

Astronomy 330



This class (Lecture 20):
Cultural Evolution

Next Class:

Exam 2!

Quick Review in Discussion Section

Music: *Human Behavior*– Bjork

Exam 2



- Exam 2 is Thursday!
- Will be similar to Exam 1 (class voted for 40 questions + 2-3 extra credit).
- Cover from last exam up to last Thursday's lecture.
- Again, 1 sheet of notes is allowed.



Outline



- Will a civilization develop that has the appropriate **technology** and **worldview**?
- Cultural evolution moves towards technology.

Drake Equation

That's 2.7 x ? intelligent systems/decade

Frank Drake



$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations
9	stars/yr	0.29 systems/star	1.03 x 0.22 = 0.23 planets/system	0.46 life/planet	? intel./life	comm./intel.	yrs/comm.

Backdrop of Civilization



- Origin of modern H. sapiens is disputed, but the genetic and linguistic evidence points toward a spread of humans across Eurasia then the Americas.
- We share a common gene pool, but genetic drifts and selection for local environments created genetic differences among groups.
- These differences have little to do with the concept of race, which has been showed by genetic studies to be a meaningless concept.
- The greatest genetic and linguistic variations are found in Africa, supporting the “out of Africa” idea.



<http://www.popular-science.net/img/out-of-africa.jpg>

Cultural Evolution



- Once humans spread across the globe, the primary method for evolutionary change shifted from biological to cultural evolution.
- Anatomically modern H. sapiens evolved 100,000 yrs ago, but the first modern behavior did not appear until 40,000 yrs ago— e.g. cave painting.
- Regardless, there has not been any significant biological evolution for the last 40,000 yrs— e.g. brain increase.



http://www.codcottage.freemove.co.uk/images/hand_castillo_spain.jpg

Cultural Evolution



- The rest is cultural— from hunter-gathers to cell-phone-users.
- Cultural evolution was fast.
- Is cultural evolution needed for ET? Why would a ET culture try to communicate with us?
 - Capability (suitable technology) and interest (worldview?).



Hunting and Gathering



- Until 10,000 years ago, H. Sapiens functioned completely as hunter-gathers.
- Small nomadic tribes with few possessions.
- Except for shortages, a fair and easy life
 - No midterms/finals
 - Only working about 4 hours a day
 - But, no way to create surpluses or free members for other roles.
 - When things go bad, they really go bad.



http://www.cnn.com/WORLD/9511/safrica_bushmen/



Agriculture



- Tribal societies– 100s of people into villages
- Due to agriculture, larger and larger communities and new societal organizations.
- Began about 10,000 yrs ago, around the dead sea.
 - Mixed hunting with harvesting of wild wheat and barley.
 - Storage, planting, and seed selection.
 - Mutant varieties took over and hunting decreased.
 - 1000 years later, animal domestication.

<http://www.ffa.org/media/comm/index.html>



Agriculture



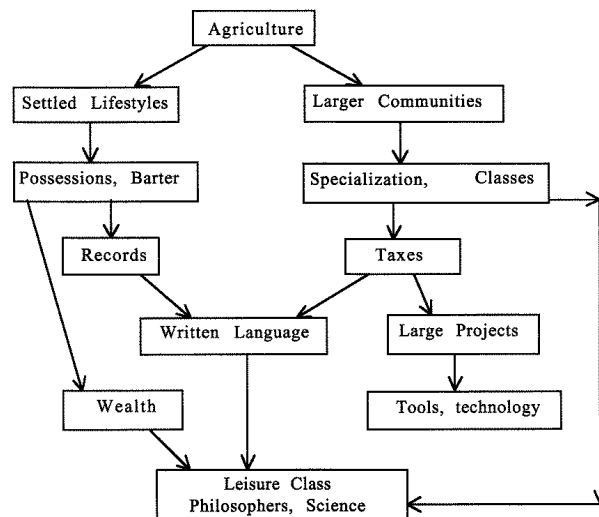
- Provided long-term settlements for cultural evolution, information, tools, and energy sources.
- At first purely agriculture communities are hard:
 - A lot more work
 - Usually dietary deficiencies



Qalat Jarmo in present day Iraq, one of the early farming communities, 6750 BCE

<http://www.ffa.org/media/comm/index.html>
http://ancientneareast.tripod.com/Qalat_Jarmo.html

The Importance of Agriculture



Question



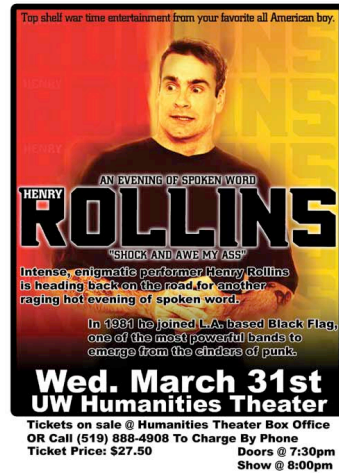
What cultural break-through eventually allowed for professional scientist, like Astronomy professors?

- Telescopes
- Religion
- The spoken word
- Agriculture
- Monkeys

Language and Information



- Limited size for brain, due to birth canal size, so limited bits of info.
- Need to develop **extra-somatic** (outside the body) information storage techniques.
- First method to store information from another person was spoken language.
- Crucial development.



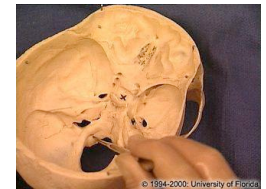
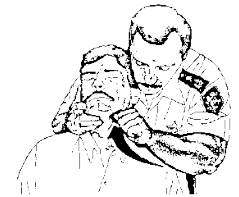
<http://www.feds.uwaterloo.ca/posters/henryrollins.jpg>

Language and Dis-Information



- But the origins of language are not well understood– no fossils.
- Probably in hunting parties for large prey.
- The control of the tongue is through the hypoglossal canal (hole) in the skull. In humans it is twice as large as chimps.
- First arose about 400,000 yrs ago in Australopithecines.

Hypoglossal Nerve



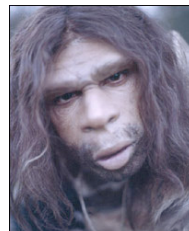
<http://members.aol.com/paroleinfo/PRESSURE.HTM>

<http://imc.gsm.com/integrated/haonline/haonline/ha/imgs/00000/3000/600/3604.jpg>

The Language Gene?



- FOXP2 was identified recently.
 - A severe speech and language disorder that affects almost half the members of a large family.
 - They are unable to produce the fine movements with the tongue and lips that are necessary to speak clearly.
- Human FOXP2 differs from chimp FOXP2 by only two amino acids, mouse by only 3, and zebra finch by only 7.
- Recent research shows that Neanderthal version is identical to ours. Maybe speech happened soon after chimp/hominid split?



http://news.bbc.co.uk/1/hi/newsid_6146000/6146908.stm

The Language Gene?



- FOXP2 also plays a role in songbirds
- In Zebra Finches a reduced FOXP2 results in incomplete and inaccurate song imitation.



Writing



- Oral language is clearly limited.
- Development of written language provided a powerful, new source of info storage.
- Earliest appearance was in Sumer– present day Iraq (8500 BCE).



MS 3008
Account of commodities, Sumer, ca. 3200 BC.
The earliest continuous writing known
<http://www.nb.no/baser/schoyen/4/4.4/441.html>

Writing



- Probably started from economic need– barter or receipts.
- Common by 3000 BCE.
- Written records of taxes and a ruling class– the rise of civilization.
- Move from symbols to syllabic language developed by 1500 BCE.



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Question



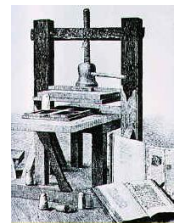
Language and writing are examples of

- a) culture.
- b) the FOXP2 gene.
- c) extra-somatic storage.
- d) how daddy went to jail.
- e) early government.

Extrasomatic Storage Leaps



- Printing press (1456) – number of books jumped from 10,000 to 10 million in 50 yrs.
- Telegraph (1844)
- Radio (1895)
- Television (1936)
- Computers (1950s)
- Internet (1970s)
 - Huge extrasomatic storage: Well above brain storage



Does all of this increase the “intelligence” of our species?

- A) Yes B) No

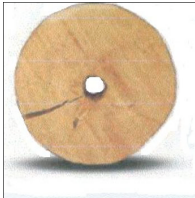


From Rocks to Metal



- Stone tools (silicates) started with H. habilis about 2 Myrs ago.
- Agriculture developed at the end of the stone age.
- First pottery (still silicates) around 7000 BCE.
- First metal (copper) in 6500 BCE, mostly ornamentation.
- The wheel was invented in 6500 BCE.

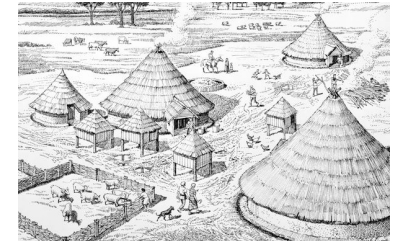
<http://www.angelfire.com/country/veneti/images/OldestWheel.jpg>



From Rocks to Metal



- Copper tools in 4000 BCE.
- Animal drawn vehicles & sailboats in 3300 BCE.
- Bronze (copper and tin) tools in 2800-1000 BCE (the Bronze age).
- Iron first showed up in 1500 BCE.



http://www.museumoflondon.org.uk/MOLsite/learning/who_are_you/teachers/images/citizenship/iron_age_settlement_no192.jpg

From Rocks, to Metal, to Rocks



- Next real step was developing energy sources.
- The industrial revolution.
- Modern technology based on electronics, crucial to our ability to communicate with ET.

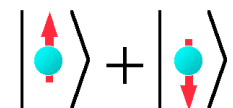


<http://www.learnhistory.org.uk/cpp/industrial-revolution-children-labor.jpg>

From Rocks, to Metal, to Rocks



- Transistor in 1948.
- Microchip in 1959.
- We went back to rocks— silicon!
We are arguably in the “silicon age”.
- This implies knowledge of electromagnetisms and quantum mechanics.



Question



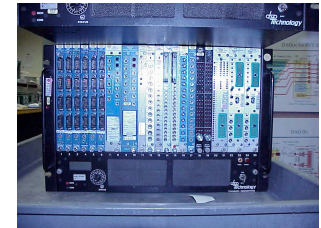
Which of the following is **not** an example of an extrasomatic storage technique?

- a) Brain synapses
- b) Wikipedia
- c) Printing press
- d) Language
- e) None of the above.

Cultural Evolution



- What do we mean by cultural evolution?
- Is that like evolution's natural selection?
- Since technology has developed out of it, we can conclude that technology was a desirable trait that is likely to develop on any planet with competition between cultures.



Cultural Evolution



- Or can we?
- If so, then would have to say that cultural evolution follows a punctuated equilibrium model.
- Or, episodic progress with long periods of dark ages.
- Like species, the fate of civilizations has been extinction, but their technology was adopted by others (cultural diffusion).

Evolution?



- The main point is how likely is it that technological civilizations exist on other planets?
- Hard to determine from Earth data, but there are some points:
 - Agriculture arose independently in Mexico and probably China, Andes (potatoes), and eastern US (sunflowers).
 - Written language independently in Sumer, China, and the Americas, maybe India and Egypt.
 - But, the wheel was not invented outside of Sumer– were examples of toys in South Americas
 - For recent developments, the world was in too much contact to distinguish.

Questions: Variations of Civilization



- What if the Americas had invented gunpowder?
- What if the Americas had large animals of burden?
- What if the germs of Europe were less dangerous than the germs of the Americas?
- Similar examples of cultural devastation in the Pacific Islands.
- Often cultures are wiped out from *Guns, Germs, and Steel* (by Jared Diamond)– manifestations of geography.

Technology Development



- Our sample of one makes it difficult to determine if technological development (to communication ability) is a fundamental step from intelligence.
- Does it depend on the planet– water/desert dominated?
- How would metal poor planets develop?
- Does the competition of civilizations matter?
- Is there a dependence on psychology of the intelligence life?

Technology

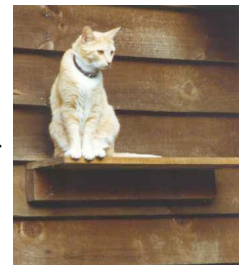


- Cultural evolution was fast.
- Especially after agriculture freed civilizations.
- Development of language.
- Increase of extra-somatic storage.
- We're living in a silicon age.
- Does the development of technology also include a correct worldview?

Next Step



- Besides needing technology, intelligent life must have a **want** to communicate with extraterrestrial life.
- That means that it MUST believe in the possibility of other life.
- Requires civilization to undergo three steps:
 1. A correct appreciation of the size and nature of the Universe
 2. A realization of their place in the Universe
 3. A belief that the odds for life are reasonable. The beings of Q'earth must have taken their Q'astro 330 class and came up with a good number of communicable civilizations in the Q'drake equation.



<http://www.bybeeweb.com/cats/amelia-step.jpg>

Big Questions



- Our capacity for interstellar communication arose at the same time as our interest in it. Coincidence?
- Can a society have a highly developed technology with an incorrect astronomy?
- What if the skies were constantly cloudy?
- What if their solar system had no other planets?
- What if they lived in a molecular cloud?
- What if they lived in a huge cluster of galaxies?

Copernican Revolutions



1. We are not the center of the Solar System.
2. We are not the center of the Galaxy.
3. We are not the center of the Universe.