

Is Human Insular Cortex Involved in Preparing to Produce Speech

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Introduction

Insular cortex is a common activation in fMRI studies of speech and language and through lesion studies has been linked to several speech and orofacial motor control disorders including apraxia of speech (AOS). Lesions with a greater overlap of the insula are linked to greater number of AOS speech errors suggesting insula is involved in pre-articulatory planning. However, recent studies have challenged this, suggesting the inferior frontal gyrus is the true region responsible for this phenomenon. Here we investigate the role of the human insula in producing speech.

Methods

Broadband gamma activity (70-150Hz) was measured from stereotactically placed depth electrodes in patients receiving seizure mapping for pharmaco-resistant epilepsy (n=22). Patients underwent two speech production tasks, repeating words or naming common objects from pictures. From this we analysed insula activity during speech production and compared activity during production of simple and complex, multisyllabic words. This was compared to activity during non-speech mouth movements and listening to external speech.

Results

We find that during speech production, posterior insula, particularly the anterior long gyrus, shows no pre-articulatory activity and instead activates at a similar timescale to superior temporal gyrus. The posterior insula was also responsive to external auditory stimuli. In the anterior insula we find limited pre-articulatory activity, presenting on a similar timescale to that of the jaw muscle activation. Neither region showed a sensitivity to the complexity of the speech articulation.

Learning Objectives

By the conclusion of this session, participants should be able to:

- 1) Describe the role of insular cortex in speech production
- 2) Identify the links between healthy insula function and symptoms of its dysfunction
- 3) Understand the process of using stereo electroencephalography to map cortical functionality

Conclusions

Our results suggest that posterior insula acts as an auditory-sensorimotor integration region while anterior insula does not have a direct effect on speech production. These results are important for the understanding of the neural pathways of speech production as this suggests the insula is not a pre-articulatory preparatory region but instead a feedback integration region which in turn has implications for the understanding of the pathophysiology of related speech disorders such as AOS.