* My project is titled ‘The Effects of Climatic Trends, Variability, and Rates of Change on Mammalian Brain Evolution.’
* Starting around 2Mya, hominin brain size began to increase dramatically, eventually reaching a cranial capacity over three times as large as the earliest hominins. Many attempts have been made to explain this hallmark of human evolution, by implicating Ecology (regarding the appearance of tools and meat eating), adaptation to life in complex social groups, as well as changes in large-scale climatic factors (such as aridity, temperature, and vegetation). My project focused on investigating the potential roles of Temperature and Vegetation change in brain size increase.
* As a framework, there are two main categories of Climatic Hypotheses regarding human evolution. This includes Consistency Selection (which focuses on an overall trend towards increased global cooling, aridity, and proportion of C4 vegetation).
* In contrast, Variability Selection focuses on increased fluctuations in all of those climatic factors.
* In Variability Selection, there are 3 main options when climatic variability increases dramatically. You can Die (or go extinct), you can move with the habitat you were originally adapted to, OR you can adapt to the changing habitat by becoming more versatile.
* One of the proposed means of doing this is by growing a larger brain, which has actually been shown to be a predictor of survival in mammals who are introduced to novel environments.
* While there have been previous attempts to investigate this in hominins, each of these studies have only tested limited subsets of climatic variables, measures of brain size, and time intervals. Furthermore, none of these studies have included a wide sample other mammalian taxa to see if climate can select for larger brains as a general principle.
* I decided to address this by looking across a wide variety of factors and mammalian taxa.
* My biological variables included Cranial Capacity, Body Size, and Encephalization Quotient for mammals spanning the last 65 million years.
* For my climatic variables, I used deep-sea core Oxygen and Carbon isotope records as proxies for global temperature and vegetation change, for those 65 million years.
* For both temperature and vegetation, I calculated Standard Deviation (as a proxy for Variability), Mean (as a proxy for consistent Trends), and Slope (as a proxy for the Rate of change), the last of which to my knowledge hasn’t been investigated much if at all in this context but I thought it would be interesting to see if speed of climatic change affects brain size.
* I used 6 different time intervals for each of these measures. These intervals correspond to different periodic orbital cycles of the planet that can force large-scale climate change, including Orbital Obliquity (at 40k) and Orbital Eccentricity (at 100, 200, & 400k). I also included 1My and 5My intervals to try to capture a large number of climatic events per unit.
* So for example, if I had a species that appeared at 2Mya, I would correlate that specie’s cranial capacity with all the different climatic variables over the course of 2 - 2.04Mya, then 2 - 2.1Mya, and then repeat for all intervals.
* For my broader extant and extinct mammalian sample, I used Shultz & Dunbar’s 2010 dataset which included Artiodactyls, Carnivores, Cetaceans, Insectivores, Perissodactyls, and Primates, for a total of 508 different species over the course of the last 65My.
* My Hominin sample included 11 species over the last 3.2My, including those from the genera Australopithecus, Paranthropus, and Homo.
* I started by calculating climatic measures for each of the taxa, and then running them through about 100,000 total bivariate correlations.
* Of those I extracted the most relevant ones for both Orders
* ….and Suborders.
* And for Hominins.
* For the purposes of this presentation, I’m just going to focus on my results for Cranial Capacity.
* In an attempt to interpret this data, I created a composite score I call a Climatic Response Profile; which is the sum of the correlation coefficients of ‘Cranial Capacity vs. Temperature’, and ‘Cranial Capacity vs. Vegetation’, then aggregated across all time intervals. I used this as a way to quantify the responsiveness of Cranial Capacity to climatic Variability, Trend, and Rate of Change.
* If we were just look at mammals as a whole, we might conclude that brain size is responsive to Variability and Trend, but not Rate. However, it’s actually much more informative to break mammals into Orders to figure out who is contributing to these values. Indeed, we find very different Climatic Response Profiles for each of these taxa, with Carnivores bring the most responsive in general.
* Others appear to contribute nothing at all, which is perhaps surprising for the very encephalized non-human primates.
* However, by breaking these Orders even further into Suborders, we find a different story.
* Within primates, Haplorrhines are actually extremely responsive to Variability, Trend, AND slope. It’s just that the Strepsirrhines were bringing them down below significance.
* When taxa are compared to Hominins, we find that Hominin brain size is very responsive to Trend and somewhat to Rate.
* I then broke up the Hominin Climatic Response Profile to look more closely at the effects of Temperature vs. Vegetation.
* I found that Hominins are actually very responsive to Global Cooling, and only slightly to Global Temperature Variability, and Speed of Change.
* Furthermore, Vegetation only seemed to have a mild effects, with Vegetation Variability actually decreasing brain size a bit.
* When I compared Hominins to Carnivores within just the past 3.2My, I found that the two taxa were actually very dissimilar. In general, over the past 65My Carnivore brain size has been responsive to cooling like Hominins, but it just hasn’t been responsive in the last 3.2My like that of Hominins. Suggesting that other large-scale or small-scale factors influence how brains evolve besides global temperature and vegetation, which makes sense since these factors can’t be expected to account for all of brain evolution. Rather, in the right evolutionary conditions, they can be drivers of brain growth.
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