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BLOCKING GAP JUNCTIONS IN THE ELECTRIC FISH PACEMAKER NUCLEUS ALTERS THE FREQUENCY AND SYNCHRONY OF OSCILLATIONS.

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The medullary pacemaker nucleus (Pn), which commands the electric organ discharge of a wave-type gymnotiform electric fish, is the most regular biological oscillator known. We have investigated the relative importance of its network and cellular mechanisms in setting its temporal regularity. The ca. 150 Pn neurons, which fire synchronously and command the EOD on a cycle-by-cycle basis, are thought to be coupled only electrotonically, with no chemical synapses intrinsic to the Pn. To investigate the mechanism of the electromotor oscillations and their extreme regularity, we blocked gap junctions in an *in vitro* preparation of the Pn. Normally, the neurons of the Pn are both frequency and phase-locked, and fire every cycle of the constant-frequency oscillation though with phase differences of up to ca. 250 μs as measured with dual intracellular recordings. After application of halothane (2 – 5%), a gap junction blocker, the frequency of intracellular and local field potential oscillations decreased steadily to ca. 50% of their original. At the same time, the cells remained synchronized, possibly due to incomplete block. However, the relative phase between cell pairs or between a cell and a field potential shifted, even to the point of changing sign. Further halothane application silenced the Pn neurons' spikes. Both the long and short term effects are reversible. Thus we find that regularity and frequency locking to some degree survive partial block and cannot be entirely dependent on network integrity. We further compare the effects of halothane to those of other gap junction blockers. Support: NIHM fellowship to KTM; and HHMI to TJS.