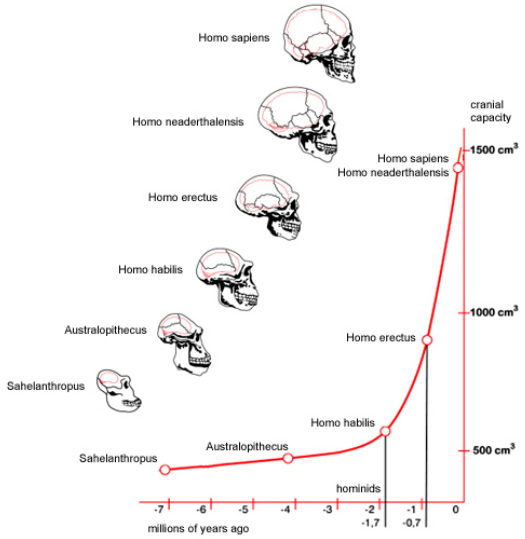
Teaching Materials Associated With Module 3

Measurement of Cranial Capacity:
- Originally measured by filling the skull (through the foramen magnum) with small seeds or beans. After emptying the skull, the volume of the seeds/beans could then be determined.
- Now cranial capacity can be measured digitally from CT scans.

Cranial Capacity Over Time:
- One of the major trends in evolution is the gradual increase in cranial capacity.
- One exception is *Homo neanderthalensis*, whose cranial capacity was comparable with modern *Homo sapiens*.
- Relevant cranial capacities: *Australopithecus sediba* = 420 cc, *Homo sapiens* = ~1300 cc, *Homo neanderthalensis* = ~1500 cc



http://readingevolution.com/hominid_evolution.html (Adapted)

Encephalization Quotient:
- Another way to consider brain size is by measuring the encephalization quotient.
- Encephalization quotient = brain-to-body weight ratio
- Why is this important? It is important to know whether an animal has a big brain for their body size or a big brain and an equally big body size. For example, Gorillas and Coyotes have similar encephalization quotients (1.75 and 1.69 respectively) despite have very different sized brains (512.92 grams and 84.24)

Species	Name	Weight (kg)	Brain (grams)	EQ
Human	*Homo sapiens*	75.00	1400.00	6.56
Whale dolphin	*Lissodelphis borealis*	73.00	1162.00	5.55
Bottlenose dolphin	*Tursiops truncatus*	119.96	1535.00	5.26
Commerson's dolphin	*Cephalorhynchus commersonii*	43.00	732.00	4.97
Macaque	*Macaca nemestrina*	4.89	108.87	3.15
Baboon	*Papio hamadryas*	9.88	155.44	2.81
Chimpanzee	*Pan troglodytes*	45.00	398.60	2.63
Capuchin	*Cebus capucinus*	3.10	66.94	2.63
Gorilla	*Gorilla gorilla*	120.50	512.92	1.75
Coyote	*Canis latrans*	8.51	84.24	1.69
African gray parrot	*Psittacus erithacus*	0.33	5.70	1.00
Lion	*Felis leo*	142.82	240.60	0.73
Tiger	*Felis tigris*	184.50	263.50	0.68
Hippopotamus	*Hippopotamus amphibius*	1351.00	732.00	0.50
Blue whale	*Balaenoptera musculus*	58059.00	6800.00	0.38

Cairó, O. (2011). External measures of cognition. *Frontiers in human neuroscience*, *5*.

Why big brains?
- Big brains are thought to be beneficial for the development and use of tools, in social behavior, and as a means of adaptation to the environment.
- According to the social brain hypothesis, brain size (specifically the neocortex) is important when considering social behavior and group size. The neocortex is wha gives us the ability to understand what others are thinking. Consider the following line of evidence: Individuals with larger brains are more successful socially, *thus* they have increased fitness (have more kids), *thus* they pass their genes off to their offspring. BUT, in order for this to be true there must be a strong selection pressure to move population towards larger brain size since big brains are calorically expensive!

Dunbar's Number:
- So if big brains equate with being more social, how big can that social network be? Anthropologists have developed an equation called Dunbar's Number, which they use to [accurately] predict how many friends an animal is likely to have based on their neocortex size. According to this equation, modern humans can maintain stable relationships with ~150 people.
- The bigger the neocortex, the more friendships can be maintained.

Perks of Being Social:
- Harder for the individual to be hunted or killed when they are in a group as opposed to when they are alone
- Cooperative hunting/gathering = sharing food and resources!
- Opportunities for learning new behaviors/strategies
- Access to mates

Drawbacks of Being Social:
- If there are a lot of people living in one area then you may have to travel farther to find enough food for everyone to eat
- Going farther to hunt/forage requires extra energy
- Physiological cost (stress)

- Intragroup violence

Why do you think modern humans have a high encephalization quotient compared to most other animals? Why has there been a selection over time for larger brains?

This module has been adapted from the following sources:
https://www.ncbi.nlm.nih.gov/pubmed/19575315
http://www.smithsonianmag.com/science-nature/humans-evolved-big-brains-to-be-social-122425811/
http://www.bbc.com/news/science-environment-23045905
http://changingminds.org/explanations/groups/dunbars_number.htm
http://humanorigins.si.edu/human-characteristics/brains