Aspects of respiratory motor control for speech and their development

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The behavioral goals of the respiratory system during speech are different from those of rest breathing, resulting in behavior-specific patterns of movement and muscle activity. These behavioral differences extend to infants and toddlers whose respiratory movement patterns during vocalizations and early speech utterances are distinct from those observed during rest breathing. In this talk, I will present data from two studies investigating respiratory control for speech and its relation to rest breathing.

The first study was designed to examine the role of sensorimotor pathways mediating metabolic respiration during speech production. One lingering question concerning the control of respiratory movements for speech relates to the interaction between putative “voluntary” respiratory centers in the forebrain and primary motor cortex and “automatic” respiratory centers and reflex pathways in the brainstem. This investigation was undertaken to evaluate the hypothesis that respiratory motor control for speech exploits low-level sensorimotor mechanisms mediating metabolic respiration.

The second study was designed to investigate the development of respiratory control for speech. Investigations of abdomen and rib cage movements during early vocalizations have shown that these structures move in ways that are quite distinct from their movements during rest breathing. Specifically, abdomen and rib cage movements exhibit weaker coupling, and a higher incidence of paradoxing (oppositional movements of the rib cage and abdomen) during early vocal productions when compared to rest breathing. A major challenge in understanding how these findings relate to the infant’s emerging motor control of the respiratory system for speech lies in accounting for other factors that have the potential to influence respiratory kinematics in this population. In particular, the biomechanical characteristics of the infant chest wall are quite distinct from those of the adult and undergo rapid changes in the first year of life. A better understanding of the effects of chest wall biomechanics on respiratory behaviors in infants and toddlers will provide insight into the developmental characteristics of respiratory motor control for speech. The present study quantified changes in the movements of the abdomen and rib cage during a period of rapid respiratory development (7 and 11 months of age) to provide a more accurate characterization of biomechanical and motor control influences on early speech respiratory movements. In addition, dependencies between respiratory movements and vocal fundamental frequency were measured to examine whether changes in respiratory function during this time period affect vocal fundamental frequency contours.