UNIVERSITY OF CALIFORNIA

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Neuroimaging Studies of the Role of Speech Motor Areas in Speech Perception

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Neuroscience

by

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The dissertation of Stephen Murray Wilson is approved.

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ABSTRACT OF THE DISSERTATION

Neuroimaging Studies of the Role of

Speech Motor Areas in Speech Perception

by

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The role of superior temporal cortex in speech perception is well established, but there is also much evidence suggestive of an ancillary role for frontal speech motor areas in the perceptual process. In this dissertation, three functional magnetic resonance imaging (fMRI) studies are presented which support a role for speech motor areas in speech perception. In the first study, subjects listened passively to monosyllables, and produced the same speech sounds. Listening to speech activated bilaterally a premotor cortical region largely overlapping a speech production motor area centered just posteriorly. These findings support the view that the motor system is recruited in mapping the

acoustic signal to a phonetic code. The next study examined neural responses to unfamiliar non-native phonemes varying in the extent to which they can be articulated. Both superior temporal (auditory) and precentral (motor) areas were activated by passive speech perception, and both distinguished non-native from native phonemes. Furthermore, speech-responsive motor regions and superior temporal sites were functionally connected. However, only in auditory areas did activity covary with the producibility of non-native phonemes. These data suggest that auditory areas are crucial for the transformation from acoustic signal to phonetic code, but the motor system also plays an active role, perhaps in generating candidate phonemic categorizations. In the final study, subjects were presented with auditory and audiovisual narratives, and model-free intersubject correlational analyses were employed to reveal areas that were modulated in a consistent way across subjects during narrative comprehension. The intersubject correlational analyses revealed an extended network of areas not typically reported in previous studies of narrative speech comprehension, including extensive bilateral inferior frontal and premotor regions. These results support a role for frontal areas in speech perception and higher level linguistic processes. In sum, at least two ventral premotor regions appear to be important for speech perception: one located in Brodmann Area 6 which is argued to be involved in attention to phonetic form, and a region in dorsal Brodmann Area 44 which may code articulatory representations. Motor areas may be especially important for speech perception under perceptually challenging conditions such as comprehending speech in background noise.