Unravelling new functions of electrical synapses in fast flapping flyers

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Insect asynchronous flight is one of the most prevalent forms of animal locomotion employed by >600.000 species, but the architecture and function of the central-pattern-generating (CPG) neural network remain elusive. Based on an experiment-theory approach including electro- and optophysiology, *Drosophila* genetics, and mathematical modelling, we uncover a miniaturized circuit solution with unexpected properties. The CPG network consists of motoneurons interconnected by electrical synapses that, contrary to doctrine, produce network activity splayed-out in time instead of synchronized across neurons. Experimental and mathematical evidence support a conceptually novel, generic mechanism for network desynchronization that relies on weak electrical synapses and specific excitability dynamics of the coupled neurons. In the asynchronous flight CPG this mechanism translates unpatterned premotor input into stereotyped neuronal firing with fixed sequences of motoneuron activation that ensure stable wingbeat power and, as we show, is conserved across multiple species. Our findings resolve the network architecture of the CPG for asynchronous flight and prove a wider functional versatility of electrical synapses in the dynamic control of neural circuits in all brains.