Using Biomechanics to Dissect the Energetic Cost of Running

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Several task consume metabolic energy during running. The leg muscles must generate force to prevent the leg from buckling as they oppose gravity and inertia. Those forces are also needed to allow tendons to act as springs that store and return energy elastically. The muscles must also generate forward propulsion. Finally, the legs must be alternately swung forward to take the next step. How much energy goes into each task? To answer that question, we perturb normal treadmill running by performing each of those tasks with simple external devices. We infer that the reduction in metabolic cost in response to these perturbations indicates the cost of normally performing the task with muscles. We find in general that vertical weight support and forward propulsion are intrinsically coupled and that each comprise a similar fraction of the overall cost of running (~40% each). Leg swing is relatively cheap (~10% of the total). Some of our devices are proving to have useful applications to helping patients with locomotion rehabilitation.