MUSCLE FUEL SELECTION IN GOVERNING PREFERRED RATES OF MOVEMENT: A MOTOR CONTROL ISSUE

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The time-honored concept regarding the coincidence between minimization of energy cost (e.g., O2 cost of transport) and preferred rates of walking is not generalizable to all forms of locomotion. The difference between the minimum aerobic demand at the preferred rates of movement and the aerobic demand at higher/lower rates may be as low as 10%. Can such a limited decrease in aerobic demand describe such a global influence on motor control? Is O2 enough to describe energy consumption, given that both O2 AND fuel consumption pathways are necessary components for aerobic metabolism?

In able-bodied humans, we observed O2 cost of transport and fuel consumption during treadmill and overground walking at various rates and walking conditions.

Under normal locomotion conditions, while O2 cost at 2 (53.6 m/min) and 4 (107.3 m/min) mph was always < 10 % higher than the nadir of O2 cost of transport at the preferred speed at 3 mph (80.5 m/min), the carbohydrate (CBO) oxidation rates were > 10 fold over this range of speeds. Minimizing effort correlated with minimizing CBO oxidation (i.e., to the level of gluconeogenesis) under all conditions. The inflection point of the exponential curve between CBO oxidation and speed was always at the level of preferred speed.

At higher rates of walking (>3 mph), when increasing sense of effort correlated robustly with increasing CBO oxidation and poorly with fat oxidation, CBO-induced fall in cellular energy in skeletal muscle may provide important inputs into the CNS during walking.

These signals ensure that the CNS selects a walking speed with minimal CBO demand, thus maximizing metabolic range of motor activity and sparing CBO fuel for emergency burst activity. Thus humans self-select (“prefer”) a walking speed that can supported almost exclusively by fat combustion. Apparently, the motor control system attempts to control CBO oxidation to gain economical advantage.

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