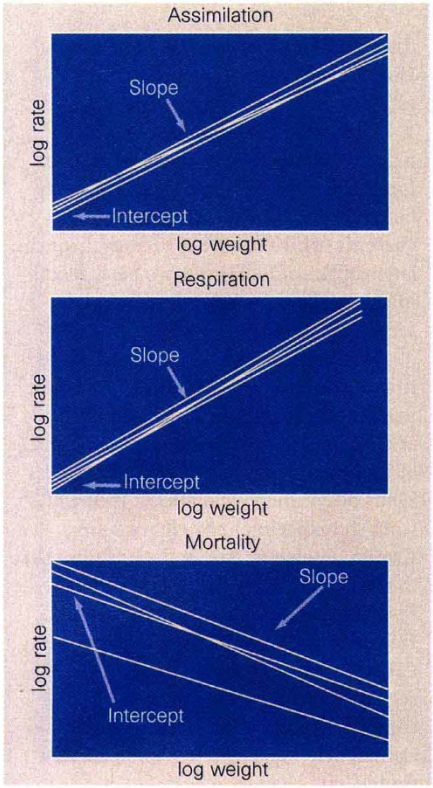


Figure 2 **The basis of Kozlowski and Weiner's model[2] of life-history evolution for animals that stop growing when they reach reproductive maturity. Within a species, the rates of energy assimilation, respiration and mortality scale with body weight. On the graphs, each line represents a different species. Across species, the slopes and intercepts of the scaling relationships vary because of ecological differences, and are normally distributed within each part of the figure. The consequence is that different species may have different optimal body sizes.**

Although the fast–slow continuum is robust to the precise choice of values assigned to ecological parameters, the means and especially the variances critically affect the interspecies scaling. Unfortunately, because we do not know what values are appropriate, quantitative tests are not yet feasible. The model's view of how mammals grow nonetheless permits one qualitative test. Whereas Charnov assumed that the scaling of growth rate on body size would be the same within species as among them, Kozlowski and Weiner expect within-species scalings to be less steep. We analysed published growth equations[10] between weaning and maturity in 31 species for which life-history timings[5] are available (Fig. 3). In every case, the within-species scaling is less positive than the among-species relationship, just as Kozlowski and Weiner (but not Charnov) predict.

The new model has important implications. The values of cross-taxonomic scaling coefficients and exponents that relate history variation to body size have attracted considerable interest (see ref. 11). But, if Kozlowski and Weiner are right, such values are all but

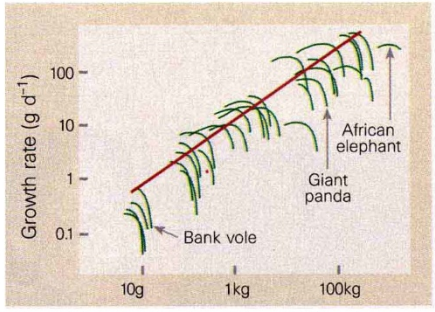


Figure 3 **A test of Kozlowski and Weiner's model[2]. Red line: interspecies scaling of maximum growth rate versus adult weight (slope estimated from independent comparisons[11]). Green lines: for each species, how growth rate scales with mass after weaning (the right-hand continuation of lines to the body-size axis, when growth rate slows as maturity is approached, is not shown). Note that the interspecies line is more positive than any part of any within-species line.**

meaningless for life history at least. Little wonder, then, that the generation of functional hypotheses from scaling relationships has not proved fruitful. Second, the peak in the body-size distribution is not an optimum for all mammals; rather, each species' optimum depends upon its combination of ecological parameters, and not all combinations are equally likely. Finally, the model casts light on why it has proved so hard to correlate life-history differences with ecology: related species with differing ecologies are expected to be different sizes, and life-history variation correlated with size differences is commonly factored out in comparative studies. By viewing interspecies scalings of life-history variables on body weight as epiphenomena and ecological differences as ultimate causes, Kozlowski and Weiner's model focuses attention on another key issue currently enjoying a renaissance — the evolution of body size itself[12]. □

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**Daedalus**

## It's all in the mind

**Compulsory games in British schools are declining. A public discussion of the matter a few years ago showed a curious distribution. Some adults recalled football and other sports as the high point of their school lives; others remembered them with loathing and rage. In this connection, Daedalus notes the claim that vigorous exercise releases endorphins into the body, stimulating the pleasure receptors. Clearly, he says, this only happens to some people. They are the extroverts who enjoy physical exertion. The introverts who detest it gain no pleasurable sensation from exercise at all; for them it is just draining.**

**So, says Daedalus, British education could be greatly improved by giving each pupil a simple exercise test, while taking a blood sample for endorphin analysis. The scholars could thus be neatly divided from the sporting types, and treated accordingly. But why does this division exist at all? Daedalus sees evolution at work. Our primitive ancestors often had physical exertion forced upon them: as in tribal warfare, or hunting or running away from mammoths and other dangerous creatures. Evolution wisely encouraged them with the endorphin mechanism. But as human intelligence advanced, some hominids began to succeed by cunning rather than violence. They lost the endorphic reward for muscle metabolism. Indeed, muses Daedalus, they may even have begun to be rewarded by brain metabolism instead.**

**So DREADCO psychologists are looking for the hitherto unremarked phenomenon of 'thinker's high'. They are seeking out compulsive intellectuals of the type of Stanislaw Ulam, whose daughter complained "All my father does is think, think, think! Nothing but think!". They are challenging them with fearsomely difficult problems and paradoxes, sampling their blood for analysis. The ultimate result could be a new form of careers advice, identifying the nation's natural thinkers for suitable education and employment.**

**Most people, however, are less extreme. They gain some reward from both mental and physical exertion. The balance between them may even be adjustable. Ritaline, the amphetamine used to control hyperactivity in children, may work by boosting mental rewards while damping physical ones. Food dyes and additives, such as tartrazine, have been blamed for causing hyperactivity in the first place. They may bias endorphin release the other way. They could be useful for snapping absent-minded professors back into the real world.**

**David Jones**