Testing the Motor Simulation Theory in Processing Canonical and Non-Canonical Finger Numeral Configurations

Fırat Soylu, Brian Rivera, Mona Anchan, & Nate Shannon

The University of Alabama

ABSTRACT

We tested the hypotheses that
- Previous studies have reported behavioral differences in processing canonical and non-canonical finger numeral configurations. Our study aimed to explore these differences using ERP methods.
- Motor simulation mechanisms were involved in processing canonical finger numeral configurations. We predicted higher mu suppression when processing canonical configurations.
- Previous studies have reported facilitative function for canonical numeral configurations, while non-canonical configurations have been associated with disruptive function. We hypothesized that canonical configurations would lead to increased mu suppression.
- A motor simulation hypothesis was proposed to explain these behavioral performance differences. When processing CC, a motor simulation mechanism is more readily engaged, whereas this may not be the case for NC, since the generation of the finger numeral configurations is part of the participants’ motor repertoire.
- Mu suppression, modulation of 8-13 Hz spectral response over central sites, has been used as a measure for involvement of motor simulations. We tested the motor simulation hypothesis by conducting an ERSP (Event-Related Spectral Perturbation) and spectral analyses, specifically focusing on mu suppression.

METHODS

- 20 right-handed, native English speaking undergraduate students (13 female, M=19.68 years, SD=1.84)
- All participants had finger counting habits compatible with the canonical configurations presented.
- 32-Channel Brainvision ActiChamp EEG system
- EEGlab was used for analysis.
- Data from the three central sites (C3, Cz, & C4) were analyzed.
- FDR correction (p-threshold = 0.05) was used to control for multiple comparisons.
- Stimuli: 8 pictures for each condition, showing numerosities from 1 to 4, with the left and the right hand.
- 320 trials for each condition, mixed across 10 blocks.
- Task: Observe the finger numeral configuration for 500 ms and decide whether the Arabic numeral shown in the validation step matches the finger configuration by clicking on of the two buttons.
- Data is publicly available [5]

CONCLUSIONS/SIGNIFICANCE

We found no evidence for mu suppression differences between processing canonical and non-canonical finger numeral configurations. Therefore, the evidence so far does not seem to support differential involvement of motor simulations in processing canonical finger numeral configurations.

FUTURE DIRECTIONS

- The data set used [5] involves 500 ms epochs, which are suitable for ERP analysis but not ideal for conducting ERSP/spectral analysis due to the short epoch durations. In a future study, we would like to re-test the simulation hypothesis by using a paradigm specifically tailored for ERP/spectral analysis, with longer epoch durations.
- An alternative paradigm can involve video clips of finger counting actions, since mu suppression is known to be more sensitive to observed actions compared to still images.
- An fMRI paradigm should also be considered, since it would allow comparison of BOLD response over motor areas during processing of canonical and non-canonical configurations.

REFERENCES