice recognition) and production (recall). Production will be evaluated both linguistically and kinematically, using data recorded via a Qualisys 3D motion capture system alongside video, with motion similarity quantified using Dynamic Time Warping (Mueen & Keogh, 2016; Pouw et al., 2021).

We predict that the quality of motor feedback will strongly modulate learning outcomes. Participants are expected to perform best in the full-feedback condition, and better when motor feedback is available without visual input than when visual input is available without motor feedback. When motor feedback is restricted (altered via gloves), performance should remain above the no-feedback condition, reflecting a gradient benefit of somatosensory cues. Crucially, learning should be more successful when motor feedback is intact but visual feedback is blocked, compared to when visual feedback is intact but motor feedback is distorted. Finally, we predict that phonologically complex signs (e.g., marked handshapes, two-handed asymmetry) will show the greatest dependence on intact motor feedback, with the benefits of somatosensory input most pronounced for these items.

Together, this project will clarify the role of somatosensory feedback in the comprehension and production of a new sign language, highlighting how sensory–motor systems support learners adapting to a novel linguistic modality.

References

Adank, P., Nuttall, H. E., Bekkering, H., & Maegherman, G. (2013). Effects of word clarity and sentence clarity on speech motor involvement during perception. *Brain and Language, 126*(2), 106–113.

Akamine, S., Dingemanse, M., & Ozyurek, A. (2025, July 10). Validating dynamic time warping as a measure of gesture form similarity. https://doi.org/10.31234/osf.io/7f6mu_v1

Corina, D. P., & Gutierrez, E. (2016). Embodiment and sign language comprehension: Perspectives from cognitive neuroscience. *Cortex, 75,* 174–185.

Emmorey, K. (2002). *Language, cognition, and the brain: Insights from sign language research*. Lawrence Erlbaum Associates.

Emmorey, K., Bosworth, R., & Kraljic, T. (2009). Visual feedback and self-monitoring of sign language. *Journal of Memory and Language, 61*(1), 121–135.

Garcia-Gamez, M., & Macizo, P. (2019). The contribution of gestures to second language word learning. *Applied Psycholinguistics, 40*(1), 123–145.

Hickok, G., Houde, J., & Rong, F. (2011). Sensorimotor integration in speech processing: Computational basis and neural organization. *Neuron, 69*(3), 407–422.

Karadöller, D. Z., Perniss, P., & Vigliocco, G. (2024). Iconicity effects in sign language acquisition. *Language Learning and Development, 20*(1), 1–24.

MacSweeney, M., Woll, B., Campbell, R., McGuire, P. K., David, A. S., Williams, S. C. R., Suckling, J., Calvert, G. A., & Brammer, M. J. (2008). Neural systems underlying British Sign Language and audio–visual English processing in native users. *Brain, 125*(7), 1583–1593.

Morett, L. M. (2015). When hands speak louder than words: Gesture and sign language in second language learning. *Second Language Research, 31*(3), 341–362.

Morett, L. M., Zesiger, P., & Emmorey, K. (2024). Somatosensory contributions to sign language learning in hearing adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 50*(2), 254–270.

Mueen, A., & Keogh, E. (2016). Extracting optimal performance from Dynamic Time Warping. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 2129–2130). ACM.

Ortega, G., & Morgan, G. (2015). Phonological development in hearing learners of a sign language: The influence of phonological markedness and iconicity. *Language Learning, 65*(3), 660–688.

Ortega, G., Sümer, B., & Özyürek, A. (2019). Type of iconicity matters in sign language learning and recognition. *Applied Psycholinguistics, 40*(1), 21–45.

Pouw, W., de Jonge-Hoekstra, L., Harrison, S., & Dixon, J. A. (2021). Gesture–speech physics in multimodal communication. *Ecological Psychology, 33*(1), 1–24.

Solomon, N. P., Robin, D. A., & Luschei, E. S. (2016). Motor system constraints in speech: Evidence from bite block studies. *Journal of Speech, Language, and Hearing Research, 59*(4), 803–815.

Watkins, K. E., & Thompson, R. (2017). Motor simulation in sign language comprehension: Evidence from handedness effects. *Journal of Cognitive Neuroscience, 29*(3), 379–392.