Motivation: The preBötzinger complex (preBötc) of the mammalian brainstem is a heterogeneous, sparsely connected, neuronal network that drives the respiratory phase of the respiratory rhythm. Resonant neural networks in the preBötc are endowed with the CAN and NaP currents, and the strengths of these currents determine the dynamics of small model networks. The connectivity architecture also has a profound effect on larger networks. How do these features combine to create the robust, synchronous bursting patterns that are observed in vitro?

The unified model: We used the unified model (10) to represent the combined effects of the CAN and NaP currents. We found clustered, heterogeneous networks (37/52/57.5% intrinsically quiescent neurons) with architectures described in the literature (9). We found that among randomly generated networks of 50 model neurons, few exhibit synchronous bursting. To elucidate the important mechanisms that give rise to synchronous bursting, we developed a genetic algorithm. By repeatedly combining the best bursting networks, we can draw out their essential features.

The results (continued): Almost all networks continue to burst when intrinsically quiescent neurons are replaced with intrinsically tonic neurons. The same network as the example from the 11th generation shown in the center column, except all intrinsically quiescent neurons are replaced with intrinsically quiescent neurons. Notice that the synchronous bursting pattern is preserved.

Without initial bias, intrinsically quiescent neurons emerge as the most common type.