Coordination of swallow and breathing: in vivo and computational model simulations

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Coordination of swallow and breathing is vital to maintain protection of the airway. However, the central mechanisms which allow for the coordination of these behaviors are not known. We speculated that coupled oscillators could be used to explain swallow-breathing interactions. In vivo recordings in anesthetized cats (n=6) demonstrate that swallow exhibits respiratory phase preference with 83% during expiration (E), 7% during inspiration (I), 7% during E-I phase transition and 3% during I-E transition. A detailed synaptic model of the medullary network for breathing has been developed and a swallow oscillator (consisting of two populations of neurons, A and B) was added. In the computational model the swallow A population excites downstream motoneurons and the swallow B population controls the inter-swallow duration. To loosely couple the oscillators the following excitatory connections were added: 1) I populations to swallow B, controlling swallow occurrence during E; 2) E-augmenting population to swallow B, increasing the likelihood that swallow would be produced at the end of E. Additionally, to reduce ongoing expiratory activity during swallow, an inhibitory connection was added between the swallow A population and an E decrementing population. The simulation exhibited repetitive breathing, and swallow occurred during the appropriate phase of the breathing cycle. We conclude that significant features of the swallow-breathing relationship can be modeled with loosely coupled oscillators.