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The role of body fat, seasonality and lifestyle in brain size evolution

Species living in seasonal habitats experience frequent periods of food scarcity which impose energetic constraints that affect many physiological and behavioural characteristics of organisms. We propose two complementary strategies on how animals cope with periods of food scarcity: species buffer lean periods either by storing fat or by cognitive flexibility to find hidden food sources. As brains are energetically very expensive, but also body fat is costly due to locomotor constraints, we predict a trade-off, expressed in a negative correlation between the ability to store fat and brain size. Here, we report a broad phylogenetic comparative study using seasonal variation of body mass in a sample of 71 mammalian species, including 21 primates. Controlling for phylogeny and average body mass or total body length, we found a negative correlation between relative brain size and seasonal body mass variation over all lineages, which was particularly strong in female primates. Furthermore, hibernators have smaller brains and a higher amount of adipose depots than non-hibernators. Further, we explored the influence of lifestyle to identify the costs of locomotion and predation risk on the brain-fat trade-off. Our results support the notion that seasonality plays a role in brain size evolution and contribute to the understanding of how humans could evolve unusually large brains and at the same time have a larger amount of adipose depots than expected for a primate of our body size.