**Seeing gestures can change what numbers you have in mind**

People talk and think about numerical magnitude in terms of space, and co-speech gestures reflect this, with English speakers using expansive gestures when talking about greater quantities (Winter et al., 2013; Woodin et al., 2020). So far, existing gestural research on the spatial conceptualisation of number has largely looked at gesture production, but we do not know yet whether gestures can also change what number observers have in mind. While we know that gesture can change people's temporal conceptualization of the event an utterance describes (Lewis and Stickles, 2017), there are no similar demonstrations in the numerical domain. This study investigates the influence of outwards and inwards moving co-speech gestures on people's conceptualisation of the numbers indicated by the vague quantifier "several".

Our pre-registered study involved 20 experimental items such as the following: "400 people were at the protest. Several of them got arrested.". We video-recorded two British English speakers, one male and one female, while producing these with either inwards or outwards moving gestures on the underlined portion (see pictures in Figure 1). Participants (N = 352) responded to the question: "Guess how many of the 400 people got arrested?". We analysed the participants' numerical estimates as a function of gesture with a Bayesian beta-binomial regression model, finding a weak gesture effect: participants who saw a speaker performing an outward gesture estimated slightly higher quantities (logit coefficient: b=0.22, [-0.09, 0.53]) than those participants who saw a speaker performing an inward gesture.

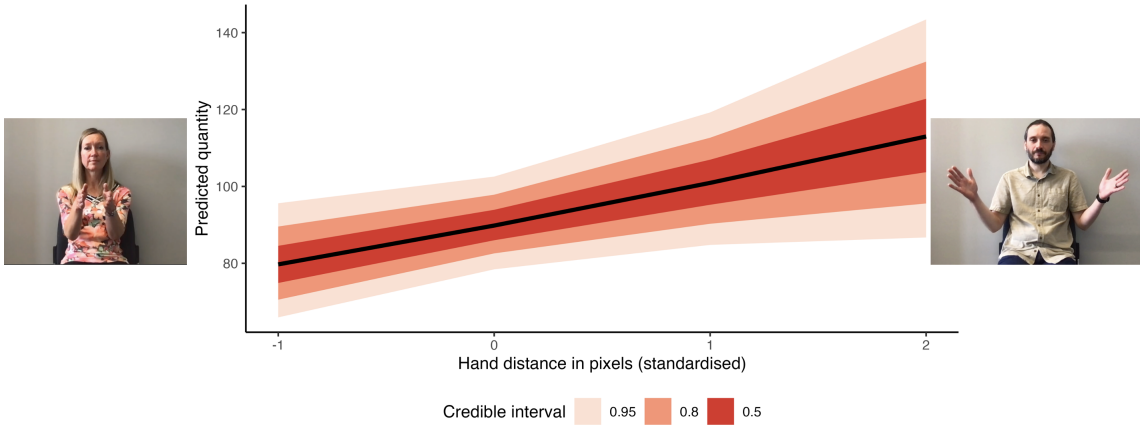


Figure 1: Posterior predicted quantities (y-axis) as a function of distance between the speakers' hand after having executed the gesture (x-axis). For illustration purposes, we included pictures of the speakers for small (left) and large (right) hand distances.

In a follow-up analysis, we found that the precise pixel distance between a speaker's hands in the final gesture position was a better predictor than using the binary inward versus outward gesture distinction (logit coefficient: b=0.15, [0.00, 0.31]). This suggests that our weak initial result may have been due to variation in how the speakers in the video produced the gestures. An additional follow-up analysis used data from independent participants (N = 30) to norm estimates for each experimental item independent of gesture. Adding this norms as a predictor to control for between item differences also amplified the gesture effect (logit coefficient: b=0.18, [0.03, 0.33]), see Figure 1. Finally,

we conducted a within-subjects pilot study (N = 30), which yielded a stronger gesture effect (logit coefficient: b=0.27, [0.11, 0.52]), suggesting that our initial between-subject design may have masked differences in what "several" means for different participants (Moxey and Sanford, 1993).

Overall, our results suggest that while the interpretation of vague quantifiers such as "several" depends on the linguistic context and peoples' internal representation, their numerical understanding may be modulated by co-speech gestures. We are in the process of replicating these results and will discuss the implications of these findings for future work in numerical cognition, multimodal communication, and metaphorical conceptualisation of quantity.

# References


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