Introduction

Speech and music share several properties, including rhythmic and tonal features (DeCleire & Ladd, 2007). Some studies have found speech and music processing to have several shared neural properties during processing through the recruitment of similar brain networks (Patek, 2007; Fediga et al., 2009).

• Associations: Patients with aphasia often show symptoms of amusia (Palea et al., 2004; Pinet et al., 1997)
• Disassociations: Patients can have aphasia, but not amusia (and vice versa); patients with major speech production deficits may be able to sing during Melodic Intonation Therapy (MIT), even when they cannot speak (Wilson, Parsons, & Reutens, 2006; Jentzsch et al., 2014)

In control subjects, functional MRI identifies overlapping, but distinct, networks associated with speech and music perception. More specifically, speech engages a lateral temporal-parietal network extending into the anterior temporal lobe, while music engages a dorsal-medial temporal and inferior parietal bilateral network.

Current Study

While the organization of speech and music in the brain has been studied in control Paradigm Overview

We sought to investigate how speech and music processing vary based on the areas of damage and the extent of language recovery post-stroke. While the organization of speech and music in the brain has been studied in control subjects, functional MRI identifies overlapping, but distinct, networks associated with speech and music perception. More specifically, speech engages a lateral temporal-parietal network extending into the anterior temporal lobe, while music engages a dorsal-medial temporal and inferior parietal bilateral network.

Predictions regarding patients with damage in language networks

• If a patient shows greater recruitment of muscular processing networks for speech, then the patient will have more speech-activated deficits.
• If the patient is able to recruit these musical networks for speech, then it will in part be determined by the extent and location of the patient’s chronic lesion.

Participants

Six chronic stroke patients recruited via the Multidisciplinary Research Consortium (MARC):
• Stroke must have occurred at least 6 months before scan
• Right-handed, native English speaker
• Focal cerebral damage (five left hemisphere damage, one bilateral patient)
• Large left hemisphere lesion

Procedure

• Data collected with a 3T Philips Ingenia research-dedicated MRI at Barrow Neurological Institute’s Keller Center for Imaging Innovation
• Functional MRI: 20 randomized blocks of speech and music separated by a 12 second interval of rest
• High resolution structural MRI
• Standard Processing Techniques were used with AFNI software
• Data preprocessing and filtering
• Slice timing & motion correction
• Spatial smoothing
• High resolution structural MNI
• Multiple regression analysis in each voxel to identify regions whose BOLD response is modulated by speech and music presentation
• Extensive MARC Cognitive and Psycholinguistic Test Battery

Behavioral Results

Syllable perception and sentence comprehension tasks: all patients perform similarly on simple tasks

Comparison of Left Frontal Lesion Patients

• Almost identical lesions
• Very different patterns of activation, both displaying overlapping, but distinct, activations for speech and music
• Both perform more poorly on working memory tasks

Executive Function Tasks

Executive Function Tasks – left frontal damage patients: On tasks requiring integration, both patients perform below ceiling, the patient with a frontal shift in activation has lower performance

Error types on the AV fusion trials: The patient with a frontal shift in activation more often than not does not integrate and instead focuses on the visual information (ta) in the integration trials.

Discussion

• Five of the six stroke patients replicated the activations for speech and music previously seen in control subjects
• However, one subject did have a frontal shift and greater separation of speech and music activations
• Structural similarities do not always result in equal functional activity
• Replicating previous work, lesion location does not predict behavioral performance, particularly on higher-level tasks
• Performance post-stroke is likely associated with functional reorganization, not just decreased activation in response to speech
• Replicating previous work, the two patients with almost identical lesions, but differing activations, perform equally on simple tasks, which may indicate the frontal shift in activation is beneficial for the subject; however, their performance diverges on more difficult tasks, which would indicate the frontal shift in activation is not sufficient

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