From **Disease**, to **Personality**, to **Culture**, to the **Future of Civilization**

- Weird infectious diseases exist
- Syphilis makes people go crazy
- Guinea worms eat their way through the body
Guinea worm disease

• Worms typically chemically burn a hole or blister in the skin of the lower leg
  – (from the inside out)
• The victim eases the pain by soaking the limb in the nearest water supply
• The worm senses the water and immediately lays many thousands of eggs into the water
Guinea worm disease (cont.)

- The **eggs** hatch and the **larvae** are eaten by **water fleas**
- **People** drink the **fleas** with the **water**
- The larvae then burrow into the body, turn into worms, mate, the male dies and the female begins her painful journey
  - (Painful to us, that is)
- To remove a worm that burned its way through the skin:
  - Wrap it around a stick, pulling a few mm out every day, for weeks until worm is out
    - Up to 3’ long; “as wide as a paper clip wire”
Guinea worm disease – broader picture

• The Carter Center leads the eradication campaign
• People need to filter their water with a cloth to remove the fleas before drinking
  – Simple, but one needs to understand why
• People also need to not dunk painful exit wounds in the drinking water supply!
• Children tend to forget the most
• The disease can be wiped out forever
Guinea worm – historical note

• First described by the ancient Greeks
• At one time millions were infected
• May have inspired the long-time symbol of medicine: the rod of Asclepius

EMS (Emergency Medical Services) symbol

Often confused with the caduceus
• Do you think you might have guinea worm disease (dracunculiasis)??
Warning!

You may have something weirder than guinea worm disease.
About this disease

• Sufferers look healthy but have changes in personality
• Many changed personalities can change a culture
• Changing culture can change the course of nations
• Changing the course of nations could change the future of civilization

What spreads it?
How the disease spreads...

Cats

Credits: http://www.animals-in-need.org/Images/Cat.jpg
Many in the U.S. have toxoplasmosis


- **How it spreads:**
  - Cat eats infected small animal (e.g. mouse)
  - Cat does not get sick, but sheds many microscopic “oocysts” in droppings
  - Animal eats oocysts; **mice get less fearful of cats**
  - Another cat eats the animal and the cycle is complete

- **We get it by eating oocysts (or transplacentally)**
  - From undercooked meat, handling cat litter, etc.
Toxoplasma gondii. Source: http://newsimg.bbc.co.uk/media/images/41351000/jpg/_41351230_toxoplasma203.jpg
Toxoplasmosis Symptoms

• Infection by *Toxoplasma Gondii* is usually symptom-free
  – Some people get temporary flu-like symptoms or swollen lymph glands in the neck
  – Prenatal & natal infection can lead to retinochoroiditis & vision loss many (even 20+) years later

• According to Flegr (2007) it is “the most common protozoan parasite in developed nations”
Yet apparently there are symptoms


- Infection causes
  - poorer motor coordination
    - (2.65x higher traffic accident risk)
  - more apprehensiveness
  - less novelty-seeking
  - clothes tidiness
    - decreases in men, increases in women
  - self control decreases in men, increases in women
Gender differences in symptoms

— Men
  • tend to disregard rules more
  • are more “expedient, suspicious, jealous, and dogmatic”

— Women
  • are more “warm hearted, outgoing, conscientious, persistent, and moralistic”
Symptoms increase over time

• In general,

    longer duration of infection
    increases the differences
    between
    infected and uninfected individuals
but...Why?

• *Toxoplasma Gondii* manipulates behavior of mice
  – so cats can catch them easier!
• Does it manipulate monkey and chimp behavior?
  – at any rate, leopards etc. ("cats") eat them in the wild
• So why not accidentally manipulate humans too?
  – more car accidents = easier to eat us?
  – Or “on purpose”...make us want to own cats...
• Important: correlation ≠ causality
  – What if the causality was reversed?
  – What if both things were caused by a third factor?
  – We could look back at the previous slides...
Toxoplasmosis: mechanisms of behavior change

• It is thought that *T. gondii* increases dopamine in the brains of mice and men
  – Dopamine modification can explain some behavioral changes

• *T. gondii* is also thought to increase testosterone
  – Testosterone affects behavior
    • (thereby improving transmission? What do you think?)
  – Testosterone reduces immune function
    • (thereby improving transmission?)
From Behavior to Culture


  – If many people have behavior changes
    • then their culture may be changed as well

  – We might describe part of culture in terms of
    • Individualism
    • Sex roles
    • Uncertainty avoidance
    • Class distinctions
Personalities and *T. gondii* infection

More effects of latent toxoplasmosis infection...
(according to Lafferty, p. 2753, but not fully proven)

- **Men:**
  - Less intelligent, more reflective, rigid, stoic, loyal, slow-tempered, frugal, emotionally reactive, changeable, affected by feelings, emotionally less stable, easily upset

- **Women:**
  - More intelligent, rule-conscious, dutiful, conscientious, conforming, moralistic, staid, rule-bound, warm, outgoing, attentive to others, kindly, easy-going, participating
Personalities and culture

• Collective behavior could change culture
  – Maybe collective behavior *is* culture?

• “Environmental determinism”
  – the theory that the physical environment controls the course of civilizations
    • *T. Gondii* is part of the physical environment
    • It affects people by accident, because it affects rodents
      – Infected rodents are
        » more active, prone to enter traps, less fearful of cats and cat smells like urine, and mice have more brain dopamine
        » But what’s that got to do with people?
T. gondii and people

• “Currently, cats rarely eat humans, so there should be little selective advantage for T. gondii to specifically manipulate human behaviour. Still, T. gondii cysts infecting a human have nothing to lose, evolutionarily speaking, in trying manipulative strategies adaptive in other intermediate host species.” – Lafferty, p. 2750

• I predict:
  – infection and cat ownership are correlated
More effects on people

• Men often have different (even opposite) effects from women

• Increases ratio of newborn boys to girls up to 2.6:1 (http://discovermagazine.com/2007/feb/toxoplasma-gondii-culture-sex-ratio)

• Guilt-proneness increases for both genders
  – Implies greater apprehensiveness, self-doubt, worry, insecurity, tendency self-blame

• Guilt-proneness “corresponds” to neuroticism
  – “Male control, materialism, rules and structure” are “associated with neuroticism”

• Do these traits propagate to the larger culture?
Results: *T. gondii* and Culture

- Positive, but weak association with infection rate was found with
  - A national culture of uncertainty avoidance
  - Masculine sex roles (male control)

- What are the implications of this for
  - technology, law, politics, war, ...?
Results: *T. gondii* and Culture II

- Highly infected countries play soccer better!

- See e.g. [http://www.slate.com/id/2259350](http://www.slate.com/id/2259350)
  
  – The 5 top FIFA team countries won 8 of last 10 World Cups

  – Toxo increases testosterone in men (& mice)
Results: \textit{T. gondii} and Culture III

- \textit{T. gondii} has a gene for making tyrosine hydroxylase
  - Has a mammalian version of this, in fact!
  - (How might that have happened?)
  - Tyrosine hydroxylase upregulates dopamine
    - A neurotransmitter also upregulated by, e.g., cocaine

- Motorcycle fatalities have high rates of infection
- 3-4x risk of fatal auto wrecks “involving reckless speeding” - http://www.edge.org/3rd_culture/sapolsky09/sapolsky09_index.html
Some notes...

• Recall the correlation-causation fallacy:
  – Did A cause B?
  – Or did B cause A?
  – Or did C cause both A and B?
• “38% of meat products...in the UK test...positive for *T. gondii*, some...probably viable” – p. 2753
• Cultural effects of *T. gondii* might differ for western cultures vs. asian, african, etc.
• “Both anti-toxoplasma drugs and dopamine antagonists normalize the behaviour of infected rats” – p. 2750
Toxoplasmosis and the future

• If culture is affected, so may other things
  – Laws
  – Politics
  – War and peace (also title of novel by Tolstoy)
  – Career choices
  – Technological change
  – Economic growth
  – Disaster preparedness (inc. existential disasters)
  – Nuclear weapon policies

• Imagine a world mostly without *T. gondii* . . .
  – This is possible!

• How much of the future of civilization, and even the survival of humanity, at stake?
Toxoplasmosis and the future II

- Perhaps biotech engineers could mutate toxo and fine tune it for psychiatric use
- Military types are interested in toxo
  – Is it a national security issue?!!


http://blog.omy.sg/aussiepete/files/2010/08/fear01.jpg

http://www.clker.com/clipart-28744.html

http://www.skydivekc.com/Uploads/jagarrett/300x300_alert.jpg
Toxoplasmosis and the future II

• Perhaps biotech engineers could mutate toxo and fine tune it for psychiatric use
• Military types are interested in toxo
  – Is it a national security issue?!!
  – Might laws be passed requiring testing and antibiotic treatment?
  – Might it be deliberately spread in an enemy country?
• Will employers require testing?
• Would you want people running for office to be tested, treated/not, and/or disclose results?
What do you think?

• Get tested. There is a standard lab test for it
• If positive, get treated(?). It can be treated
• Vaccinate your cat(s). There is a vaccine
• Demand politicians reveal infection status
• Employment screening; other screenings
• Support research into more-resistant cats
• Cover sand boxes that children play in
• Consider not owning a cat(!?).
  – Rats are friendly, social animals and make great pets! And “rat” rhymes with “cat” so they’re almost the same thing