on bats also indicate a positive correlation between residual neocortex and cerebellum size (n = 158 species, r^2 = 0.45, P < 0.0001). Hence different analyses in several taxa all point to a relationship between relative neocortex and cerebellum size. A problem with using volume proportions is that these correlate with overall brain size in all taxa studied, and hence confute allometric trends (nonlinear scaling) among brain components with variation in component size that is independent of whole-brain variation. Clark et al. mistakenly claim that volume fractions among insectivores do “not vary systematically with brain size for any principal developmental brain division”. As in primates, neocortex proportion is positively correlated with brain size among insectivores (linear regression on log-transformed brain volume, n = 50 species, r^2 = 0.18, P = 0.002) and also in bats (r^2 = 0.58, n = 158 species, P < 0.0001), suggesting that this is not an unusual feature of primates associated with “directed selection pressure” in that taxon.

This conflation of brain size and size-independent structural differences limits the utility of the cerebrotype measure for evaluating adaptive patterns and phylogenetic relationships. For example, cerebrotypes place gibbons (Hylobates) with similarly sized Old World monkeys and not with their closest phylogenetic relatives, the other apes. Clark et al. suggest that selection has caused important shifts in brain proportions at the origin of major mammalian taxa, whereas constraints have resulted in “a relatively uniform cerebrotype” within each taxon. In contrast, another study concludes that mosaic brain organization is caused by selective adaptation within orders, whereas between orders there is an interplay between selection and constraints. However, it is unnecessary to postulate that constraints have been more active either at the origin of major taxa or during their subsequent evolutionary radiation. Clark et al. interpret the partly non-overlapping distributions of their multivariate representations of brain proportions as evidence that shifts in cerebrotype evolved at infrequent (about 10-million-year) intervals, followed by relative stasis. However, these distributions would be expected from an evolutionary pattern of gradual divergence and extinction of some intermediate forms. The most parsimonious assumption is that both selection and constraints operate similarly at different taxonomic levels.

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A third type of error arises when components are combined for analysis. The sum of two power laws of differing exponent can never yield a power law. Therefore any analysis (including Barton’s) that combines multiple components (for instance, the rest of the brain, or neocortex equals grey plus white matter) intrinsically contradicts the power-law assumption.

Underlying our disagreements with Barton is the fact that allometric relationships constitute ad hoc models that often provide only a rough fit to the data. Where power-law phenomena have an explanation, such as in the circulatory system, the tissue in question is substantially more homogeneous than the whole brain. For this reason, using residuals based on subtracting approximate power-law trends may not be particularly effective at identifying relationships in the architecture of mammalian brains.

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