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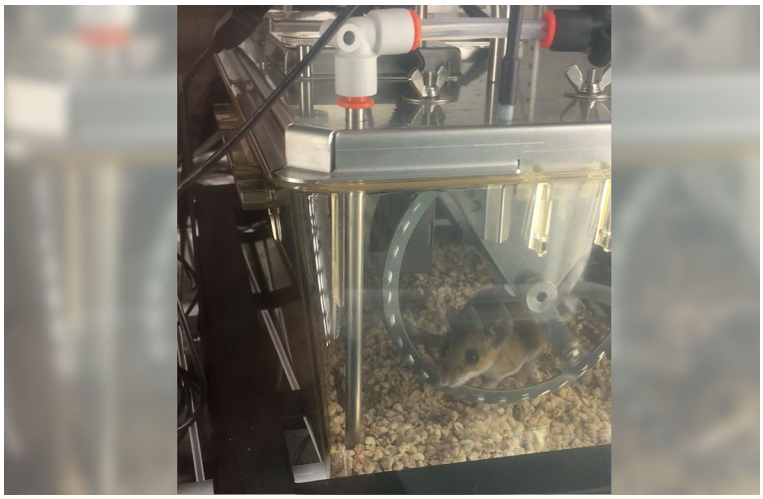
INSIDE JEB

# Some mice are better than others at recycling warmth to conserve energy



A white-footed mouse (*Peromyscus leucopus*) on a running wheel inside a cage that measured the rodent's oxygen consumption. Photo credit: Caroline Maloney.

Generating your own internal warmth to keep going regardless of the conditions is all well and good when it's temperate and balmy, but as soon as the mercury begins to fall, your energetic costs can become exorbitant as you struggle to keep the furnace fuelled. 'Many endotherms [warm-blooded animals] spend a considerable amount of energy on simply keeping warm', says Vincent Careau from the University of Ottawa, Canada. However, some warm-blooded animals may be able to capitalise on heat generated by tissues as a side-effect of activity to supplement body warmth when chilly. 'Substitution cannot reduce the energy used to thermoregulate, but can use that energy efficiently if the activity that generates heat can be potentially invested in physiological processes', Careau explains. Effectively, animals can get two bangs for their metabolic buck. However, populations are made up of unique individuals, some of which may be more talented at specific tasks than others, which made Careau and Caroline Maloney (University of Ottawa), wonder whether some individuals are better placed to benefit from supplementary warming than others and, if so, which tissues and organs may give them a warm head start.

The duo investigated how much individual white-footed mice (*Peromyscus leucopus*), widespread from Mexico to chilly Canada, might profit from the warmth generated by their muscles as they scampered on a wheel. Selecting 48 rodents, the researchers isolated each mouse in individual cages where they could run and rest to their heart's content for 4 days, 2 of which they spent at a comfortable 22°C, while the remaining 2 days were at a cool 10°C. In addition, the pair recorded the animals' oxygen consumption, to keep track of their metabolic rates, to find out how much each one utilised the warmth generated by their exertions, repeating the entire procedure another 2 times, to determine out how hardwired their ability was to supplement their warmth with exertion.

Calculating how much each rodent was able to take advantage of the warmth generated by their muscles, Maloney and Careau confirmed that some individuals benefited more from the heat produced by their muscles than others, conserving energy which they could then reinvest in other aspects of life. But how are some white-footed mice able to take more advantage of the warmth generated by their exertions than others?

The duo took a close look at the animals' vital organs, as well as their calf muscles – which power running – and their insulating fur mass and skin area, to find out whether they might influence an individual's ability to retain supplementary warmth. Although, the skin and insulation barely had an impact, the animals with a smaller surface area seemed better at retaining their muscle warmth. However, the longest mice conserved more of their muscle heat than shorter animals, probably because they have larger heads – which lose less heat to their surroundings – to retain more of their muscle warmth. Having a larger heart also seemed to allow the mice to conserve more heat, likely because larger hearts cope better with the higher blood pressure that chilly animals experience when they close off blood vessels close to the skin and direct blood to the core to retain heat.

So, some white-footed mice are better than others at making the most from the warmth generated by their muscles as they exercise to supplement their body temperature, and Maloney and Careau are curious to find out how much of an advantage recycling body warmth may give the lucky beasts that benefit most.

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**Maloney C. M. and Careau V.** (2022). Individual variation in heat substitution: is activity in the cold energetically cheaper for some individuals than others? *J. Exp. Biol.* **225**, jeb244186. doi:10.1242/jeb.244186.

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