Visual boundaries in sign motion: processing with and without mouthing cues

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Sign languages allow investigation of the hypothesis that language processing builds on neural circuitry underlying general, non-linguistic abilities – such as the ability to identify, parse, and interpret actions. Sign languages utilize articulator motion profiles similar to motion profiles of observed events, conveying event-based semantics and constructing grammatical features such as aspect. Studies of unrelated sign languages indicate that event structure, expressed by verbs and their arguments, is overtly expressed in verb sign dynamics, manifesting Event Visibility (cf. Malaia & Milković, 2021). For instance, signs denoting an event with an endpoint (telic verbs, e.g. English 'fall') have a sharper final movement with rapid deceleration to a stop. In contrast, verbs denoting an ongoing event, or one without an inherent endpoint (atelic verbs, e.g. English 'sleep'), might be conveyed by a steady movement without rapid acceleration profile (Wilbur 2008). Remarkably, visual event structures of sign language verbs are recognized by hearing non-signers without any knowledge of sign language. In an alternative-forced-choice task, hearing non-signers were found to associate unfamiliar (pseudo-)signs involving a dynamic visual boundary with telic events (Strickland et al. 2015). Non-signers also were found to neurally process the perceptual-kinematic difference between atelic and telic verbs in American Sign Language (Malaia et al. 2012). In this study, we first assessed the timeline of neural processing mechanisms in non-signers processing telic/atelic signs to understand the pathways for incorporation of physical-perceptual motion features into the linguistic system. Experiment 2 further probed the possible impact of visual information provided by mouthing (speech decoding based on visual information from the face of the speaker, most importantly, the lips) on the processing of telic/atelic signs in non-signers. Hearing German speaking non-signers (N=27) were presented with telic and atelic verb signs unfamiliar to them, which they had to classify in a two-choice decision task (cf. Strickland et al. 2015). The stimuli consisted of signs from unrelated sign languages (Turkish, Italian, Croatian and Dutch). Behavioral data analysis confirmed that non-signers could classify

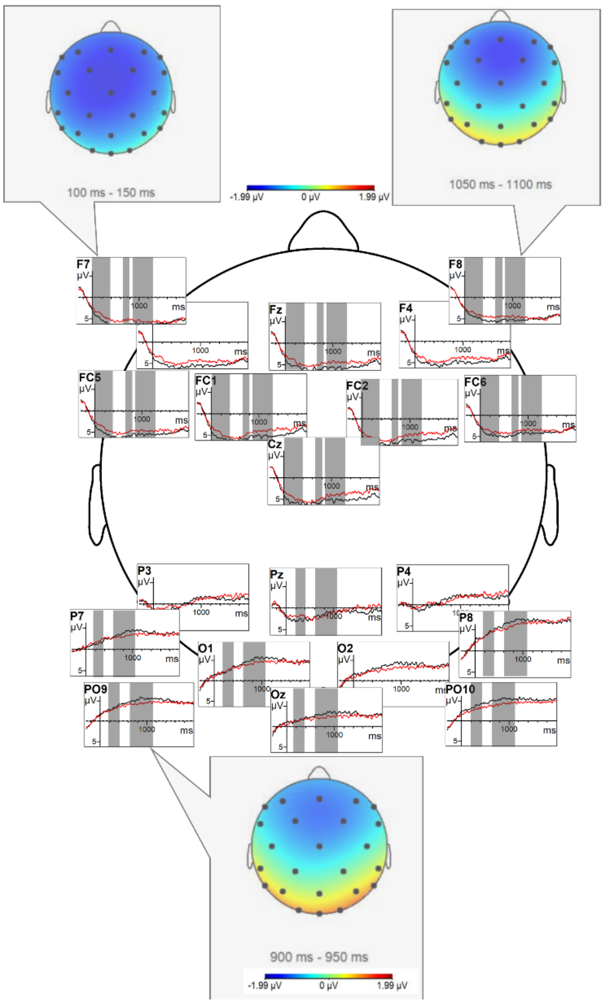

Figure 1. Telic/atelic sign processing without non-manual cues

telic/atelic verbs, whereby telics were easier to classify than atelics. Processing differences for atelic compared to telic sign stimuli were revealed at the neurophysiological level (Figure 1). Beginning from sign onset (i.e. target handshape positioned in target location), statistically significant neural differences in processing appeared anteriorly (0-200ms, 650-800ms, 850-1300ms), posteriorly (600-1050ms), and in a broadly distributed manner (200-400ms). The timing and distribution of ERP effects appear to reflect both the differences in perceptual processing of verb types and the integration of perceptual and linguistic processing required by the task. These findings suggest that non-signers use visual-perceptual features of signs while engaging higher cognitive processing for classifying the percepts linguistically. Non-signers appear to segment visual sign language input into discrete events as they try to map the observed sign language form to a linguistic concept that might represent the sign. The mechanism might be indicative of the potential pathway for co-optation of perceptual features into the linguistic structure of sign languages. In Experiment 2, the participants were presented with telic and atelic signs of Austrian Sign Language (ÖGS), which both evidence a distinct telic/atelic motion profile (Krebs et al. 2021), and are accompanied by mouthing information (movement of the mouth forming (part of) the German corresponding word). In general, in ÖGS mouthing is relatively common (Schalber, 2015). Behavioral data revealed that participants responded more accurately, faster, and with more certainty to the classification task. ERP findings differ from those of Experiment 1: ERP effects for telic compared to atelic signs started in later time windows, extended into later time windows, and showed a primarily posterior distribution (Figure 2). The findings suggest that non-signers rely on information provided by mouthing, if available. In this case non-signers pay more attention to mouthing (as self-reported after the experiment), as opposed to tracking visual motion profiles in the stimuli. Because linguistic information provided by lip movement is part of audio-visual spoken language processing, it was easier for non-signers to classify the signs in Experiment 2 compared to Experiment 1. The ERP effects for telics vs. atelics observed in Experiment 2 also reflected the qualitatively different mapping/ integration processes for telic compared to atelic verbs. However, a different strategy was used by the participants in the two experiments, leading to different ERP patterns in both experiments. In line with previous work (e.g. Malaia et al. 2009; Ji & Papafragou 2020), the differences in ERP effects during processing of telic vs. atelic stimuli observed in both experiments appear to indicate easier event segmentation in response to telic stimuli.

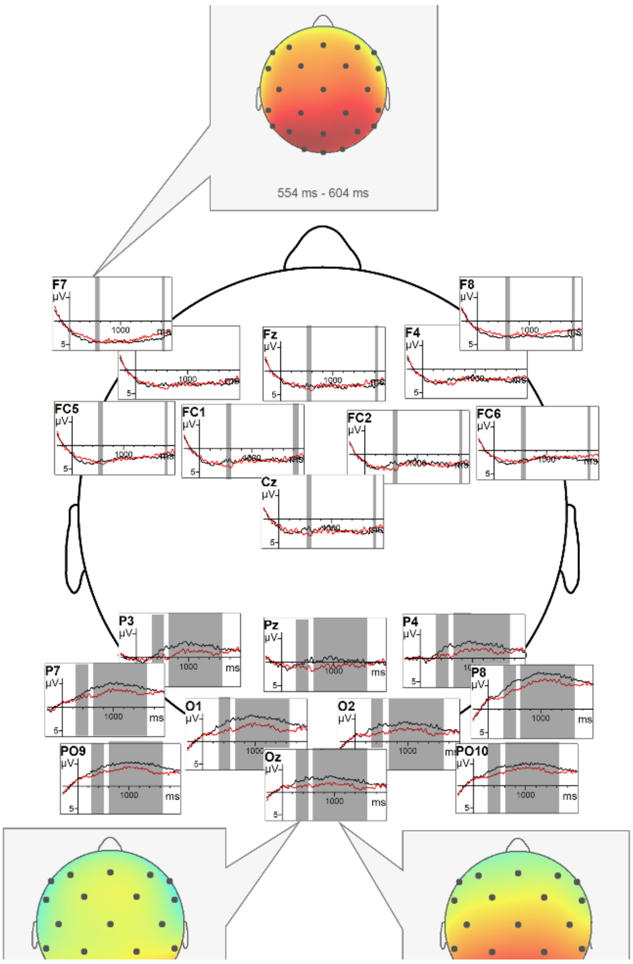

Figure 2. Telic/atelic sign processing with non-manual cues

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