German Sign Language sentence processing in hearing beginning and advanced L2 sign language learners: An ERP study

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When learning a signed language, hearing L2 learners must acquire unique features pertaining only to the visual-gestural modality. Sign languages use the three-dimensional signing space to realize various functions, such as marking syntactic information. Specific verbs, so-called agreement verbs for instance, move between locations within this space, with their starting and end point indicating different arguments in an utterance. Acquiring agreement seems to be particularly challenging for L2 learners in production as it requires the appropriate use of the signing space [1]. Processing sign language involves neural responses similar to those seen in spoken language comprehension. Deaf adults demonstrate similar neural correlates as hearing adults for spoken languages [2, 3]. First studies on proficient hearing L2 signers reveal comparable effects when processing semantically anomalous sentences [4]. However, it remains unclear whether beginning and advanced L2 learners exhibit similar neural responses and how these responses evolve increasing sign language proficiency. Given the modality-independent nature of neural responses, we expect an N400 when processing semantic and a P600 for syntactic anomalies in both groups with amplitude and latency being modulated by proficiency.

This event-related potentials (ERP) study examined neural processes during German Sign Language (DGS) sentence processing. Participants included 17 beginning (mean age = 23 years) and 17 advanced L2 learners (mean age = 26 years), all learning DGS at university. They watched videos of 90 signed DGS sentences that were grammatically correct or contained either a semantic or syntactic violation. ERPs were recorded from 64 scalp electrodes. To maintain the participants' attention, they performed a probe verification task. Approximately 8 weeks later, the same participants judged the sentences on a 4-point scale.

Data analysis focused on mean amplitudes from the moment when the handshape of the verb sign was fully recognizable until 1000ms in 100ms time windows using generalized additive mixed-effects models. Judgment data were analyzed with mixed-effects models. Unexpectedly, semantic violations did not elicit the anticipated ERP effects. While beginning learners showed no N400 but a right anterior negativity (400-700 ms) and a posterior positivity (500-700 ms) (400-500ms: $F(11.17) = 5.76$, $p < 0.001$; 500-600ms: $F(22.91) = 8.40$, $p < 0.001$; 600-700ms: $F(25.18) = 13.64$, $p < 0.001$), advanced learners demonstrated an N400-like effect but rather late (600-700ms: $F(27.45) = 37.36$, $p < 0.001$; 700-800ms: $F(22.20) = 40.98$, $p < 0.001$). Yet, both groups rated semantic violations lower than correct sentences ($\beta = -.89$, $SE = .06$, 95 % CI [-1.0 – -.78], $p < .001$) suggesting that all learners understood and judged the sentences consistent with our predictions. As participants are still developing their DGS skills, high inter-individual differences in these skills might have canceled out effects at the group level analysis [5]. Thus, an N400 effect might be in a developmental stage for advanced signers not yet reaching proficient learner-like patterns as in [4]. For syntactic processing, the results aligned with our predictions: advanced learners showed a more pronounced P600 effect (500-1000 ms: beginners: $F(11.58) = 61.45$, $p < 0.001$; advanced: $F(31.86) = 48.51$, $p < 0.001$) with a different distribution than beginners implicating an incremental development in the perception of syntactic agreement violations.

To further explore the effect of sign language proficiency, by the time of the conference, the ERP data will be correlated with sign language competence measures [6] to determine gradual effects of language proficiency. This is the first study to compare sign language sentence processing across hearing L2 learners with varying levels of proficiency, providing new insights into neural responses and language acquisition in the visual-gestural modality.

References

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