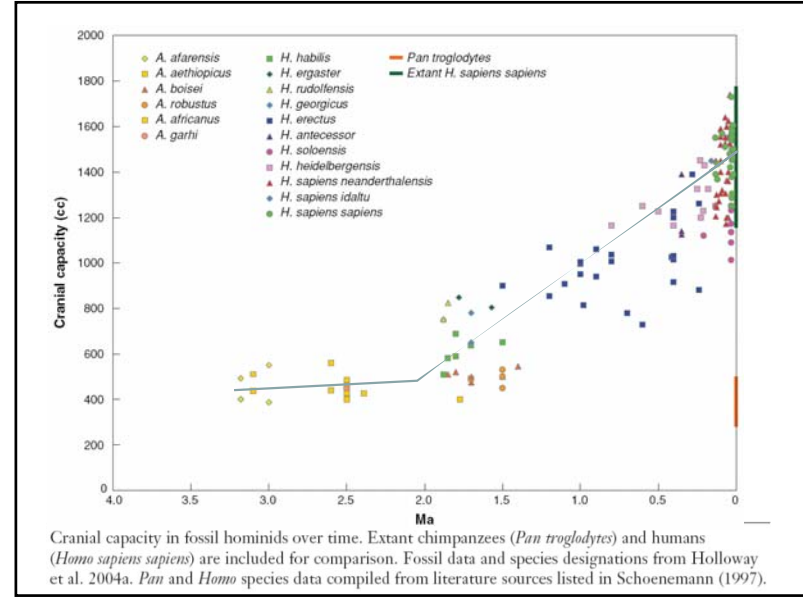
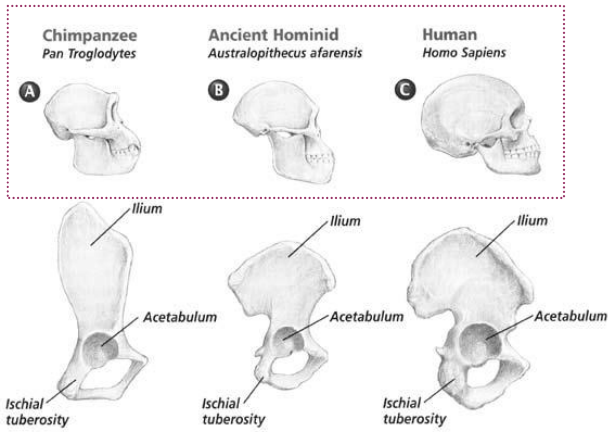


Some skeletal features of Australopithecus are intermediate between those of modern apes and humans.
Cranial capacity larger than but closer to that of modern apes.

Figure 16.9
Some skeletal features of an australopithecine are intermediate between those of modern apes and humans. Compare the skull and pelvic bone of *Australopithecus afarensis* (B) with those of the chimpanzee (A) and the human (C).



Cranial capacity in fossil hominids over time. Extant chimpanzees (*Pan troglodytes*) and humans (*Homo sapiens sapiens*) are included for comparison. Fossil data and species designations from Holloway et al. 2004a. *Pan* and *Homo* species data compiled from literature sources listed in Schoenemann (1997).

Evolution of cranial capacity in hominid line

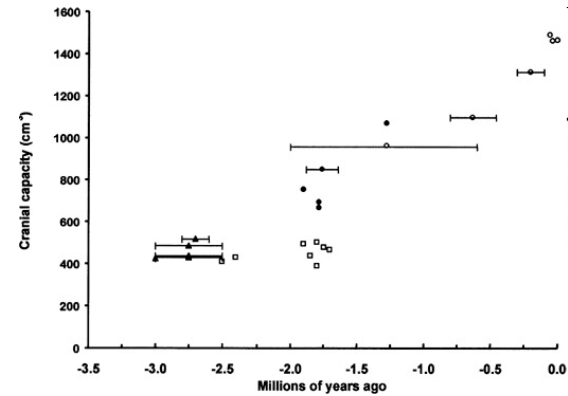
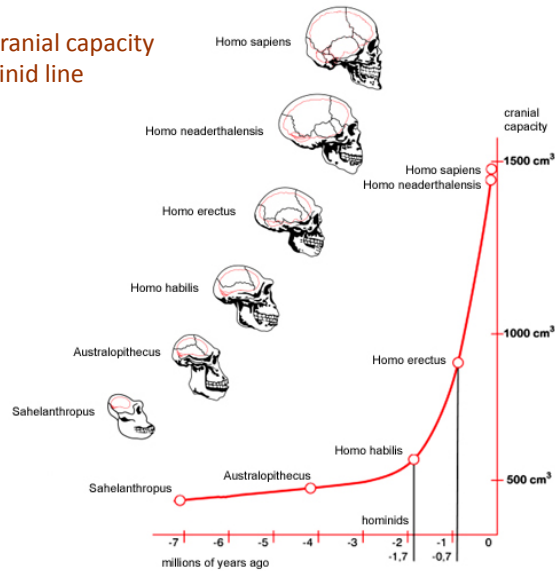


Figure 2. Cranial capacities plotted against time. Key to symbols; triangles, South African australopithecines (*Australopithecus africanus*) that may have been ancestral to *Homo*; squares, australopithecines from South and East African (Paranthropus) that became extinct without leaving descendants; circles, *Homo* (filled, individual specimens; open, group averages). Where appropriate, error bars indicate ranges of possible dates. Brain size has tripled in living people compared to the capacities of the australopithecines that lived from 3.0 to 2.5 million years ago. Absolute brain size is shown here. Because body size also increased with the appearance of *Homo*, the change in absolute brain size is less dramatic in the first widely successful members of our genus. The largest capacities shown are for Neanderthals that lived between 90,000 and 30,000 years ago. Courtesy of Dean Falk.

Humans differ from other primates: much longer growth period.

Brain growth delayed even more: cranial volume of **newborns**:

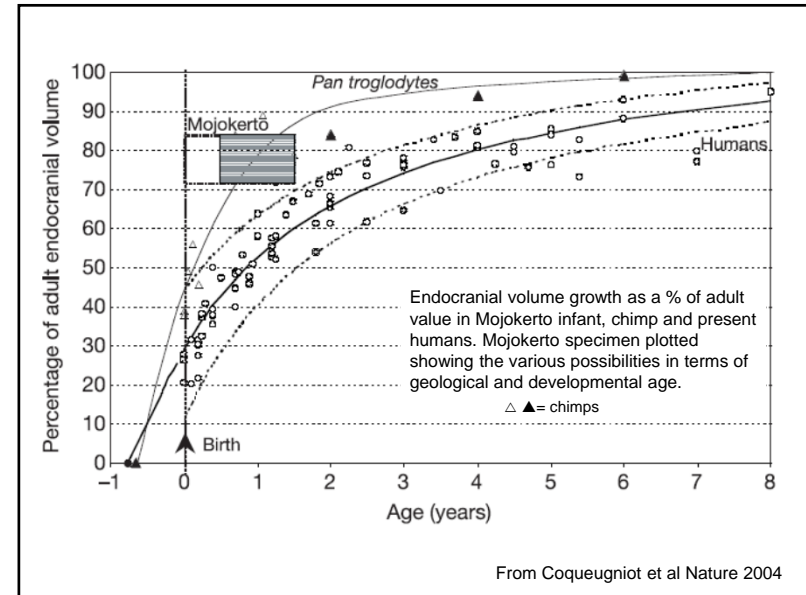
- Macaca ('typical monkey') 70% of adult size,
- modern apes 40%
- modern humans 25%

Cranial volume at **1 years old**:

- Macaca ~100% of adult size,
- modern apes 80%
- modern humans 50%

Cost of secondary altriciality: extended parental care necessary

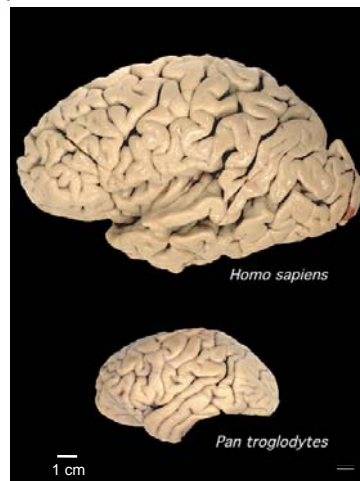
Coqueugniot et al Nature 2004: Analysis of well-preserved skull of 1.8-million-year-old Mojokerto child, a *Homo erectus* infant estimated to be about 1 year old, with a cranial capacity of 72-84% of adult. Find that pattern of brain growth resembles that of living apes much more than that of living humans.



Herrmann, Call, Hernandez-Lloreda, Hare & Tomasello
 "Humans have evolved specialized skills of social cognition:
 The Cultural intelligence Hypothesis" *Science* 2007

Large brain clearly supports cognitive skills not found in other primates, e.g., language.

Evolutionary question: given the enormous energetic expense of a large brain, why and how did humans evolve such powerful and distinctive cognitive abilities requiring so much neural tissue?



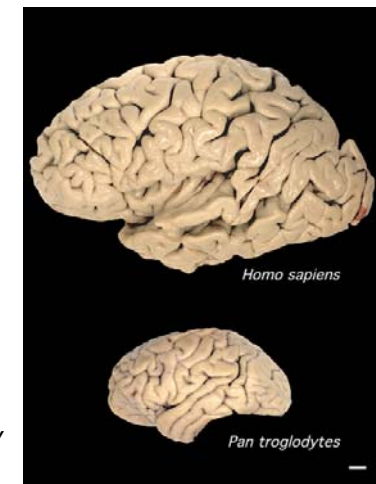
Human brain 3X larger than brains of nearest relatives: **WHY?**

General intelligence hypothesis

Larger brains enable humans to perform all kinds of cognitive operations more efficiently

- Greater memory
- Faster learning
- Faster perceptual processing
- More robust inferences
- Longer range planning
- etc...

Humans should be better at *any* task requiring intelligence...



Chimp v Human scale bar = 1 cm

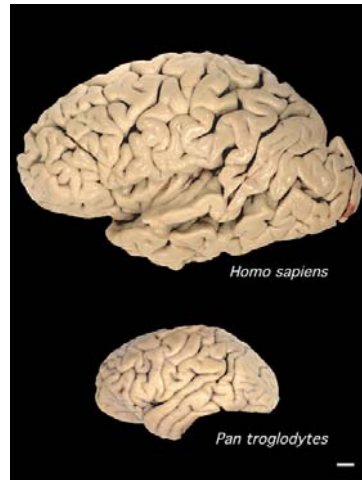
Human brain 3X larger than brains of nearest relatives: WHY?

Adapted intelligence hypothesis

Cognitive abilities evolve in response to relatively specific ecological challenges (e.g., memory in caching birds).

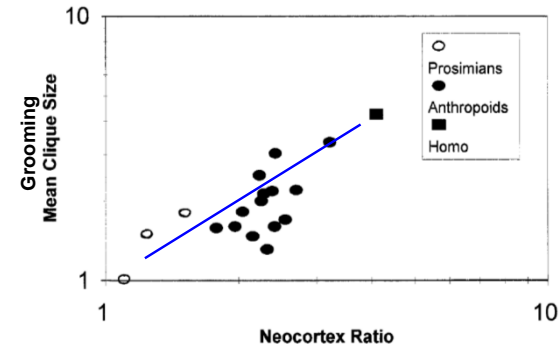
So perhaps distinctive aspects of primate cognition evolved mainly in response to:

- Ecological challenges?
- Complex social life of constant cooperation and competition with others in the social group (**Social Brain hypothesis**)?



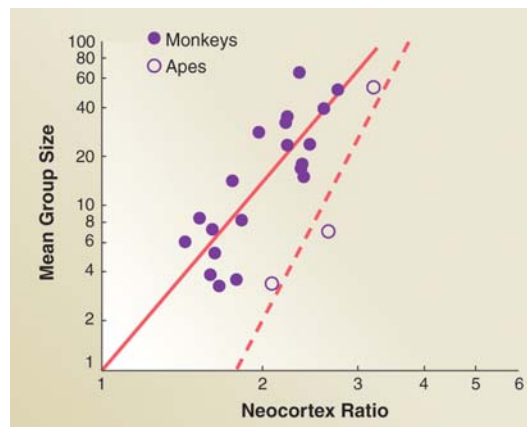
Chimp v Human scale bar = 1 cm

Social Brain hypothesis



Studies have found positive correlations between relative brain size (e.g., neocortex size) and social variables (e.g., group size, grooming clique size). Provides support for the social brain hypothesis, but they do not relate brain size differences to particular cognitive skills, nor help us to identify which cognitive skills humans may have that other primates lack.

Social Brain hypothesis



In anthropoid primates, mean social group size increases with relative neocortex volume (indexed as the ratio of neocortex volume to the volume of the rest of the brain)
Dunbar et al., Science 2007

Social Brain hypothesis – extended: The Cultural intelligence Hypothesis

We are not just social, but **ultra-social**: we have gone beyond the sophisticated primate social-cognitive skills for competing and cooperating with conspecifics, to evolve skills that enable us to actually create different cultural groups, each with its distinctive set of artifacts, symbols and social practices and institutions.

Human children learn to use these artifacts and tools and to participate in these practices, which require some **special social-cognitive** skills of **social learning**, **communication** and **“theory of mind”**.

Some other ape species transmit some behaviors socially or culturally, but their species-typical cognition does not depend on participating in cultural interactions in the same way as it does in humans.

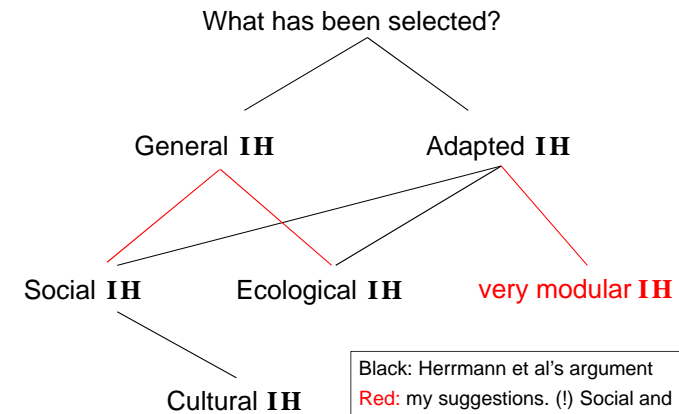
Social Brain hypothesis – extended: The Cultural intelligence Hypothesis

Humans must:

- Learn their native language in social interactions with others
- Acquire necessary subsistence skills by participating with experts in established cultural practices and
- (in many cultures) acquire skills with written language and mathematical symbols through formal schooling

In the end, human adults will have all kinds of cognitive skills not possessed by other primates, **but this outcome will be due largely to children's early emerging, specialized skills for absorbing the accumulated skillful practice and knowledge of their social group**

Hypotheses about the Evolution of Intelligence (IHs)



Herrmann, Call, Hernandez-Lloreda, Hare & Tomasello
"Humans have evolved specialized skills of social cognition:
The Cultural intelligence Hypothesis" *Science* 2007

In this study, the investigators sought to identify the distinctive features of human cognition that exist at an early stage of ontogeny, in order to directly compare the cultural intelligence and general intelligence hypotheses.

They gave a battery of tests (16 total) to chimps, orangutans and human children (age 2.5 years).

Two types of test: tasks relating to **physical cognition** (inanimate objects and their spatial-temporal causal relations) or tasks involving **social cognition** (animate beings and their intentional actions, perceptions and knowledge)

All subjects were naïve to the tests. The apes were living in semi-natural environments, i.e., had had a relatively species-typical upbringing.

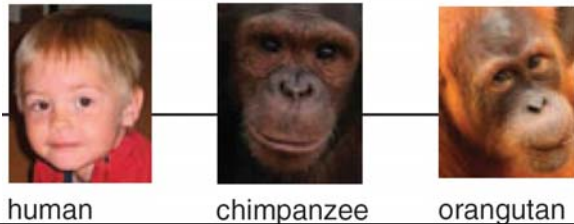
Rationale for The Tests (PCTB)

Primate cognition of the **physical world** evolved mainly in the context of foraging. To locate food, primates need cognitive skills for dealing with **space**; to choose wisely among multiple food sources, they need cognitive skills for dealing with **quantities**; and for extracting food from difficult places, they need cognitive skills for understanding **causality**.

Primate cognition of the **social world** evolved because of the tension between cooperation and competition among group members: To manipulate the behavior of others, primates need skills of **communication**; to learn things vicariously from observing others, they need skills of **social learning**; and to predict the behavior of others in competition, they need cognitive skills for understanding psychological states such as goals and perceptions (**theory of mind**).

The PCTB comprised the two domains of physical cognition and social cognition, each of which comprised 3 cognitive scales (**the six items indicated in brown above**)

Cultural intelligence hypothesis predicts that there should be an age in early human ontogeny (before children have been seriously influenced by written language, symbolic math and formal education) at which human's skills of physical cognition concerning things such as space, quantities, and causality) are very similar to those of our nearest primate relatives but at which their skills of social-cultural cognition (specifically those most directly involved in cultural creation and learning, such as **social learning, communication, and Theory of Mind**) are already distinctively human. **General intelligence hypothesis** predicts **no** such differences.



Scale	Task	Description
Space	Spatial memory (1 item, 3 trials)	Locating a reward.
	Object permanence (3 items 9 trials)	Tracking of a reward after invisible displacement.
	Rotation (3 items, 9 trials)	Tracking of a reward after a rotation manipulation.
	Transposition (3 items, 9 trials)	Tracking of a reward after location changes.
Quantity	Relative numbers (1 item, 13 trials)	Discriminating quantity.
	Addition numbers (1 item, 7 trials)	Discriminating quantity with added quantities.
Causality	Noise (2 items, 6 trials)	Causal understanding of produced noise by hidden rewards.
	Shape (2 items, 6 trials)	Causal understanding of appearance change by hidden reward
	Tool use (1 item, 1 trial)	Using a stick to retrieve a reward which is out of reach.
	Tool properties (5 items, 15 trials)	Understanding of functional and nonfunctional tool properties.
Social learning	Social learning (3 items, 3 trials)	Solving a simple but not obvious problem by observing a demonstrated solution.
Communication	Comprehension (3 items, 9 trials)	Understanding communicative cues indicating a reward's hidden location.
	Pointing cups (1 item, 4 trials)	Producing communicative gestures in order to retrieve a hidden reward.
	Attentional state (4 items, 4 trials)	Choosing communicative gestures considering the attentional state of the recipient.
Theory of Mind	Gaze following (3 items, 9 trials)	Following an actor's gaze direction to a target.
	Intentions (2 items, 6 trials)	Understanding what actor intended to do (unsuccessfully).

