

# Central generator oscillating between two steady states underlies rhythmic arm movements

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**Primary Theme and Topics**      Sensory and Motor Systems  
- Pattern Generation and Locomotion  
-- Pattern generation: Other

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- Kinematics and EMG  
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Rhythmical arm movements may be produced in a pendulum-like manner by central destabilization of the system at one equilibrium position. Alternatively, a central generator may provide transitions between several equilibrium positions without reducing stability of each. We tested these hypotheses by asking standing subjects to swing at ~ 0.8 Hz one arm or both arms synchronously or reciprocally from the shoulder joints. In randomly selected cycles, one arm was transiently arrested by an electromagnetic device. Oscillations quickly resumed but with a random shift in the phase. During bi-manual movements, the non-perturbed arm often stopped moving before resuming swinging at a position that was close to either the extreme forward or backward position observed during regular oscillations. Oscillations usually resumed when both arms arrived at similar extreme positions if a synchronous bilateral pattern was produced or at the opposite positions if the pattern was reciprocal. Results suggest that the central generator provides transitions between two equilibrium arm positions without destabilizing any of them. In this framework, the frequency and spatial boundaries of arm oscillations may be controlled by changing the rate of the transitions and by adjusting the equilibrium positions, respectively. These positions appear to be natural points at which the system may modify its behavior: to halt the oscillations, resume them at a new phase (as observed in the present study), or initiate a new motor

action. Our findings are relevant to locomotion and suggest that walking may also be generated by transitions between several equilibrium states of the body.

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