Probability of human-like intelligence

[Note: only first 9 pages of these notes are required reading and may be covered on the exam. The rest is only for the interested.]

Nearly all views of the evolutionary record imply a *continuity* between species, and in particular between humans and other species, which suggests that humans are not dichotomously unique. Yet when we consider phenomena like logical thought, language, self-consciousness, and various human attributes (see below), there is a strong tendency to think that humans *are* unique. So the main question we are examining here is: **How distinct, and in what sense, are humans distinct from other animals (in particular other primates)?**

If there are real discontinuous distinctions, could they be genetic?
Look at the primate family tree presented in class that shows DNA differences and time of branching. All evidence indicates that our closest relatives are the pygmy chimps (pan paniscus). About 98% of DNA in common with this species. (Similar results from all molecular clocks: mitochondrial DNA, protein amino acid sequences, DNA hybridization, and base sequences.)

Many other behavioral similarities between humans and pygmy chimps: e.g. Food sharing; strong bonds among females, and females and males, not just among males; sexual similarities (females sexually receptive for much of a month; copulation can be initiated by females; in variety of positions, including face to face). [Language ability? We'll discuss later in course] {Note: Pygmy chimps nearly extinct due to habitat destruction, capture for zoos and for medical research.}

So our *differences* from pygmy chimps (upright posture, larger brains, language, sparse body hair) must be concentrated in 2% of the genetic material (*if* the difference is entirely genetic). And most DNA is "junk"--duplicated or lost former function, so differences must be concentrated in *less* than 2% of genome.

Is it possible for so much differerence to come from so little genetic material?

Some traits *are* specified by a single protein and gene. e.g.
hemoglobin (oxygen-carrying protein);
Tay Sachs disease (fatal)--carried by 1 enzyme and 1 gene;
Sickle-cell anemia--change in just one of hemoglobin's 287 amino acids, due to change in just 1 of 3 nucleotides that specify that amino acid.
Similar large changes from small DNA differences known in other species.

But other traits are affected by *many* genes, as well as external factors. e.g. height as an adult--determined by many genes as well as nutrition as child. Complex behaviors? e.g. aggression, language, homosexuality, ...intelligence?

There are two recent developments claiming discovery of a gene controlling the development of "big brains" in humans:

1. The ASPM gene—mutations in this gene cause severe reductions in cerebral cortex size of current humans (microencephaly). (It is also seen in analogous form in mice and fruit flies—it apparently codes for mitotic spindles.) That brain size is controlled in part by this gene had been found by J. Bond et al. (2002 Nature Genetics, 32, 316), and J. Zhang (2003 Genetics, 165, 2063) and P. D. Evans (2004 Human Molecular Genetics 13, 489) studied evolution of ASPM in different creatures, and found accelerated evolution in ape lineages leading to humans. Lineage from last chimpanzee/human branching shows signatures of intense adaptive evolution (positive selection). They propose dominant role in evolutionary enlargement of human brain.

2. H. H. Stedman et al. (March 23 2004 Nature, team of cell biologists, muscle specialists, geneticists, and surgeons) have found that a mutation in the human myosin gene known as MYH16 differs from the older unmutated gene found in many nonhuman primates, including macaques and chimps. This mutation apparently disabled the large and powerful jaw muscles found in earlier hominids and may have launched a lineage of prehumans (about 2.4 million years ago) with smaller jaws and larger skull and plenty of room for bigger brains.

So you can see that single genes *could* have had big effects, but the question is how many genes do you really need to affect a trait as complex as brain size or something even more complicated like cognitive circuitry in that brain ("intelligence").

Some people think that all of this is incomplete without considering the environment, which may have been the reason these genes were selected for in the first place. Several groups have pointed out the large temperature variations (and probably other environmental changes) that occurred during the time when "modern humans" (~ 100,000 yr ago) appeared.

If the requirement for "this kind of intelligence" to arise elsewhere involves several crucial genes and particular environmental variations, how likely is it that "intelligence" has arisen elsewhere in the Galaxy?

See your textbook for more discussion of hominid evolution.

Many ideas about human uniqueness center on *bipedality* as being a fundamental human distinction, but there is no agreement on how or why bipedality came about (the article you will read by W. H. Calvin summarizes a few suggestions), or on the most important of its many consequences (freed hands to build tools? But crows are now known to build compound tools. Allowed development of complex muscle and bone structure needed for language?

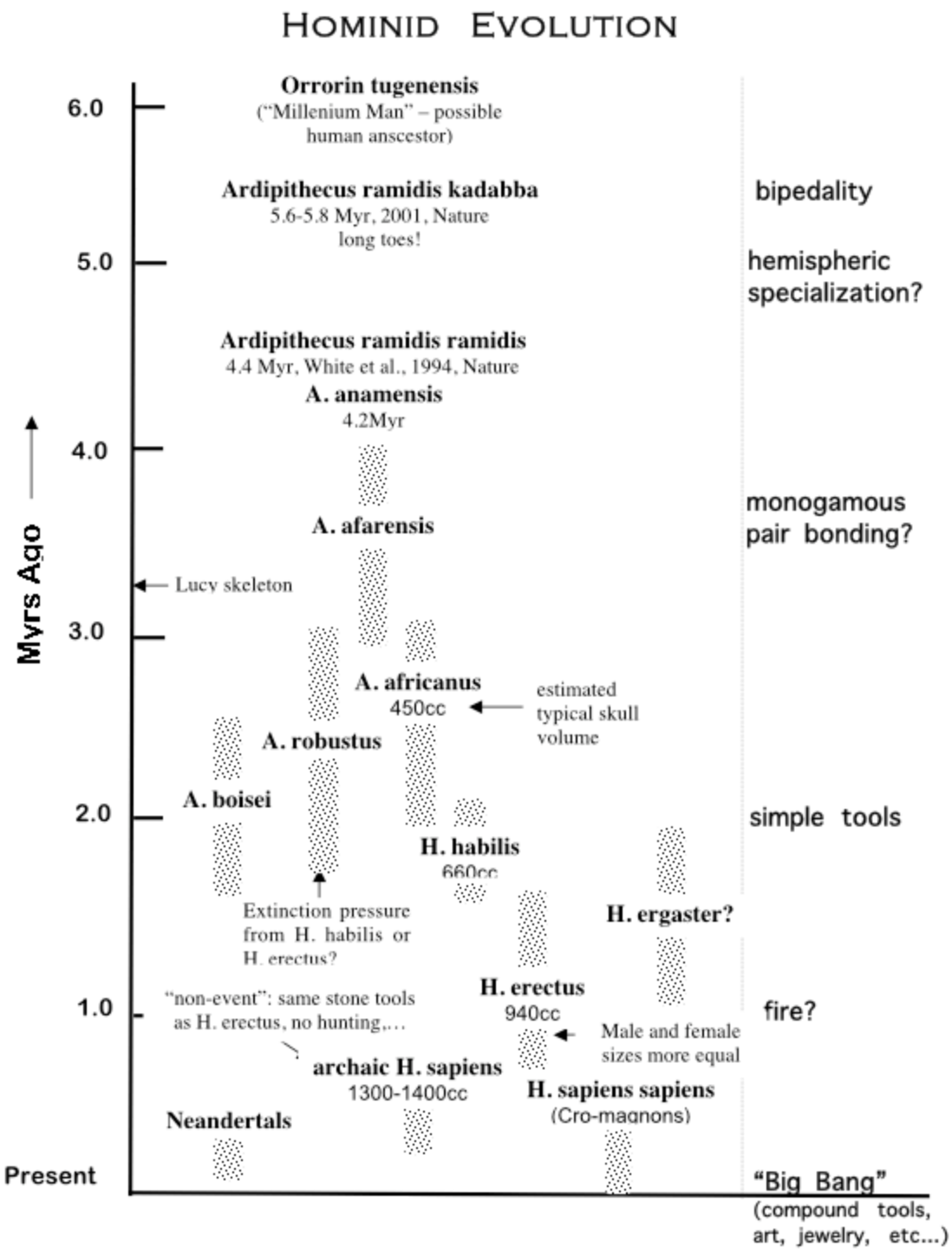
My favorite: upright posture narrowed birth canal. Combined with big heads for big brains, this forces human infants to be born several months prematurely, so the brain undergoes neural development in the presence of environmental stimuli.)

Within last month or so: bipedality discovered in octopi! Unclear how often they use it (for camouflage in the cases seen so far), but it is interesting that the octopus, formerly considered a creature of very low "intelligence," has in recent years become more and more appreciated for its cognitive abilities.

Most people think that bipedality in humans probably arose *at least* around 4 Myr ago (known from fossils; infer from pelvic anatomy + Mary Leaky's 70 footprints of 3 hominids, etc.)

Other suggestions focus on some supposedly unique property of human brain development. Examples: brain weight/body weight (see figure; sometimes called "*encephalization*"), expansion of the cortex (around 2 Myr ago, H. Erectus); hemispheric specialization (left-right brain laterality; foldings; modular functional structure) Unfortunately most of these are continuous with or have been found in other animals.

There are a large number of suggested crucial factors for human uniqueness, from those named above to concealed female estrus to language. A brief outline of 18 of these is given in an Appendix I of these notes (you won't be tested on it). Appendix II is a summary of some ideas concerning the nature and origin of consciousness.



Ardipithecus ramidis kadabba
5.6-5.8 Myr, 2001, Nature
long toes!

bipedality

hemispheric

The BIG changes during the evolution to modern humans appear to fall into 3 groups:

1. **Early shift** (~ 5 Myr ago): Besides the earlier adaptations associated with tree life discussed in your book (more than 50 Myr ago), many anthropologists claim that the primary development responsible for many many later traits (e.g. tool use, language, ….) was bipedality. One possible line of cause and effect (among many theories) is:

bipedality--->(narrowed birth canal, large head, premature birth)----> early neural development in presence of external (environmental and animal/human) stimuli. Also responsible for anatomical changes (more bone and muscle structures in throat) leading to complex spoken language?

What led to bipedality? There are numerous speculations but basically it is unknown. (I have removed about three pages of notes on this topic.)

[Development of concept of "individual self"? Many people have argued that this concept only became "reified" (taking a concept for a real thing) much later, only several *hundred* or *thousand* years ago.]

2. Cro-Magnon (35,000-40,000 years ago, "Aurignacian period"; Europe's Neanderthals are referred to as "Mousterian culture")

Anatomically modern, jump occurs in tool complexity, weapons, hunting, boats, tailored clothing (from paintings, eyed needles, occupation of N.Russia and Siberia), art, body ornamentation...)

[Development of concept of social "self"?]

3. Domestication---around 10,000 years ago--permanent dwellings, agriculture, domestication of animals. Many ways in which these could have affected our "intelligence," cognition, and interpretation of experience.

[Domestication of "cultural" self?]

Domestication, with the advent of **literacy**, eventually led to 'technological culture" (or other characterization of dominant features) of today (at least in the Western world).

Importance for SETI: the question of convergence again. **If the same opportunity for extended neural development occurred elsewhere (and even that is chancy: and what makes us suppose that "brains" would be remotely similar at an architectural level?), as in (1) above, what are the chances that the same type of subsequent, essentially cultural, developments would occur, leading to extraterrestrials who would be interested in and capable of interstellar communication or travel?**

"**INTELLIGENCE**"

How likely is it that extraterrestrial life will have developed the same kind of "intelligence" that we currently use? What do we mean by "intelligence"?

[An excellent general reference is *Metaphors of Mind: Conceptions of the Nature of Intelligence* , by R.J. Sternberg (1990).]

A few suggested criteria:

1. Information processing capability (#neurons; #neural connections; brain size). **2**. Ability to solve "complex problems" (in an efficient and adaptive way).

3. Complexity of "mental models." The ability to model the world, including the organism's own self. Or: Ability to form in the mind, conceptual thought.

4. Adaptive (in terms of differential reproduction or "fitness") cognitive behavior. (Hard to define.)

5. Anything a culture says it is (radical cultural relativism).

I will try to explain some of these in class.

There are a number of **general models for intelligence**: computational (most of cognitive science), biological (brain localization, neural transmission), epistemological (types of knowledge capabilities; e.g. Piaget), anthropological (intelligence as cultural invention), sociological (intelligence as internalization of social processes), modular (e.g. multiple intelligences, H.Gardner), geographical (structure of map of the mind, e.g. J.P. Guilford's "structure of intellect" model), ... These are all *metaphors* for the mind. [A *fascinating* book, with wonderful illustrations, outlining 60 different major models for mind throughout history, from Saint Augustine and Chinese Taoists to Freud and Jung and Chomsky, is "Maps of the Mind: Charts and concepts of the mind and its labyrinths" by C. Hampden-Turner (1981).]

Another way to classify models:

1. Nativism/rationalism (inborn hypotheses and conceptual representations)

2. Empiricism (emphasizes specific learning experiments)

3. Piaget's school (emphasizes studies of logical competence; really a subclass of (1) above)

4. Information processing (emphasizes strategies of encoding and retrieval)

Notice that "intelligence" could include a very broad range of abilities, e.g. reasoning, memory, categorization, imagination, abstraction, generalization, creativity, selective attention, knowledge, decision-making, deceptive strategies, spatial visualization...And even these faculties aren't understood. E.g. Much recent-work indicates that decision-making is controlled by emotional circuits in brain, not "rational thought," if that exists at all.

How to quantify this? Most tests are based on some "mental abilities model" testing some things in the above list. Any single numerical (*one dimensional*) measure, like IQ, has been seen as inadequate for over 20 years. (Can depend on, e.g. family income before age 5 [G. Duncan 1993], whether you listened to Mozart in the last 15 minutes [*Nature*, Oct.14, 1993]) But *multidimensional* measures rapidly get out of hand (e.g. Guilford, 120 factors!)

Another crude single-number measure of intelligence that has been proposed is an exceptionally large ratio of brain size to body size. Your text has a good discussion of this "encephalization quotient" or "EQ." (And you will see it in your other readings.) It seems to correlate well with (what we think of as) intelligence among various kinds of animals.

Modular model: Gardner (1983, *Frames of Mind: The Theory of Multiple Intelligences)* — proposes seven (and possibly more) distinct intelligences: linguistic, logical-mathematical, spatial, musical, bodily kinesthetic, interpersonal, intrapersonal. Derived from evidence such as isolation by brain damage, exceptional individuals, evolutionary history,...

Presently a trend toward (naturally) tests based on information-processing (computational) models — intelligence as computer program.
Measure (primarily) reaction times and error rates, e.g. speed of lexical access (e.g. letter names), errors in divided attention, ..

Two general views of intelligence (notice implications for ETI; also notice these are same as nature vs. nurture, rationalism vs. empiricism, modernism vs. postmodernism, etc.)

1. **Innateness** (=**universalism**) — suggests that intelligence, and even culture, are hard-wired in our *biological* structures.

—> Levi-Strauss: "structuralism". Universal "deep structure" to thought in all cultures. Essential feature of thought = binary oppositions.

—> Piaget: universal cognitive developmental stages (he classified 4 general stages); depends only on unfolding of brain structure. Saw cognitive development as elaboration of logico-mathematical structure, and as paralleling the history of science.

[Think about ETI here, convergence. But is there a "higher" stage?]

2. **Contextualism** (=**relativism**) — cognitive development might depend more heavily on:

—> social development

—> affective (emotional) development

—> use of language (Sapir-Whorf) or writing

—> mediating agents (usually parent, sibling, teacher; e.g. R. Feuerstein 1980)

Most extreme version called "radical cultural relativism", which rejects *any* cultural universals (e.g. J.W. Berry). [Possible support from recent studies of animal learning mechanisms]

Some examples (discussed in class):

1. Luria (Soviet psych., 1930s) – nonlinterate but intelligent subjects unable to reason abstractly.
2. Contextual calculations by housewives and racetrack bettors.
3. Puluwat (Caroline Islands) navigators.
4. Visual spatial memory in aboriginal and Anglo-Australian children.
5. Visual discrimination and spatial skills in hunting/agricultural societies.
6. Functional/taxonomic groupings in Kpelle tribe.
7. Nonuniversal "color-to-form shift" from child to adult.

—>This view suggests: intelligence = anything a culture defines it to be. Or just "adaptive cognitive behavior".

—>Implies that extraterrestrial intelligence will be ***very*** different from us, and perhaps unrecognizeable, since environments (physical, social, cultural,...) probably vary enormously.

[Excellent book on cross-cultural aspects of intelligence is by Ceti.]

EXTREMELY IMPORTANT PAGE

Some of the pros and cons on "intelligence" in extraterrestrial life

Note: This list is also meant as a review guide to the course packet readings--most of the arguments given below are paraphrases of specific articles you were supposed to read. It would be to your benefit, from the practical standpoint of the exam, if you could identify each article from the argument given.

CON:

1. All the contingencies we have seen, from processes of evolution at the genetic level to extraterrestrially-induced mass extinctions.

2. It's hard to argue that human "higher intellectual abilities" (e.g. math, music, ...) could have been the product of natural selection.

3. Our type of intelligence is not conducive to a long duration in this phase; some modes of our "intelligence", and their consequences, have had a "runaway" effect that is not adaptive. Our brains are just too big (or too something) for our own good. (This theme is presented in Vonnegut's novel "Galapagos", the surviving creatures refer to the now-extinct humans as "big brains".) Therefore, if there are long-lived civilizations elsewhere in our galaxy, they are unlikely to exhibit our forms of what we call intelligence.

4. Even if increasing brain complexity *is* a universal direction of evolution, this increases the probability of unique properties and behaviors (e.g. language, self-concept, art, ...in humans). These properties might just look "random" to an alien, so why should we expect to recognize them in aliens?

PRO:

1. Connectioninst argument--any system of massively connected excitation units (like neurons) may exhibit "intelligence" to some degree. And brains with massively interconnected neurons have occurred with great generality in terrestrial animals.

2. Brain structure similarities as convergent. Examples: 1. Repeated and independent appearance of certain functionally specialized structures in the brains of "very different" groups of animals; 2. sensorimotor mappings in lots of different brains.

3. Self-organization argument: Traditional Darwinian theory is incomplete--it doesn't take into account self-organization of complex systems, which may be built into the laws of nature (or else they are a trivial simulation result; this argument is mostly based on simulations similar to the artificial life experiments you read about earlier in the course). So the growth of complexity, including our kind of brain and thought, is in a way inevitable.

4. Non-human animal thought argument: The similarities between human conceptualization abilities and other species, even distant species (e.g. pigeons) suggests that this type of "thinking" is so adaptive as to be universal.

5. Human infancy argument: Conceptualization begins so early in infancy (a few months or less) that it *couldn't* depend on details of our motor abilities (and perhaps unique bodies)--it must either be innate or just depend on perceptual experience. But to the degree that other worlds have similar environments (because of the presumed uniformity of the laws of physics), extraterrestrials will have broadly similar perceptual experience, so develop the same kinds of concepts.

6. Environmental/category argument (related to 5 above): Any organism in any environment is likely, given enough time, to develop categories like space, time, and causality, in order to cope with the environment. This should result in a more specific and complex system of categories and modes of thought that resemble our own.

Following material is optional and will NOT be on the exam.

Appendix I. Suggested Crucial Factors for "Human Uniqueness"
[Note: I have not updated references in a few years, so if interested, you can probably find updates on most of these via the internet.]

1. Hunting. Behavioral catalyst that selected for enlarged brain, tool use, bipedalism, social cooperation and even language? (Darwin ....Lee and DeVore's *Man the Hunter* 1968) Now regarded as *very* unlikely. No evidence for hunting skills until around 0.1 Myr ago. Much more evidence for foraging and scavenging; current human foraging societies (Hadza and San) are avid scavengers; also in chimps. (See Oct.1992 Sci.Amer., p.90, for a conservative account. They propose scavenging as major effect on human evolution, e.g. tools for carving up carcasses, bipedalism for carrying food away,...)

[A recent and unique book about the history and sociology of the "hunting hypothesis" ("the view that our ancestry as hominid carnivores explains not only the origins of our genus but also much that is lamentable about our contemporary nature and behavior") is: *A View to a Death in the Morning*, by Matt Cartmill (1993)]

2. Control of chemical fuel (fire)--->control of environment, more leisure time. Occurred about 1.4Myr ago? But could be lightning.

3. Tools--e.g. Darwin; popular until 1970s; but probably an expression or vehicle of "intelligence", not cause.

Earliest hominid tools around 2 Myr ago, but tool use and *manufacture* (using one tool to make another) only took off around 70,000 yr. ago.

Compound tools--ability to construct unlimited number of different forms from a finite number of elementary parts, e.g. wooden handle + axehead; stone point + wooden spear---> precursor of "generativity" (see below) or just another case of it? (But examples in other species.)

Recent book on human development primarily as tool use:_____

For non-human animals, see *Animal Tool Behavior*, by Benjamin Beck (1980), or chaps.4 and 5 of *Animal Minds* by D.R. Griffin.

[Non-human tool use is not so easy! Anthropologist Geza Teleki spent months in Gombe learning to dip for termites from teacher "Leakey" (preadolescent chimp). He failed miserably--couldn't find entrances to termite mounds, select good stalks, prepare them or insert them correctly.]

4. Brain development

---brain weight/body weight (see figure; sometimes called "encephalization") [Usually associated with Harry Jerison] [But note that the distributions of relative brain size overlap between fish, reptiles, birds, mammals; i.e. *some* birds have relative brain size as large as in some primates.]

---expansion of cortex (around 2 Myr ago, H.Erectus); but no discontinuity with other primates. [Cerebral cortex=80% of brain in humans, 74% in apes, 68% in monkeys, 50% in prosimians]

---Other neural specializations for, e.g. abstraction, categorization? (but cf. birds)

---hemispheric specialization (surprise: probably occurred more than 4 Myr ago; also in other species)

---significant brain development after birth (see 7 below).

5. Bipedality --around 4 Myr ago? [from fossils: infer from pelvic anatomy + Mary Leakey's 70 footprints of 3 hominids] Almost certainly *preceded* increase in brain size.

---endurance enhanced, but speed and agility reduced. [Energy efficiency no different than quadrupedal locomotion, unlike earlier claims]

---freed hands for tools, signals, weapons? Carrying (food, children). [But only need *occasional* bipedality for these]

---thumb-opposed hands in place of forefeet

---W. H. Calvin--claims throwing was a crucial development. (But Cebus monkeys throw objects at other animals and to knock down suspended food.) [See Calvin, *The Cerebral Symphony* 1989, ch.11]

---narrowed birth canal (see 7 below).

6. Monogamous pair bonding (around 5 Myr ago?)--matrifocal group replaced by "*nuclear family*".

---eliminates many causes of infant death, improves survivorship (e.g. survival of second parent, fewer deaths by predation when mom stays at home, ...) [Mainly due to Lovejoy 1981, Jan.23 *Science* 211, 341]

[But some prosimians, and even birds, are monogamous. Also, evidence from studies of foraging societies suggest importance of *multiple* caretakers--see July 1992 *Developmental Psychology* by Tronick et al on Efe foragers in Africa.]

Romantic attachment as adaptive? See J.C. Gutin 1993, *Anatomy of Love: The Natural History of Monogamy, Adultery, and Divorce*.

7. Changes in stages of lifespan

---big head (4 above) and small pelvic canal (5 above) result in short gestation phase, long infancy and childhood (compared to other primates). [So humans are born prematurely, human babies are in effect fetuses for about the first 9 months after birth.]

--->So human brains undergo lots of development *after* birth, when child is exposed to influences of environment. [Humans only 24% of adult at birth, chimps about 60%; many mammals have brains fully developed at birth]

---Also, long postreproductive phase: unique to humans, explanation unknown.

8. Concealed estrus, continuous female receptivity, private copulation. (Sexual strategies? Related to 6 above? Discussed in class.)

9. An aquatic phase of human evolution? [Proposed in 1960 by Sir Alister Hardy, developed by Elaine Morgan in *The Descent of Woman* 1972, revised 1985; only taken seriously after endorsed by G.Richards in *Human Evolution* 1987 and M. Corballis in *The Lopsided Ape* 1989. See Morgan's *The Scars of Evolution*, 1994.]

---Response to flooding in Africa 4-8 Myr ago (accounts for fossil gap). Land areas became islands with dwindling resources--->forced to the sea.

(Just the type of situation most evolutionary biologists suggest would be ideal for origin of a new species.)

Could explain relative lack of body hair, downward-pointing nostrils, weeping, sweating, natural breaststroke in infants, webbing; also, aquatic life would favor bipedalism.

10. Language [*not* just signaling or communication] (Developed around 0.1Myr ago? 1-1.5 Myr ago?)

---Required complex vocal apparatus, unique in humans [nasal passages, larynx, tongue, diaphragm, associated muscles, throat structure, hyoid bone (possibly found in 60,000 yr. old Neanderthal)] [Philip Liebermann is major figure in this idea.]

---Creates new categories and modes of thought; restricts others?

---Suppresses other means of communication (e.g. olfactory, gestural,...)

11. "Generativity" (Corballis, *The Lopsided Ape*)--ability to construct an unlimited number of different forms from a finite number of elementary parts, e.g. compound tools, language, music. i.e. combine elements using rules .

12. Possession of certain types of "mental states"

---Self-consciousness [Will discuss later; but some still-debated evidence in apes (Gallup experiments) and elephants]

---Attribution of mental states to others--i.e. a "theory of mind" or "folk psychology" [D.L Cheney & R.M. Seyfarth, *How Monkeys See the World* (1990)]

---Empathy, morality, ethics--But consider the notorious "shocking" experiments of Stanley Milgram (see *Obedience to Authority*, 1974), in which about 65% of subjects would physically harm "victims" rather than defy authority of experimenter. In analogous later experiment in which macaque monkeys were only fed if they pulled chain to shock an unrelated macaque in view, only 13% did so--87% preferred to go hungry (one went without food for nearly 2 weeks).

---Social learning--too many non-human examples (Best-known is macaques on Japanese island of Koshima in 1950s, with "genius" monkey Imo; social learning found in octopus in 1993)

13. Art--painting at least 40,000 B.C. Advent of mental imagery? Isolate attributes and transfer to another context. [Current ideas on technique involves *breathing* the pigments onto the wall!]

Recent Dec.1994 find of 300 well-preserved 20,000 yr.old wall paintings in Vallon-Pont-d'Arc, France rivals Lascaux. "I was deeply moved by the paintings. They're as good as any art made anywhere in the world." [archaeologist Jean Clottes] Includes symbols and geometric signs. Summary in Sci.News.1.28.95)

[See E. Dissanayake, *Homo Aestheticus* 1992 and earlier book]

1995--Finding of what appears to be a flute (piece of young bear's thighbone with four artificial holes on one side, in a straight line.) at a *Neandertal* site in a Slovenian cave, dated at between 43,000-82,000 yr. (Blackwell, B. 1997 Geoarchaeology) Oldest known Homo sapien sapien bone flutes in Europe and Asia are 22,000-35,000 yr.

14. Domestication of humans ("architecture") [See Peter J. Wilson, *The Domestication of the Human Species*, 1988] Adoption of designed construction of permanent shelter, as distinct from temporary use of natural shelters, or flimsy, temporary shelters.

From point of view of foragers (hunter-gatherers), domestication is a radical and far-reaching innovation.

--- First cultural move that altered the landscape.

---Affected visual perception and categories?

15. Domestication of animals (dogs around 12,000 B.C. from Asian wolf in Iraq; goats around 10,000B.C., horses not until around 4,000B.C.)

---First form of capital (Latin "capita" = head count of cattle)

16. Domestication of plants (agriculture) --around 10,000 B.C. in New Guinea.

---Transition from forager, or hunter-gatherer (group effort, shared, roughly equal distribution) to highly unequal distribution of "wealth".

[For more on the nature of foraging societies, see J. Woodburn 1982 "Egalitarian Societies" in *Man*, v.17, p.431; C.A. Turnbull 1983, *The Human Cycle*; M. Power 1991, *The Egalitarians--Humans and Chimpanzee: An anthropological view of social organization*; J. Zeran, "Future Primitive", in *Anarchy*, Summer 1992, p.24.]

[For evidence from study of 650 Australian cave paintings that organized warfare among aborigines predates agriculture, see Tacon and Chippendale, Oct.1994 Cambridge Archaeological Journal. Summary in Sci.News.1.7.95]

---Emergence of priestly classes and ruling elites, notions of order, linear time, progress, a "chosen people"? See C.L. Martin 1992, *In the Spirit of the Earth: Rethinking History and Time*.

[For a negative view of other cultures, see Edgerton, R. B., *Sick Societies: Challenging the Myth of Primitive Harmony* (glorifies Western civilization by describing warfare, torture, human sacrifice, child abuse, female genital mutilation, male dominance, disease, footbinding, suttee,... in small and large traditional societies)]

17. Literacy (writing) --Sumerian around 3300B.C.

---Increased information storage, but separated language from body. Began tendency to depend on external abstract symbolic forms and to regard them as "truth". [See R.C. Logan, *The Alphabet Effect* 1986]

18. Cities (e.g. Jericho 8000B.C., many more by 7000B.C.; Uruk 3500B.C.--largest Sumerian settlement)

---insulation from nature and company of other animals

---political states, hierarchy of social classes, bureaucratic institutions...

Appendix II. Consciousness (Self- and otherwise)

What about self-consciousness? Does it exist as anything more than a useful idea? Is it detrimental, in the sense of suppressing other modes of consciousness once available?

Here are some notes from an interesting book on the development of self-awareness within the last several centuries (one idea among many):

Segmented Worlds and Self: Group Life and Individual Consciousness by Yi-Fu Tuan (1982).

"A cultural and historical survey touching on how groups and cohesive wholes break down as their members grow in self-awareness and withdraw into fragmented spaces...."

Evidence for progressive awareness of self from Middle Ages onward:

1. Increasing importance of autobiographical components in literature.
2. Proliferation of self- and family portraits.
3. Growing importance of authorship (in literature, music, painting,...).
4. The growing popularity of mirrors (this is from a book by Berman, not Tuan).
5. The concern with child as a stage in the blossoming of human personality.
6. The use of chairs rather than benches.
7. The multiplication of private and specialized rooms in the house.
8. The inward turn in drama and literature.
9. Psychoanalysis.
10. Evolution of food preparation and table manners – specialized utensils and an etiquette that makes diners increasingly self-conscious (no forks before ~1500).
11. *Literacy*---writing and reading, when a habit, tend to enforce our perception of the world as causal, linear, segmented.
    Story-telling and oratory require public arena and audience; reading is best done in *private*.
    [Literacy also may have also suppressed the "musical" component of language, meaning the intonational components.]

[Tuan also has a long and interesting section on the dominance of vision over other senses in modern humans.]

You can find a large number of books that are more recent, and more philosophical/neurological speculations about consciousness in local bookstores in the science section (Book People has an especially good selection). I'll summarize a few of these below.

Some American/British views on "consciousness" in the 1990s: a brief survey (many are quotes from reviews of their work)
[Again, not on exam]

These books are meant to give you a feel for the variety, and lack of quantitative basis, of the many ideas that exist about this. And I am not even including the much different Asian and other concepts of "consciousness" which are often more like an all-pervading immanent field rather than these self-centered conceptions.

First, a book that should not be missed is the 1981 "Maps of the Mind: Charts and concepts of the mind and its labyrinths". This covers just about everything from ancient Greeks to the 1970s in picture/text form. You will find it amazing to see how many ways the mind has been conceptualized. The "maps" described below are just the most recent wave of these pictures, riding the crest of whatever sciences tend to be dominant at present. I have not updated this since 1999, so any more recent books that you find on this subject that you can summarize would be appreciated.]

Daniel Dennett (philosopher, director of Center for Cognitive Studies at Tufts U.):

Consciousness Explained

Early popular representations often showed a "homunculus" pushing buttons and pulling levers in the skull. Dennett argues against this centralized "Cartesian theatre", but instead posits swarms of these figurative imps, a "Pandemonium of Homunculi," all clamoring andcompeting for attention, like traders on the floor of the stock exchange. Each of them specialises in different aspects of perception -- shape, language,motion and so on. As they go about their tasks, they confer with each other and form coalitions, producing "collated revised, enhanced" drafts of the raw data they take in. The process goes on endlessly: "Information entering the nervoussystem is under continuous 'editorial revision,' so that at any point in timethere are multiple 'drafts' of narrative fragments at various stages of editingin various places in the brain." Ultimately, we experience this as a sort of"silent narrative," a single, coherent stream of consciousness - in the same waythat our eyes seem to bring us a clear, steady image of the world although they jiggle around like handheld cameras. [Very reminiscent of Marvin Minsky's older model presented in his book "Societies of Mind" --see the movie "Tron".] If there is no central consciousness, can there be a self? That, too, says Dennett, is something of an illusion, a "useful" fiction. All organisms, he says, have a built-in, functional sense of self, based, like so much else in evolution, on survival. It ranges from the rudimentary protective instinct of the lobster that prevents it from eating its own claws, all the way up to the "magnificent fictions" of self that humans spin out of their cumulative experience, like bowerbirds assembling nests from a melange of found objects. In short, it's just a story, a "representation" of a self, concludes Dennett. I am a character in a story my brain is making up. Consciousness is a property I have by virtue of my brain's attributing it to me." Dennett has allies; he also has enemies, including a group he dubs "Nihilists" and "Defeatists", and others call "Mysterians", philosophers such as Colin McGinn and Jerry Fodor, who believe that consciousness is an intractable mystery which Dennett has merely "explained away", rather than solved. [See below.]

Susan Greenfield (pharmacologist, Oxford U.)

Journies to the Centres of the Mind (1994)

Greenfield does not quite believe in the kind of neural correlates of consciousness that others do. Her theory is that you cannot pinpoint particular neurons, or even a collection of neurons, to explain consciousness. You have to think more holistically. What she believes is happening during consciousness is that transient groups of neurons, or "neuronal gestalts", form, operate and reform in multiple areas of the brain. The bigger the gestalt, the more conscious you are. "The degree of consciousness triggered by an orange," writes Greenfield, "would depend not only on how many associations are recruited, that is, the significance of the orange to you in particular, but also on your current circumstances, such as whether you are thirsty, or hot, or nauseous, and how long you have to contemplate the orange before a new trigger generates a new conscious state...it is analogous to a raindrop hitting ... a puddle and creating ever-widening concentric ripples. Consciousness draws on associations as a poet does on images."

Antonio Damasio (neurologist; specialist in dissociation, imaging)

Descartes' Error (1994?)

The main point of his book is that emotion is central to human "rationality". Patients who can't experience emotion can't make useful decisions, even though the rest of intelligence is intact. In Damasio's view, the "mind" consists of 1000's of "convergence zones", areas of brain that pull together specific information, e.g. names of objects, animals, and people, another for verbs, etc., ... every sort of info. brain needs to be functional. [Sounds like Dennett again; modularity.] For Damasio, "consciousness" is the concept of your own self, *reconstructed moment to moment* on the basis of your image of your body, your autobiography, and a sense of your intended future. Damasio focuses on an area in the right parietal lobe of the central cortex; lesion studies indicate this region is essential for keeping continuous update of our concept of ourselves as an embodied "I" that endures through time. The area is also connected to thalamus and other subcortical structures.

Francis Crick (co-discoverer of structure of DNA)

The Astonishing Hypothesis: The Scientific Search for the Soul (1994?)

Crick modestly claims that if we are to make headway in our understanding of consciousness, we have to start somewhere: best, therefore, to begin with something physically observable and definite rather than get lost in foggy abstractions. Hence Crick focuses on the discovery, by Koch andd others, that when higher animals appear to be aware of an object visually, low-frequency (around 40 Hz) waves of electrical activity appear that synchronize neurons (or keep them in phase) over large parts of the brain. Crick and Kock think this synchronization effected by these waves is somehow responsible for the feeling that there is a mental unity, i.e. consciousness. However it's still just neurons firing, but "orchestrated" by the 40 Hz waves. This is based mainly on visual system--they claim *visual* consciousness is activity coordinated at 40Hz in layers V and VI of the primary visual cortex (so could have different consciousnesses for different sensory modalities)But Crick's leap from this modest proposal to his published hypothesis is, indeed, astonishing. "You, your joys and your sorrows," he writes, "your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules." That phrase "no more than" is key. In the vulgarised shorthand that finds its way into general acceptance, it translates into: the mystery of human consciousness is no more than 40 hertz oscillation!

Crick's reasonable protestation that his strategy is confined to empirical data, merely as a secure starting point, is hardly corroborated by a subtext that rumbles through his book like bottled thunder. For Crick's astonishing hypothesis is as much a sustained attack on religious belief as it is about

neuroscience. Crick appeals for the abandonment of religious faith in order to eradicate belief in souls and make way for the advent of a Neuroscientific Enlightenment. At the same time, we are invited, in the publicity blurb, to draw a direct equivalence between the book and the great discovery of the Double Helix.

Christof Koch (neuroscientist, Cal Tech)

See Crick, above.

Rudolfo Llinas (neuroscientist)

Timing effects in the brain produce conscious experience (similar to Crick and Koch). Llinas measures (indirectly) brain activity with MEG (magnetoencephalography). Sees similar large-scale coordination as Koch. He finds these oscillations, at the same frequency, in every area of the cortex, and all were in phase. The 40Hz activity is seen when awake, and in REM (dreaming) sleep, but *not* in non-REM sleep; this suggests a connection with consciousness. See the figure in Churchland's book. He would locate the contents of consciousness within layers of the primary sensory cortex, rather than the ILN as in Churchland. Llinas says "We can say that being awake or being conscious is nothing but a dramlike state." It [consciousness] may correspond to objective reality, but it has no objective reality itself."

Paul Churchland (philosopher of mind; see pp.213-226 for his views)

The Engine of Reason, the Seat of the Soul (1995)

Colin Blakemore (zoologist)

Mind Machine

Argues that the brain is an evolved biological computer that gives rise to the impression rather than the reality of free will. [I'm short on info. about this book, but Blakemore has been studying this area for many years.]

Richard Edelman (Nobel prize-winning immunologist)

Neural Darwinism (1990?); *Bright Air, Brilliant Fire* (1992)

Basing his argument on his experience as an immunologist, he contrasts two different models of how the brain might assimilate and respond to experience. The first (instructional) says that nerve cells have the capacity to respond to their environment, to learn and generate conscious experience by adaptively changing their pattern of connections. In the alternative, selectionist view, connections proliferate excessively as the brain develops. Connections which fail to meet the environmental challenges they face simply wither and die; those which succeed grow and prosper. Edelman's Nobel prize came from showing that the immune system works on a selectionist and not instructional principle, and this is clearly the one he favours for the brain. Edelman believes that the way the brain works has more in common with a vast jungle or ecological habitat than a computational system.

His contribution to the mind-body debate is a hypothesis he calls the Theory Of Neuronal Group Selection, which argues that the brain develops, before and after birth, by a process not unlike natural selection in evolution. As a model, or a metaphor, nothing could be further from the Crick-Churchland brand of computational neuroscience. Edelman stresses the

dynamism, the ceaseless novelty and creativity of mental processes, and draws constant contrasts between the machines of our own devising and the brain's predicament as an evolved living (and dying) organism. He concludes that while evolutionary theory can elucidate the problem of consciousness, no ultimate scientific explanation of a human individual is possible.

As with Crick, Edelman's theory has attracted some distinguished supporters from neighbouring scientific disciplines, including the writer-neurologist Oliver Sacks, who believes that Neuronal Group Selection is ideally suited to his holistic approach to clinical neurology.

Walter Freeman (neuroscientist)

Societies of Brains (1995)

His group found evidence for chaotic activity (or at least irregularity) in rabbit olfactory and visual cortex around 1988. He generalized this to picture the brain as basically a background chaotic state, poised for transitions to various structures. This state is a flexible "I don't know" state. Freeman is a neurophysiologist, but is at odds with most materialists, and cognitivists, too, when it comes to a conception of "mind". Materialists see the mind as a by-product of the brain's biology and physics, whether billions of neurons (neurobiologists), chemical and hormonal interactions (geneticists and pharmacologists), or quantum effects (Penrose). Freeman instead pictures mind as a product of an unfolding sequence of goal-directed behaviors providing individuals with constant feedback, shaping perceptions and future actions. He endorses the view of existentialist Sartre--self is constructed through a person's own actions and we know that self as it is revealed in our actions. Also closely related to views of psychologist J.J. Gibson (1980, "Ecological Perception").

He, surprisingly, and unlike almost all other neuroscience/cognitive science investigators, rejects the view that the mind contains representations of the world in the form of thoughts, ideas, images, symbols, processed according to some rules. He sees social interactions as calculated stressful activity to "meltdown" old neuronal connections and associated attitudes and beliefs. Group dancing, chanting, music, initiation rites, sporting e4vents, ... This is similar to Pavlov/Soviet "brainwashing" and "reeducation"--induces brain states that are conducive to incorporating collective values and identity (even though these are not "real").

Roger Penrose (physicist/mathematician)

The Emperor's New Mind (1989), *Shadows of the Mind* (1993?)

He argues that consciousness cannot be algorithmic/computational/rule-based, based largely on Godel's theorem, which most others interpret differently w/r to mind; see Churchland's comments. He suggests that consciousness might emerge from quantum events in the brain, maybe in "microtubules".

Penrose rejects the computer model of consciousness, professing instead some sympathy for the "mystical" point of view. "It may well be there is something else going on in the brain that we don't have an inkling of at the moment," he says. Penrose's views are espoused by freelance philosophers such as Danah Zohar, who sees an equivalence between quantum physics and mysticism ("The Quantum Mind"). This type of appropriation of scientific-sounding terminology is similar to what can be seen in many other areas. But it is still interesting that someone like Penrose (famous mathematician/physicist) is skeptical that humans can ever fully comprehend the human mind (see Searle and McGinn, below).

John Searle (philosopher of language, Berkeley)

Rediscovery of the Mind

Mental life emerges as an inherent feature of the brain, just as liquidity is a feature of water, in Searle's view. Moreover, consciousness feeds off an individual's singular point of view, thus rendering it subjective and not reducible to traditional objective measurements of behavior, he maintains (following Nagel's "Bat" paper). Investigators of consciousness must strive to understand "the first-person point of view". What is going on in the brain is neurophysiological processes and consciousness and nothing more--no rule following, no mental information, processing or mental models, no "language of thought". [He suggests we compare with understanding digestion, and making models for it.] He claims that behavior or causal relations to behavior are not essential to the existence of mental phenomena, and that it is inconsistent with what we know about the universe and our place in it to suppose that everything is knowable by us. [Similar to McGinn, below.]

He declares that one of the purposes of his most recent book is "to put the final nail in the coffin of the theory that the mind is a computer program." Searle also attacks the notion of unconscious rules of "universal grammar" championed by linguists such as Noam Chomsky. Chomsky and others have theorized that the ability of healthy children to learn readily the language of their community and other natural human languages -- but not logically possible "artificial" languages --shows that the brain contains an innate "language-acquisition device" consisting largely of grammatical rules that are unavailable to conscious thought. Searle, an ardent foe of universal grammar for more than 15 years, agrees that human brains contain a biological capacity for language acquisition that limits the type of languages we can learn. But proposing language rules that lie beyond the grasp of consciousness makes as little sense as proposing a universal visual grammar that tells us, "If it is infrared, don't see it, but if it's blue, it's okay to see it," Searle holds. The brain's visual system simply limits what sort of colors humans can see. Connectionist computers, also known as neural networks, work on this principle, he notes. Some connectionist models convert meaningful input into meaningful output by mathematically altering the sensitivity of connections between processing units rather than by manipulating rules or symbols. Neural networks may still fail as models of the mind, but they avoid the quicksand of "deep unconscious rules" that sucks down cognitive science, Searle says.

The problem is that Searle so abhors the idea that anything we already know from physics or biology could ever account for consciousness that he falls into vagueness; vigorously denying any dualist nonphysical mind-stuff, he has no clear idea what sort of new principle might be found. At times, he approaches Herbert's "elemental" concept, comparing mind to physical properties like mass, and other times he refers to some new "neurobiological feature" of the brain--on faith more than hard data. [See Churchland's criticism of Searle, although it is based primarily on the presumption that Nagel's subjectivity problem had already been dealt with, which it hadn't.]

Colin McGinn (philosopher)

The Problem of Consciousness; *Problems in Philosophy*

The problem of mind-body dualism, how the "water of the physical brain is turned into the wine of consciousness", can never be solved because humans are simply not equipped (biologically). Although we don't have to invoke anything other than brain--no magic that contravenes the laws of nature--we will never fully understand the connection. McGinn is amaterialist, in that he thinks that the mind is a function of the brain. But beyond that, he's convinced there are things we simply can't know, because we're not equipped. "It's like monkeys trying to do physics," says McGinn. Or "like slugs trying to do Freudian analysis". "Which is not to say it's miraculous or has anything to do with God. It's just not available to us." The problem is one of "cognitive closure": that we are biologically incapable of understanding certain things, and consciousness is one of them. In his second book he claims this same cognitive closure for all major problems in philosophy.Thus he, as much as anyone in this list, harkens back to the Greek Sceptics. I admit that this is my favorite.

His claim has been widely dismissed as frivolous obscurantism, foreclosing the possibility of further research and licensing the wilder forms of religious mysticism. It is nothing of the sort. However he does, surprisingly, think that it is legitimate, in a way, to convert the mystery of consciousness into a theological system, since at least in that approach the fact that it cannot be understood is openly admitted.

[Note: I have read that even Noam Chomsky thinks that human consciousness may be beyond human understanding, but I don't know of a reference. This would be extremely interesting if true, since the approach that he initiated is at the heart of cognitive science.]

David Chalmers (philosopher, rather new kid on block)

The Conscious Mind (1995)

He, like a few others above, thinks neuroscience cannot explain subjective experience, or "qualia". Chalmers describes the so-called "easy" problems of consciousness, the sorts of questions being tackled in neuroscience laboratories around the world: How does sensory information get integrated in the brain (the "binding problem")? How do we see and reach out for an object? How are we able to verbalize our internal states and report what we are doing or feeling? What is the difference between awake and asleep? The "hard" problem is this: What is the nature of subjective experience? Why do we have vividly felt experiences of the world? Why is there someone home inside our heads? Thus far, nothing in physics or chemistry or biology can explain these subjective feelings, Chalmers said. "What really happens when you see the deep red of a sunset or hear the haunting sound of a distant oboe, feel the agony of intense pain, the sparkle of happiness or meditative quality of a moment lost in thought?" he asked. "It is these phenomena, often called qualia, that pose the deep mystery of consciousness." At the 1996 Tucson meeting on consciousness, people mounted four responses to the hard problem: it doesn't exist (e.g. Dennett, Churchland), it will be answered soon enough by conventional science (Crick,...), there must be something else in the universe that we do not yet understand (Penrose, Chalmers), and hey, forget it, we can never understand consciousness (McGinn, Searle).

But Chalmers wants to claim that consciousness (as *experience*) is an "irreducible" (can't be described as anything simpler) basic feature of the universe, like space and time, so it can be realized in all sorts of systems. He is largely viewed as a quack by the scientists (as

they view all philosophers), but because he has a degree in mathematics, he is given a little more credibility.

John Eccles (Nobel prize-winning neurophysiologist) and Karl Popper (historian, philosopher of science)

How the Self Controls the Brain

They claim that contemporary neuroscience is entirely compatible with the existence of an immaterial soul (a viewpoint known as body-soul dualism). Eccles is perhaps the last of the scientists who openly declares that he is a dualist when it comes to mind and consciousness. The rest of the consciousness community essentially think this is just silly. Cognitive science is extremely abhorrent of any dualism that sounds like "soul-talk" because they are firmly committed to a reductionist explanation of everything.