

Effects of cortical thickness on pause duration in neurotypical adults' speech: Evidence for the role of the left middle temporal gyrus in lexical retrieval

Georgia Angelopoulou¹, Dimitrios Kasselimis^{1,2}, Maria Varkanitsa^{3,4}, Panagiotis Fotiadis³, Charalambos Themistocleous⁵, Dimitrios Tsolakopoulos¹, Christally Grillou¹, Foteini Christidi¹, Efstratios Karavasilis⁶, George Argiropoulos⁶, George Velonakis⁶, Sofia Karanassou⁷, Zoi Nikitopoulou⁷, Petros Roussos⁸, Dionysios Goutsos⁸, Nikolaos Kelekis⁶, Ioannis Evdokimidis¹, Constantin Potagas¹

¹Eginition University Hospital - National and Kapodistrian University of Athens

²University of Crete

³Massachusetts General Hospital - Harvard Medical School

⁴University College London

⁵University of Gothenburg

⁶Attikon University Hospital - National and Kapodistrian University, Athens, Greece

⁷Panteion University of Athens

⁸National and Kapodistrian University of Athens

The relationships between individual differences in speech production and individual variability in measures of cortical structure in healthy individuals have received relatively little attention. This study aims to reveal the neural correlates of pauses, by investigating possible associations between cortical thickness of specific brain regions and pause duration, a measure thought to reflect speech planning and word retrieval.

Twenty five right-handed Greek speaking neurotypical adults (9 males) with a mean age of 49 years (SD=9.54) and a mean education level of 14.44 years (SD=3.38) participated in the study. Speech samples were derived from participants' narrations about an experience of an illness. All pauses were automatically segmented using a customized Praat script, followed by manual correction. Cortical surfaces from the T1 MR images were reconstructed using the automated pipeline of FreeSurfer 5.3.0 (<http://www.surfer.nmr.mgh.harvard.edu/>) and cortical thickness was calculated for each participant for specific left-lateralized regions of interest (ROIs).

To investigate the relationship between pause duration and cortical thickness we used linear mixed effects models in R. Pause duration was included in the model as the dependent variable, cortical thickness in a set of left hemisphere ROIs and demographics (age, education level, sex) as fixed factors, and subjects as a random

factor. ROIs were selected on the basis of previous literature, indicating brain areas related to language functions. Data were transformed to facilitate the analysis. The best model was selected using model comparison. Cortical thickness in the Middle Temporal Gyrus (MTG) was found to have a negative effect on pause duration (intercept: 28.84, estimate coefficient: -2.27, p -value: 0.00310).

Our results show a strong negative relationship between the MTG cortical thickness and pause duration, therefore indicating that an increase of the thickness of the middle temporal cortex would result in reduced mean pause length during speech. The contemporary view of the neurobiological substrate of language points to two different streams: a dorsal stream, involved in articulation-to-sound mapping, and a ventral stream, involved in meaning-to-sound mapping. The latter stream includes the MTG. Moreover, it has been argued that selective retrieval may be facilitated by a network supported by pars triangularis interconnected with temporal cortices, including the MTG, with the extreme capsule fasciculus. In line with these findings, our data suggest that the MTG may play a crucial role in lexical retrieval, as revealed by its effect on pause duration, which, in turn, serves as an index of access to lexical representations and the ability to construct hierarchically organized, meaningful clusters of words.