Introduction

Background:
Aphasia is an acquired speech-language disorder commonly resulting from post-stroke damage to the left hemisphere. Depending on factors such as the size, location, and type of the stroke, individuals with aphasia exhibit a wide range of behavioral variability including, but not limited to, impairments in speech fluency, auditory comprehension, word-finding, and speech repetition that impact everyday communication ability.

Evidence from several studies has suggested the notion that certain aspects of behavioral impairment in aphasia may be accounted for by damage to the sensorimotor network that supports auditory feedback processing during speech.

Objectives:
The present study was a systematic investigation toward understanding the impairment of sensorimotor integration mechanisms that underlie speech auditory feedback processing in patients with post-stroke aphasia. Our goal was to investigate behavioral, neurophysiological, and lesion correlates of impaired sensorimotor integration of speech in aphasia.

1. How speech auditory feedback processing is impaired in aphasia?
2. What are the lesion predictors of impaired speech sensorimotor integration in aphasia?
3. How neurophysiological measures represent speech impairment?

Speech sensorimotor integration:
The principles of integrative models of speech are centered around the idea of an internal forward model that estimates the dynamical states of speech articulators based on learned and internally maintained ascriptions to motor commands and their actual sensory (e.g., auditory) feedback.

According to these models, speech control is not directly mediated by incoming sensory feedback, but rather via internal representations of predicted sensory consequences of motor commands even before sensory feedback has become available.

During overt production, sensory feedback can be used to correct for speech feedback errors and update the internal forward model.

Experimental task:
Sixteen patients with post-stroke aphasia (6 Broca’s, 5 anomic, 5 condu- tion) and 16 neurologically intact control individuals completed a speech vowel production task under altered auditory feedback (AAF) condition. During vowel production, a randomized (up or down) pitch-shift stimulus perturbed speech auditory feedback at 100 cents (Fig. 2).

Speech compensation:
For each aphasic patient, speech compensation responses to AAF were calculated based on the log-transformed ratio of speech compensation magnitude normalized to the mean of the control group response for both upward and downward pitch shift stimulus.

Speech Compensation Ratio = 10 × log₁₀(X补偿/平均)

Lesion maps:
Neuroimaging data in stroke survivors were used to determine lesion predictors of impaired sensorimotor function associated with diminished compensatory responses to errors in speech auditory feedback (Fig. 3).

Results

Behavioral responses:
Results of the analysis revealed a significant main effect of group (F(1,30) = 16.02, p < 0.001), indicating that the magnitude of speech compensation responses to AAF was diminished in aphasia vs. control (Fig. 4).

ERP Responses:
The temporal-specific pattern of diminished compensatory speech errors in auditory feedback in aphasia is influenced by damage to distinct neural networks within sensory, motor, and sensorimotor integration networks.

Discussion

Our approach combined behavioral, neurophysiological, and lesion correlates to characterize impaired sensorimotor integration of speech in post-stroke aphasia.

We argue that the results support the following notions:

1. The measure of compensation responses to altered auditory feedback (AAF) provides an objective biomarker to probe the integrity of speech sensorimotor mechanism and identify its impairment in patients with post-stroke aphasia.
2. The temporal-specific pattern of diminished compensatory speech errors in auditory feedback in aphasia is influenced by damage to distinct neural networks within sensory, motor, and sensorimotor integration networks.
3. These findings emphasize the role of cortical auditory areas in speech monitoring and sensory detection of feedback error in the early phase of speech motor control. We argue that the IFG and SMG subserve functions associated with motor predictions and sensorimotor integration for detection and correction of speech errors in auditory feedback.

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References