NEURAL CORRELATES OF SPEECH AND NON-SPEECH PRODUCTION IN CHILDHOOD

LANCHEROS, M.*[1], ATANASOVA, T. [1], LAGANARO, M.[1]

*Corresponding Author: monica.lancherospompeyo@unige.ch

[1] Faculty of Psychology and Educational Science, University of Geneva, Geneva, Switzerland

Speaking is a complex behavior at the intersection between cognitive and motor processes that implies the coordination of multiple systems and of multiple vocal-tract muscles. The uniquely-human ability to speak indicates that some mechanisms underlying speech production have diverged from those of our prelinguistic ancestors. However, the basic capacity to vocally produce sounds is shared with a surprisingly diverse group of species. In fact, the oromotor structures in charge of articulating speech are not only responsible of the production of speech targets but they also generate other sounded orofacial movements, such as lip smacking or tongue clicks. Although the brain dynamics underlying the production of speech and non-speech gestures in adults are shown to differ (Lancheros, Jouen and Laganaro, 2020) the issue is then when in ontogeny the production of speech differs from that of non-speech. In the present study we explore this question, with the hypothesis of a specialized motor control system for speech arising only after some years of full practice of speech. Since the production of speech starts early after birth and its motor entrainment extends over more than a decade (Ackermann, Hage & Ziegler, 2014), it is likely that a gradual specialization for speech emerges during childhood as a consequence of its progressively extensive production. However, given that the phonetic inventory is not achieved before the age of seven, a distinct specialized speech neural architecture might be established only some years ahead (i.e. >10 y.o.).

In the present study participants included fifteen French-native 7-to-9-year-old children. They were asked to produce 20 sounded non-speech gestures, 20 high frequency syllables and 20 low frequency syllables, paired on type and mode of articulation of the gesture onset. Stimuli were presented throughout video clips in a task targeting motor encoding processes: a delayed production task combined with an articulatory suppression task. Their brain activity was in parallel recorded with electroencephalography (EEG) and event-related potential (ERP) analyses based on microstates were performed on the time window preceding the vocal onset.

Behavioral results showed that children were less precise when producing low frequency syllables as compared to non-speech. Concerning production latencies, non-speech productions were initialized slower than both types of speech stimuli. The ERP data aligned to the vocal onset showed activation of the same topographical maps preceding the production of speech and of non-speech sequences, indicating the recruitment of the same neural networks for non-speech and speech. Additionally, the temporal distribution of the same recruited brain circuits did not differ between the two oromotor behaviors, suggesting similar activation dynamics for speech and non-speech.

Considering that adults do show different brain activation patterns for speech and non-speech (Lancheros et al. 2020) with the exact same experimental setting, results of the present study seem to support the hypothesis that a specialized neural circuit for speech is not established yet in children aged 7-9 years. Since a distinct neural representation for speech has been proposed to arise from its extensive motor learning, it might be the case that children at those ages have not practiced enough this oromotor behavior and thus, speech is not yet a well-established overlearned motor activity with its specialized brain circuits. Unquestionably, speech does not only depend on the amount of rehearsal it is subjected but it also relies on cognitive, linguistic and motor developments occurring during childhood, which might also explain why a specialized neural circuity for speech is not yet mature, or at least it is not neurally evident, in 7-to-9-year-olds.

References

Ackermann, H., Hage, S. R., & Ziegler, W. (2014). Brain mechanisms of acoustic communication in humans and nonhuman primates: An evolutionary perspective. *Behavioral and Brain Sciences*, *37*(6), 529-546.

Lancheros, M., Jouen, A., & Laganaro, M. (2020). Neural dynamics of speech and non-speech motor planning. *Brain and language*, *203*, 104742.