The interaction of positive and negative sensory feedback loops in dynamic regulation of a motor pattern.
Ausborn J, Wolf H, Stein W

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Proprioceptors often provide seemingly conflicting positive and negative feedback to motor pattern-generating networks and motor neurons. This modeling study sorts out these conflicting effects on control wing-beat frequency for the locust flight system.

The tegula proprioceptor is activated by the downstroke of the wing and provides negative feedback during locust flight {1-4}. It resets the flight CPG and provides excitation of elevator and inhibition of depressor motor neurons {3}. Removal of the tegulae causes a dramatic decrease in wing-beat frequency {1,4}, thus posing the question of how negative feedback can increase CPG cycle frequency. Previous work by the same authors, using a hybrid system experimental approach, showed that, whereas implementing artificial proprioceptive feedback in a tethered 'flying' locust increased wing-beat frequency {1,4}, the positive feedback loop through interneuron 301 {6}. Modeling experiments show convincingly that this positive feedback is necessary and sufficient for the frequency-increasing effect of feedback, whereas the negative feedback pathways always cause a frequency decrease that is enhanced as feedback strength increases. The authors posit that such frequency regulation may be a hitherto unnoticed general consequence of the balance between positive and negative feedback on rhythmic CPGs. It will certainly be worthwhile to look for such regulation in a variety of experimental preparations.


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