Brain Signatures of Communication Prior to Speech Onset: Predictive Brain Activity Indexing Illocutionary Type (BraiSiCo Project, FU Berlin)

Isabella Boux[1,2,3,†], Rosario Tomasello[1,3,4,†], Luigi Grisoni[1] and Friedemann Pulvermüller[1,2,3,4]

[1] Brain Language Laboratory, Department of Philosophy and Humanities, WE4, Freie Universität Berlin Habelschwerdter Allee 45, 14195 Berlin, Germany

[2] Einstein Center for Neurosciences, Charitéplatz 1, 10117 Berlin, Germany

[3] Berlin School of Mind and Brain, Humboldt Universität zu Berlin, Luisenstraße 56, 10117 Berlin, Germany

[4] Cluster of Excellence 'Matters of Activity. Image Space Material', Humboldt Universität zu Berlin Unter den Linden 6, 10099 Berlin, Germany

† Both authors contributed equally to this work

People normally know what they want to communicate before they start to speak. However, brain indicators of communication are typically observed only after speech act onset and it is still unclear when any anticipatory or predictive brain activity prior to speaking first emerges, along with the communicative intentions it possibly reflects. Here, we investigated predictive brain activity prior to the production onset of two different illocutionary types, request and naming actions performed by uttering the same spoken words. Although the experiment was done in the laboratory, all speech acts were embedded into language games similar to natural communication. Already 600 milliseconds before speech production onset, an event-related potential maximal at fronto-central electrodes, which resembled the Readiness Potential (Di Russo et al., 2017; Kornhuber & Deecke, 1965), was larger in preparation for requests as compared with naming actions (figure 1). Differences between the illocutionary functions of the two speech act types were not only reflected in ERP amplitudes, but also in their topographies and, interestingly, their estimated underlying sources in the brain. In particular, source estimation indicated a relatively stronger involvement of fronto-central motor regions for requests. This brain activity may reflect the speakers' expectation of and prediction on partner actions typically following requests, e.g. the handing over of a requested object. Our results are consistent with the proposal that different neuronal circuits underlie the processing of different speech act types performed with the same utterances (Pulvermüller, 2018). We discuss our results in the context of previous work on the neural basis of speech act understanding (Egorova, Pulvermüller, & Shtyrov, 2014; Egorova, Shtyrov, & Pulvermüller, 2013, 2016) and relate the predictive brain indexes in speech act production to the ones previously observed in comprehension, shortly after presentation of speech act information.

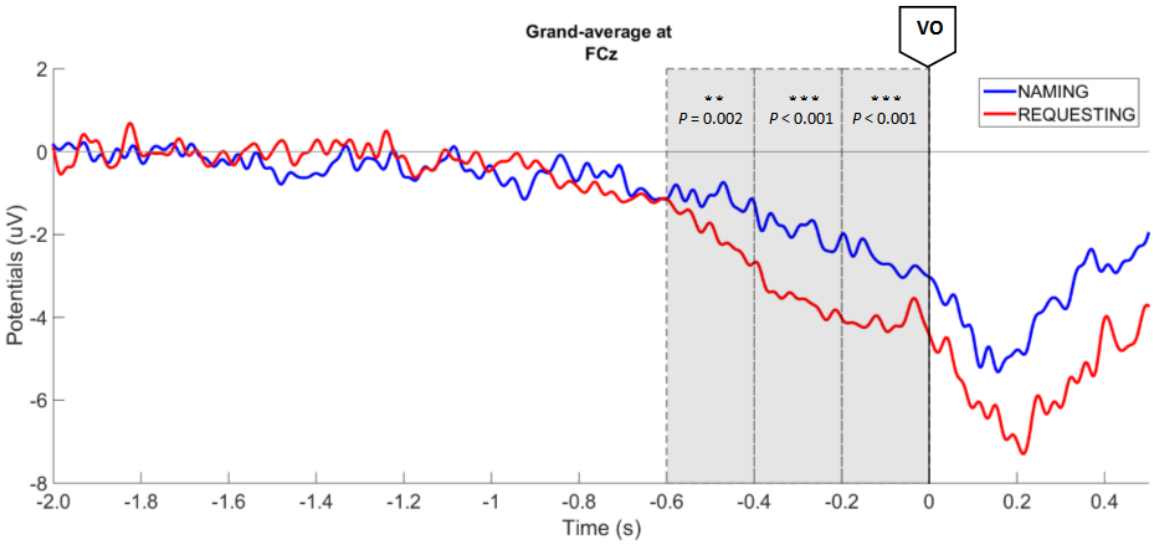

Figure 1: Grand average event-related potentials (ERP) measured prior to the onset of naming (blue) and request (red) actions. Recordings are from mid-fronto-central electrode FCz. The X axis represents time in seconds before and after speaking onset (voice onset, VO) and the Y axis represents the ERP amplitude in micro-Volt (µV). The grayed areas indicate the time windows where the difference between naming and request were significant (after Bonferroni-corrected post-hoc t-tests), as well as their respective significance levels.

References

Di Russo, F., Berchicci, M., Bozzacchi, C., Perri, R. L., Pitzalis, S., & Spinelli, D. (2017). Beyond the "Bereitschaftspotential": action preparation behind cognitive functions. *Neuroscience & Biobehavioral Reviews*, *78*, 57–81.

Egorova, N., Pulvermüller, F., & Shtyrov, Y. (2014). Neural dynamics of speech act comprehension: An MEG study of naming and requesting. *Brain Topography*, *27*(3), 375–392. https://doi.org/10.1007/s10548-013-0329-3

Egorova, N., Shtyrov, Y., & Pulvermüller, F. (2013). Early and parallel processing of pragmatic and semantic information in speech acts: neurophysiological evidence. *Frontiers in Human Neuroscience*, *7*(MAR), 86. https://doi.org/10.3389/fnhum.2013.00086

Egorova, N., Shtyrov, Y., & Pulvermüller, F. (2016). Brain basis of communicative actions in language. *NeuroImage*, *125*, 857–867. https://doi.org/10.1016/j.neuroimage.2015.10.055

Kornhuber, H. H., & Deecke, L. (1965). Changes in the brain potential in voluntary movements and passive movements in man: Readiness potential and reafferent potentials. *Pflugers Archiv fur die gesamte Physiologie des Menschen und der Tiere*, *284*, 1–17.

Pulvermüller, F. (2018). Neural reuse of action perception circuits for language, concepts and communication. *Progress in Neurobiology*, *160*, 1–44. https://doi.org/10.1016/j.pneurobio.2017.07.001