Thinking about Thought

- Introduction
- Philosophy of Mind
- Cognitive Models
- Machine Intelligence
- Life and Organization
- Ecology
- The Brain
- Dreams and Emotions
- Language
- Modern Physics
- Consciousness

Make it idiot proof and someone will make a better idiot
(One-liner signature file on the internet)

Session Five: Ecology

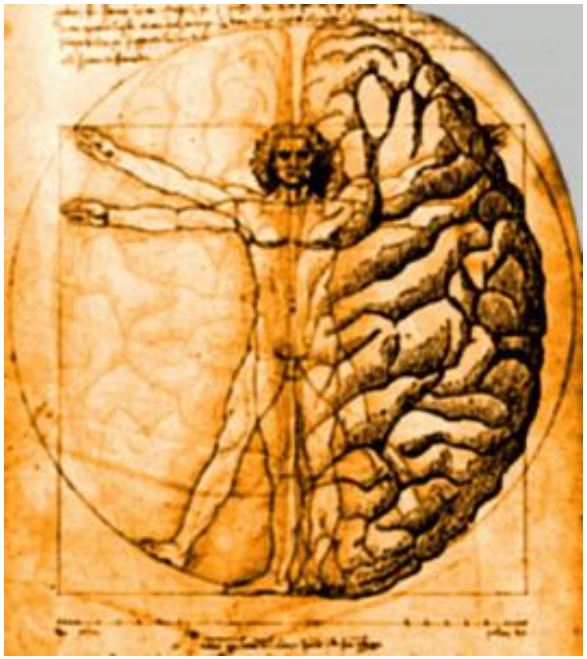
for Piero Scaruffi's class
"Thinking about Thought"
at UC Berkeley (2014)

Roughly These Chapters of My Book “Nature of Consciousness”:

11. Ecological Realism: The Embodied Mind

14. Altruism: From Endosymbiosis To Sociobiology

Ecological Realism: The Embodied Mind



"Life is what happens to us
while we are making other plans"
(Allen Saunders, 1957)

Ecological Realism: The Embodied Mind

- Is a transcendental disembodied mind possible?
- The brain is in the body, and the body is in the world
- Life is a continuously changing equilibrium between an organism and its environment
- The brain is one of the many organs that help an organism survive in the environment
- “Cognition” is about the interaction between organisms and their environment

Ecological Realism: The Embodied Mind

- Minsky and Searle: “Brains cause minds. Mind is what happens to brains.”
- How about: “Bodies cause minds. Mind is what happens to (some) bodies?”

Ecological Realism: The Embodied Mind

- Empiricism: All knowledge comes from experience (e.g., 20th century behaviorists)
- Platon: All knowledge comes from reasoning
- Kant: Perception is shaped by innate knowledge (space, time, cause/effect, etc)
- Helmholtz: Perception is a mere hypothesis on what the world is
- Ecological realism: our senses, shaped by natural evolution, don't tell us what the world is really like but simply what needs to be known for surviving and reproducing
- Perception is an active process

Ecological Realism: The Embodied Mind

- The mind operates in a world that is the outcome of the body's experience
- Jakob von Uexküll (1934)
  - The "umwelt" of a species is the set of all possible stimuli from the environment that the species can perceive plus all possible actions that the species can perform in the environment.
  - A species' reality is confined in its umwelt
  - Each species grasps reality differently because it lives inside a different umwelt.

Ecological Realism: The Embodied Mind

- Hermann von Helmholtz (19th c)
  - Mind is separated from the world and only knows what the senses deliver
  - The senses deliver signals, and the mind has to figure out how to interpret them
  - The mind uses whatever knowledge it has accrued
  - Perceptions are "hypotheses" on what reality just might be

The Information Flow

- James Jerome Gibson (1966): Cognition
  - Cognition “is” the interaction between living beings and the environment
  - The process of perceiving is a process of picking up information that is available in the environment
  - Information originates from the interaction between the organism and its environment
  - Information = continuous energy flow of the environment
  - Cognition is the information flow

The Information Flow

- James Jerome Gibson: Action and perception
  - The sensory data coming from the environment already contain all the relationships needed to navigate the environment.
  - No “representation” is needed by the brain
  - Cognitive life is passive, not active: the organism is free to move in the world, but it is the environment that feeds it information
  - The way this information is "processed" is direct: there is no mediation by the mind
  - Action follows perception, and the two can be viewed as dual aspects of the same process.

The Information Flow

- James Jerome Gibson: information patterns
  - What the brain truly does is recognize the information that matters.
  - The information that matters is patterns: any pattern of environmental stimuli that repeats itself over time constitutes "information".
  - Our brain is an organ capable of discovering "invariants" in the environmental stimuli
  - The information that matters is, ultimately, a pattern of energy that flows through the sensory system and that reflects the structure of the environment.

The Information Flow

- James Jerome Gibson: Perception
  - A continuously ongoing process
  - Detecting the invariants of the environment
  - The function of the brain is to orient the organs of perception for seeking information
  - Perception and action are not separate processes
  - Perception cannot be separated from the environment
  - Our perceptive system evolved in the environment, i.e. based on the information that is present in that environment
  - Perception, action and the environment are tightly related

The Information Flow

- James Jerome Gibson: Cognition
  - The environment is a source of stimulation
  - Organisms move in the world using all the information that is available in it
  - Perceptual organs are not completely passive: they can orient themselves to pick up information, to "resonate" with the information in the environment
  - There is much more information in the world and less in the head
  - The environment does most of the work that we traditionally ascribe to the mind

The Information Flow

- Ulric Neisser (1975): Cognition
  - Cognition as the skill of dealing with knowledge that comes from the environment
  - The mind developed to cope with that knowledge
  - Directionality of exploration by the organism: the organism is not completely passive in the hands of the environment, but somehow it has a cognitive apparatus that directs its search for information

The Information Flow

- Ulric Neisser: Cognition
  - The brain probably “knows” in advance which objects are more likely to be “seen” in a certain situation
  - "We can see only what we know how to look for"
  - Schemas express the direct relation between action and perception
  - A schema is a blueprint for what information the organism presumes to encounter and what it entails in the environment
  - A cognitive map guides the organism around the environment

The Information Flow

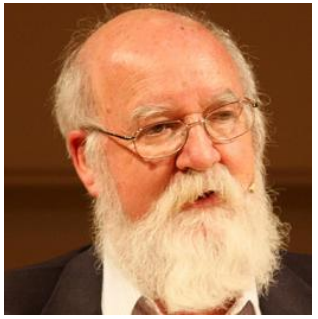
- Ulric Neisser: Perception
  - Perception is therefore a perennial cycle,
    - from schemas to action (schemas direct action)
    - …to information (action picks up information)
    - …to schemas (information modifies schemas)
  - The mind "filters" the huge amount of information that would exceed its capacity

The Information Flow

- Ulric Neisser: Perception
  - Perception is not about classifying objects in categories
  - Perception is about using the information available in the surroundings for the purpose of directing action in it.
  - Perception/cognition transforms the perceiver: an organism "is" the cognitive acts it engages in

Philosophical Variants

- Fred Dretske (1981)
  - Information is in the environment and cognitive agents simply absorb it, thereby creating mental states
- Daniel Dennett
  - The "intentional stance" defines the relationship between an organism and its environment
  - The organism continuously reflects its environment
  - The organization of its system implicitly contains a representation of the environment



Impact of Ecological Realism

- Reversal of the traditional role between the organism and the environment: the organism not as an actor but as a “reactor”
- Generalization of the concept of cognitive system: any living being can be considered, to some extent, a cognitive system
- A living organism is a part of the world capable of perception and action
- Life and cognition lose some of their exclusive status

Situation Theory

- Jon Barwise And John Perry (1983)
  - "Situational semantics" opposed to Frege's theory of meaning.
  - Frege: meaning is located in the world of sense
  - Barwise and Perry: meaning is located in the real world
  - Meaning is not an exclusive of language, it is pervasive in nature (e.g., smoke means fire)
  - Reality is made of situations
  - Situations are the unit of reasoning

Situation Theory

- Jon Barwise
  - The similarities between various situations make it possible for an organism to make sense of the world.
  - At the same time they are understood by all members of the same species, by a whole "linguistic community"
  - Relational nature of information (perception is a relation between perceiver and perceived)
  - Circumstantial nature of information (information is information about the world)
  - The mind, which processes that information, is controlled by the environment

Ecological Realism

- Radu Bogdan (1994)
  - Organisms manage to survive and multiply in the world by organizing themselves to achieve goals
    - Organisms evolve ways to identify and track goals
    - Such ways determine which knowledge is necessary
    - To obtain such knowledge, organisms learn to exploit recurrent patterns of information in the world
    - The information tasks necessary to manipulate such information "select" the appropriate type of cognitive faculties that the organism must be capable of

Ecological Realism

- Radu Bogdan
  - The mind is not only controlled by the environment: it was created (or at least “selected”) by the environment

Cognition As Adaptation

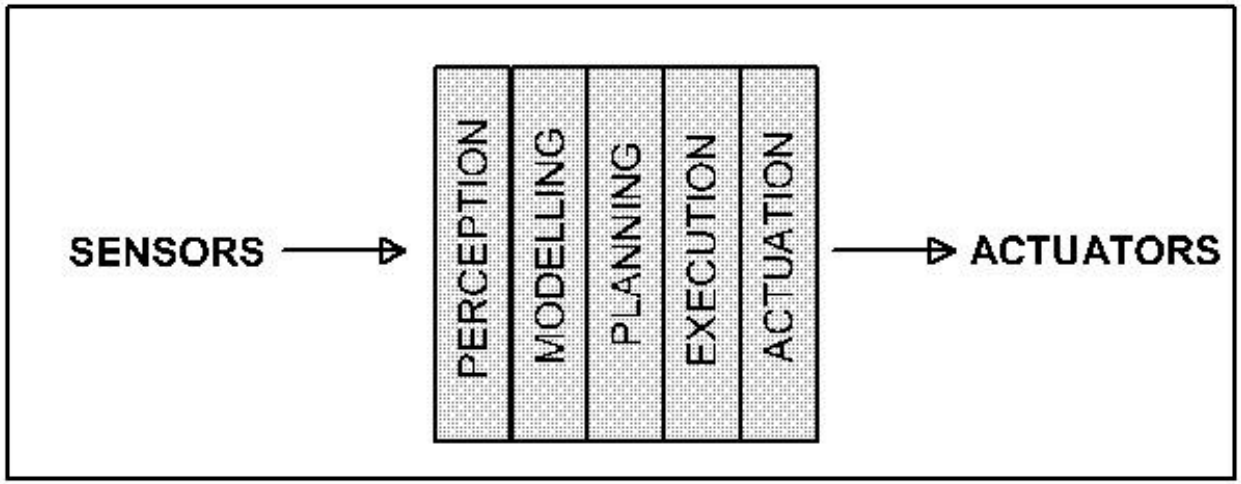
- Randy Gallistel (1980)
  - The nature of cognition lies in an organizational principle
  - “Something" enables living organisms to make rapid adjustments of patterns of action in response to the environment.
  - That "something" is the way they are internally organized.
  - No movement in nature is random, it always serves the purpose of "adapting" the state of the system to the external conditions

Situated Cognition

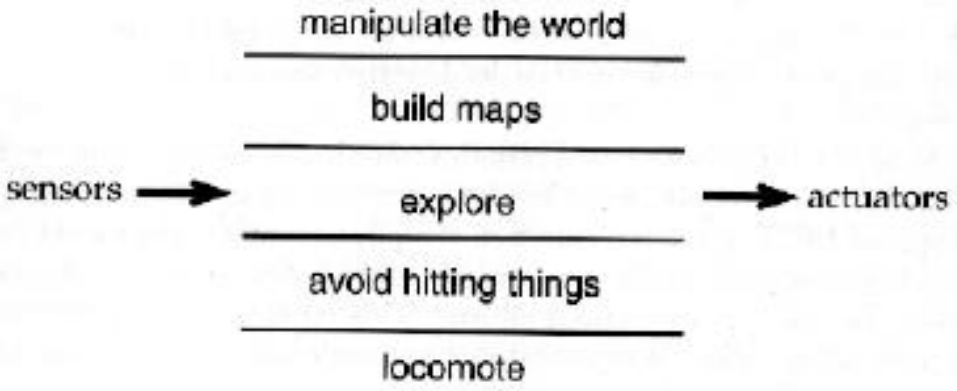
- Rodney Brooks (1986)
  - Robot = situated agent
  - Interaction between an agent and its environment.
  - Situated agents have no knowledge (unlike expert systems)
  - The world contains all the information that the organism needs, therefore there is no need to represent it in the mind
  - The environment acts like a memory external to the organism, from which the organism can retrieve any kind of information through perception

Situated Cognition

- Rodney Brooks



Traditional architecture



Brooks

Situated Cognition

- Rodney Brooks
  - Behavior is determined by the structure of the environment
    - The system decomposes in layers of goal-driven behavior
    - The system incrementally composes its behavior through the interaction with the world
  - No difference between perception, reasoning and action
  - The environment is the center of action, not the mind
  - The environment is action, continuous action
  - Cognition is rational kinematics.
  - Every intelligent being has a body!

Situated Cognition

- Rodney Brooks

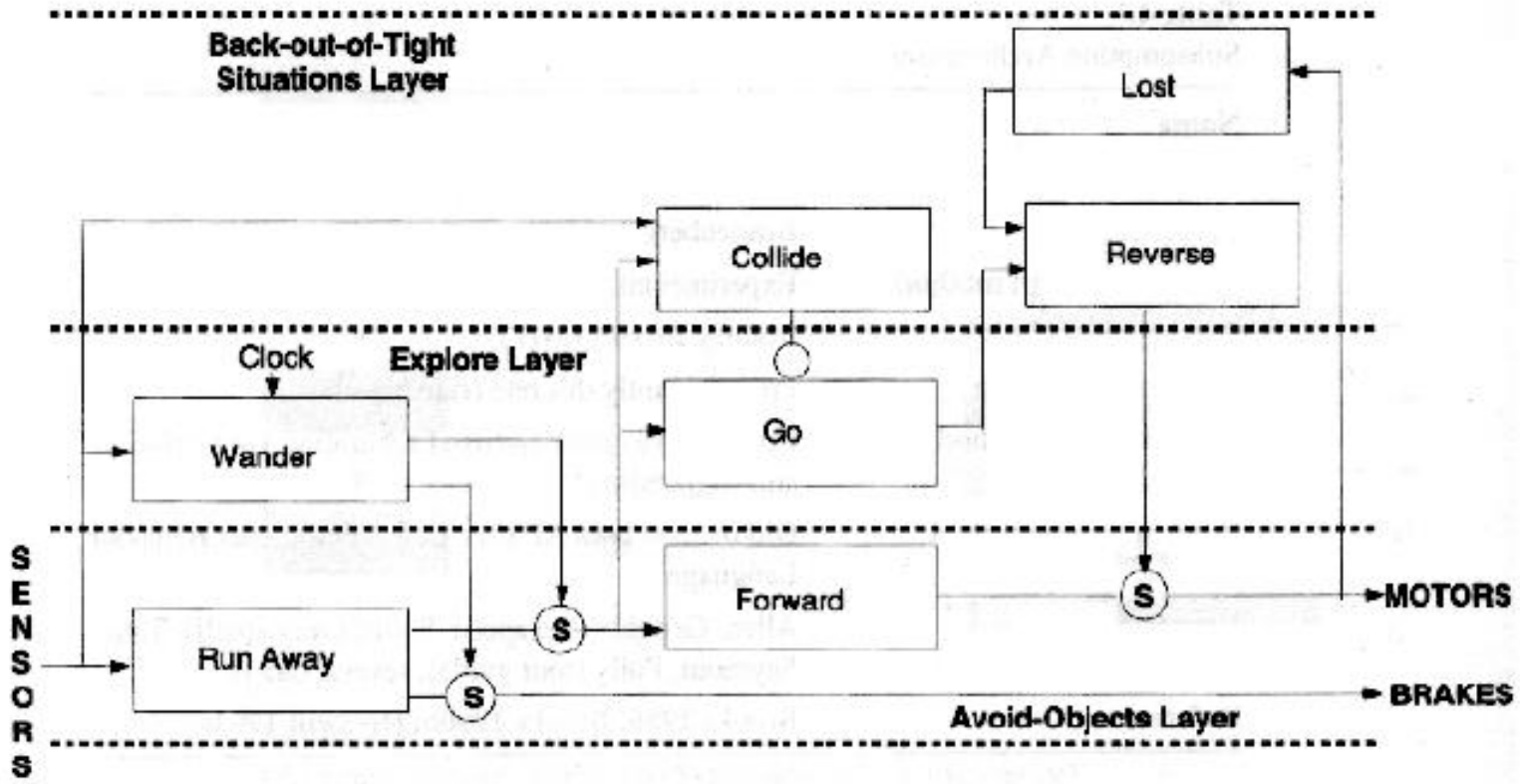
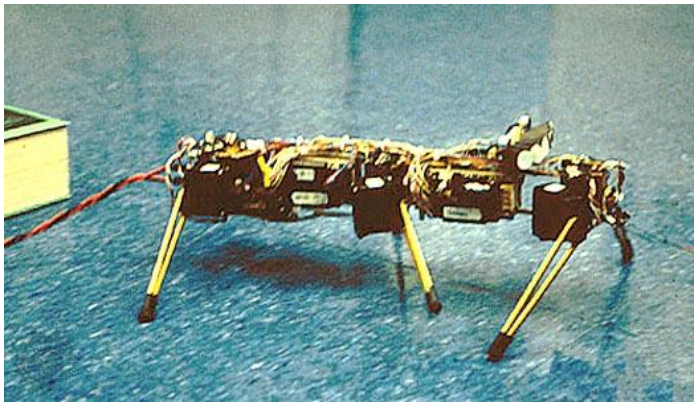


Figure 3 – Simple three-layered robot architecture (Brooks 1987)

Situated Cognition

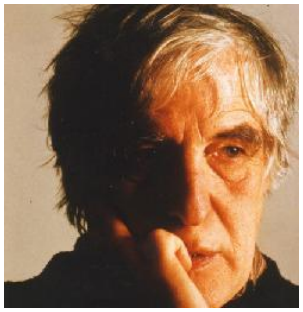
- Rodney Brooks



(1986)

Baxter (2012)

Situated Cognition



- Valentino Breitenberg (1984)
  - Vehicles: simple electro-mechanical components
  - At the beginning, there are only “vehicles” that respond to their environment.
  - As their circuitry increases, the vehicles seem to exhibit more sophisticated feelings.
  - Depending on the wiring Vehicle #2 is either "aggressive“ or "afraid".
  - These vehicles seem to acquire not only new skills, but also a stronger personality.
  - It is far easier to create machines that exhibit "cognitive" behavior than it is to analyse their behavior and try to deduce the internal structure that produces such behavior

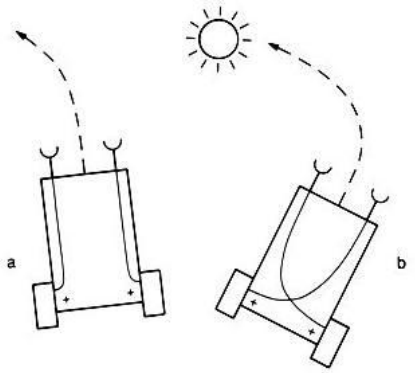
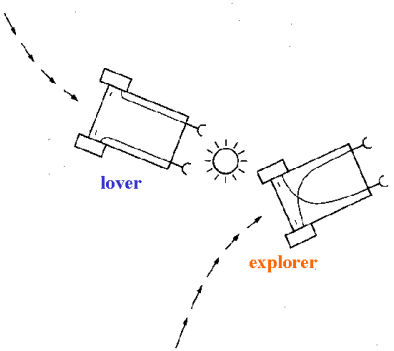


Figure 3
Vehicles 2a and 2b in the vicinity of a source (circle with rays emanating from it). Vehicle 2b orients toward the source, 2a away from it.



Situated Cognition

- Richard Carlson (1997)
  - Mental representations must have a "performatory" character, they must have to do with our body, they must be about performing an action in the environment.
  - Most cognitive skills are not conscious, or non-conscious (e.g., understanding language).
  - Consciousness is necessary only when learning the skill.
  - Introspection is actually difficult for experts, who often cannot explain why they do what they do.
  - Most of our cognitive activity comes from a specific kind of learning: skill acquisition.
  - Cognition is embodied and situated: it is always about our body and/or our environment.

Situated Cognition

- Andy Clark (1997)
  - We can dispose of the body and still find ways that a brain would calculate how to perform actions
  - But the very reason that we have bodies is that bodies make it a lot easier to perform those actions even without calculating every single movement
  - The fact that a body's movements are constrained by the body's structure is actually an advantage: once the brain directs a general action, there are only so many ways that the action can be carried out by the body.
  - There is no need to calculate ways that are beyond the capabilities of the body.

Ecological Realism

- Summary
  - Minds belong to bodies!
  - James Jerome Gibson
  - Ulric Neisser
  - Rodney Brooks
  - Valentino Breitenberg
  - Reversal of the traditional role between organism and environment
  - Generalization of the concept of cognitive system

Autopoiesis

- Humberto Maturana (1970)
  - The frog sees patterns of small moving shadows and , by reacting to those patterns, catches insects, its food stuff (1959)
  - "Autopoiesis" is the process by which an organism can continuously reorganize its own structure
  - Adaptation consists in regenerating the organism's structure so that its relationship to the environment remains constant
  - Living systems are units of interaction
  - They cannot be understood independently of their environment
  - The relationship with the environment molds the configuration of a cognitive system

Autopoiesis

- Humberto Maturana
  - Living systems are organized in closed loops
  - Goal: maintaining the circular organization of the whole.
  - A cell exhibits autopoiesis, as does the Earth as a whole.
  - Autopoiesis is self-maintenace
  - The product of a living system is a new organization of itself
  - A living system continually produces itself
  - Organisms use energy (mainly from light) and matter (water, carbon, nitrogen, etc) to continuously remake themselves

Autopoiesis

- Humberto Maturana
  - The circular organization of living organisms constitutes a homeostatic system whose function is to maintain this very same circular organization.
  - This circular organization helps maintain the organism's identity through its interactions with the environment
  - Cognition is biological in the sense that the cognitive domain of an organism is defined by its interactions with the environment.
  - Cognition is the way in which an autopoietic system interacts with the environment (i.e., reorganizes itself)

Autopoiesis

- Humberto Maturana
  - All living systems are cognitive systems
  - Action and cognition cannot be separated (”All doing is knowing and all knowing is doing")
  - Cognition is biological
  - Evolution is a natural drift, a consequence of the conservation of autopoiesis and adaptation.
  - Communication is not about transmission of information but rather coordination of behavior among living systems.

Autopoiesis

- The biosphere as a whole is autopoietic as it maintains itself through a careful balance of elements
- Life (the sum of all living beings) can counter cosmological forces and make sure that the Earth continues to be a feasible habitat for life
- Lynn Margulis: life "is" the surface of the Earth

Autopoiesis

- Vladimir Vernadsky (1926): living matter is the most powerful of geological forces
- James Lovelock views the entire surface of the Earth, including "inanimate" matter, as a living being (which he named "Gaia").
- Vernadsky: the Earth is developing its own mind, the "noosphere

Autopoiesis

- Francisco Varela (1979)
  - The human body is a collection of both matter and experience, both a biological entity and a phenomenological entity
  - Cognition is embodied action (or "enaction")
  - The world reflects the actions in which we engage, i.e. it is "enacted" from our actions
  - Organisms and environment mutually specify each other
  - Organisms drift naturally in the environment.
  - Evolution is not optimal adaptation but "natural drift"

Autopoiesis

- Francisco Varela (1999)
  - "*The mind is not in the head"*
  - *"The mind is in this non-place of the co-determination of inner and outer, so one cannot say that is outside or inside"*
  - Mind is *"a coherent whole which is nowhere to be found"*
  - "*The mind neither exists nor does it not exist "*
  - My mind is a "*selfless self"*

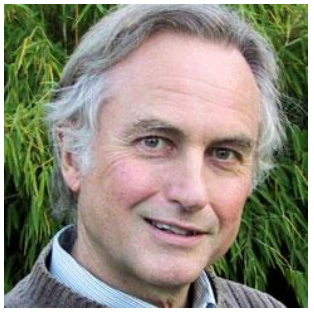
Autopoiesis

- Mark Johnson (1987)
  - We are bodies connected to the world
  - The human body is not just a machine that passively receives perceptions. It is an entity involved in a complex interaction with the world and with other bodies.
  - Human rationality is “embodied” because our reality is shaped by bodily movements
  - Our mental life is a creation of this embodiment.

The Extended Phenotype

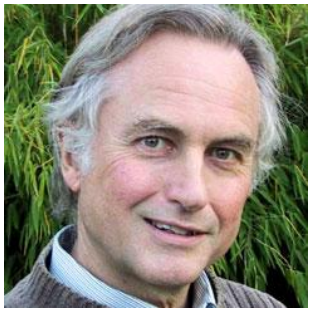
- Richard Dawkins (1982)

The Extended Phenotype



- Richard Dawkins (1982)
  - The "extended phenotype" includes the world that an organism interacts with
  - The organism alone does not have biological relevance
  - What makes sense is an open system made of the organism and its neighbors
  - The very genome of a species can be viewed as a representation of the environment inside every single cell

The Extended Phenotype



- Richard Dawkins (1982)
  - The control of an organism is never complete inside and null outside: there is a continuum of degrees of control, which allows partiality of control inside (e.g., parasites operate on the nervous system of their hosts) and an extension of control outside (as in the spiderweb)

The Extended Phenotype

- Ruth Millikan (1987)
  - The "system" must include more than just the organism, something that extends beyond its skin
  - The immune system can only operate if it is attacked by viruses
  - Tools are an extension of the organism

The Extended Phenotype

- Richard Lewontin (1981)
  - Each organism is the subject of continuous development throughout its life
  - Such development is driven by mutually interacting genes and environment
  - Genes per se cannot determine the phenotype

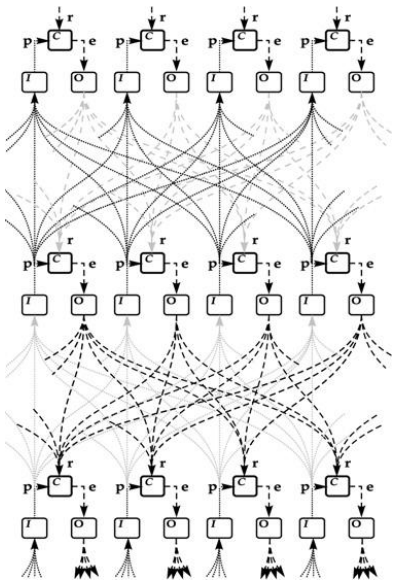
The Extended Phenotype

- Richard Lewontin (1981)
  - Organisms construct environments that are the conditions for their own further evolution and for the evolutions of nature towards new environments
  - Organism and environment mutually specify each other
  - An organism is both the subject and the object of its evolution

The Extended Phenotype

William Powers (1973)

- An organism is ultimately a hierarchy of control systems, each of which senses something in the environment and tries to control it
- This hierarchy of goals extends outside the system into their ecosystem



Organism

Environment

Sensory Exotica

Some animals have other senses

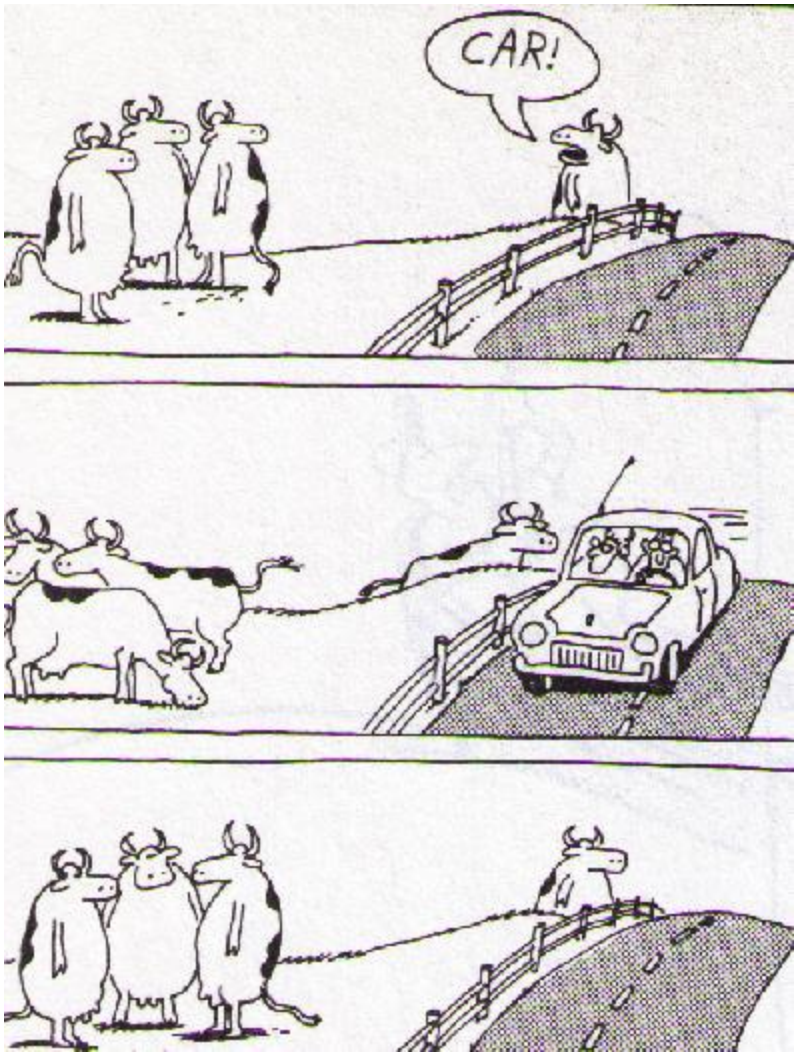
- The bat can avoid objects in absolute darkness at impressive speeds and even capture flying insects
- Dolphins generate their sonar calls also through their nose, besides their larynx
- Migratory animals (birds, salmons, whales…) can orient themselves and navigate vast territories without any help from maps
- Butterflies take more than a generation to complete the journey, i.e. those who begin the journey are not the ones that reach the destination

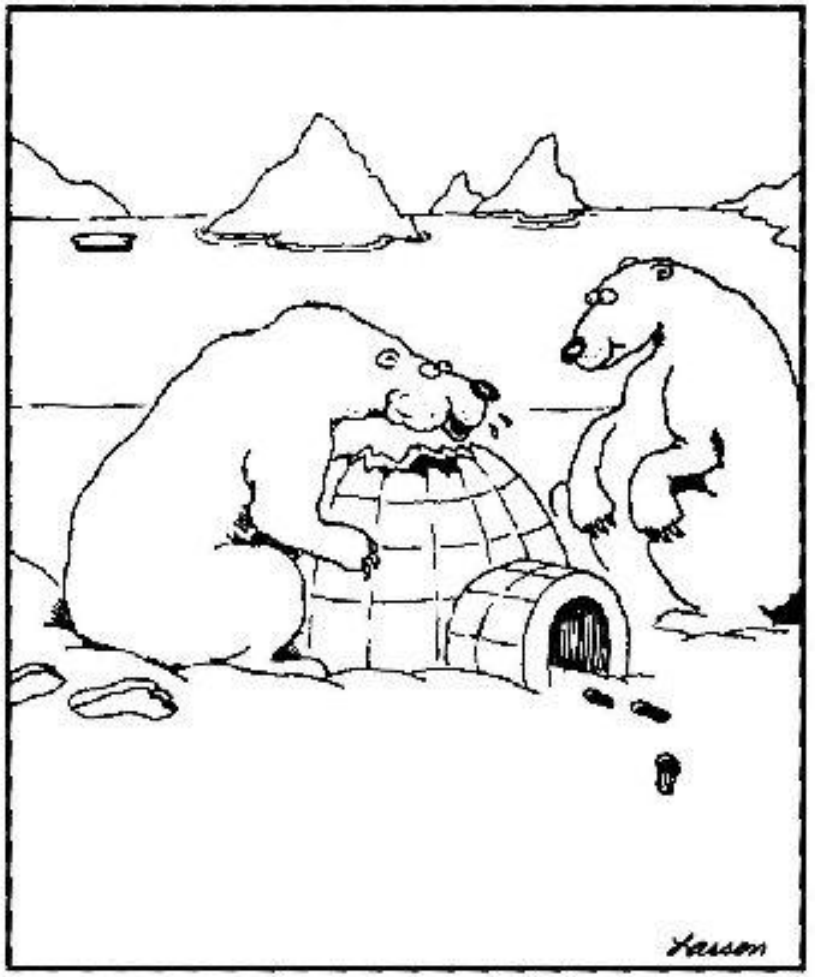
Sensory Exotica

Some animals have other senses

- Birds are equipped with a sixth sense for the Earth's magnetic field
- Bees know where the Sun is even when they cannot see it because their eyes can see ultraviolet sunlight
- Many animals can camouflage
- Some fish emit electrical current
- Cephalopods can even change body shape

Sensory Exotica





"Oh, hey! I just love these things! ... Crunchy on the outside and a chewy center!"

The Farside

Logic vs Biology

- Abstract manipulation of symbols vs bodily experience grounded in the environment
- Meaning based on truth and reference vs meaning based on the relationship between body and environment
- The mind independent of the body vs the mind back firmly in the body and the body in the environment and meaning in the relationship between them
- All minds use the same reasoning system vs the reasoning system we use depends on our collective experience as a species and on our individual experience as bodies

Ecological Realism

- Summary
  - Humberto Maturana and Autopoiesis
  - Richard Dawkins and the Extended Phenotype

Break

"Nature has all the answers, so what is your question?"
(Howard Odum)

Altruism

"Hell is other people"
(Sartre)

Altruism

- The Veneer Theory of human morality: morality is just a thin veneer over a cauldron of selfish brutal instincts

Altruism

- Darwin's theory of evolution ("survival of the fittest") is ultimately about competition for scarce natural resources

Altruism

- Competition belongs to a powerful thread of Western thought (Adam Smith, capitalism)
- Cooperation belongs to a very minor thread of Western thought
- Cooperation more likely to emerge out of communist and Eastern philosophical backgrounds

Altruism

- Petr Kropotkin (1902)
  - Animals must be social and moral
  - Not an individual struggle for survival, but struggle for survival by masses of individuals, a struggle not against each other but a collective struggle against the common enemy, i.e. the environment
  - Cooperation is more important than competition

Altruism

- Kinji Imanishi (1941)
  - Darwin was wrong
  - Cooperation is more important than competition in nature
  - Individuals form societies and cannot exist outside societies because it is through societies that they can solve the needs required to their survival

Altruism

- George Williams (1966)
  - An individual's chances of survival are increased by having friends and decreased by having enemies
  - Evolution has endowed individuals with "altruistic" instincts and emotions because it helps them survive

Altruism

- George Williams (1966)
  - Genes encouraging altruism would quickly become extinguished, and therefore genes must be "selfish" in nature (gene selectionism ante-litteram)
  - The origin of sexual selection: for a woman the main "investment" to reproduction is giving birth and nurturing the baby, a lengthy and complex consequence of a few minutes of sex; for a man the main investment is just those few minutes of sex (evolutionary psychology ante-litteram)

Altruism

- John Maynard-Smith (1973)
  - Game theory proves that individuals cooperate not because they share genes but because cooperation is the best strategy

Altruism

- John Maynard-Smith & Eors Szathmary (1993)
  - Each major transition in evolution affected biological units that were capable of independent replication, and each transition turned them into biological units that needed other biological units in order to replicate
    - Independently replicating nucleid acids evolved into chromosomes (assemblies of molecules that must replicate together)
    - Sexless life was replaced by species that have male and female members, and that can replicate only if a male and a female “cooperate”
    - Ants and bees can only replicate in colonies
  - Each “major transition” seems to produce cooperation

Altruism

- John Maynard-Smith & Eors Szathmary (1993)
  - In each major transition, sets of identical biological units were replaced by sets of specialized units that needed to cooperate in order to survive and replicate
  - A world of multifunctional self-sufficient biological entities evolved into a society of specialized entities
  - The multifunctional cell led to cellular organization and eventually to bodies with specialized limbs and organs that eventually led to societies of specialists (ants, bees, humans)

Altruism

- John Maynard-Smith & Eors Szathmary (1993)
  - Division of labor among a group of specialists is more effective than a multifunctional non-specialist but only if the specialists cooperate
  - Altruism, or at least division of labor and cooperation, appeared very early in the history of life, as soon as molecules were enclosed within membranes.

Altruism

- John Maynard-Smith & Eors Szathmary (1993)
  - Cooperation is inherent in Mendel's laws: a gene's chances of surviving in future generations depends on the success of the cell that hosts that gene, a success that depends on the success of all the other genes that determine the life of that cell
  - Hence a gene has a vested interest in "cooperating" with the other genes.
  - The cell would not survive if its genes did not form an efficient society.

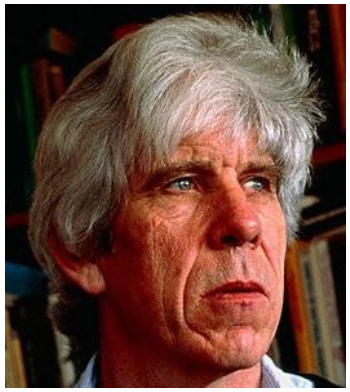
Altruism

- Peter Corning (2003)
  - Darwinism cannot explain complexity (on large scales) precisely because its emphasis is on competition and not cooperation.
  - Living beings actively participate in determining their own evolutionary future by
    - 1. Continuously reshaping the environment that will "select" their evolution
    - 2. Learning behavior that is not in their genes and passing it on to the next generation
  - Humans, the most active living systems, have "invented themselves" by creating the environment that they wanted.

Altruism

- Kin selectionism
  - John Haldane (1955)
    - Altruism is proportional to genetic proximity
    - The genetic self-interest of the individual peaks in its own body, but it extends to all of its kin, proportional to how genetically close they are
    - It is not the survival of the individual that matters: it is survival of as many genes as possible
    - The individual is programmed to preserve not only itself but also other individuals that share a similar genetic repertory, in a manner proportional to that similarity.

Altruism



- Kin selectionism
  - William Hamilton (1964)
    - Altruism helps genes even if at the expense of the survival of a specific individual
    - The social behavior of animals and humans can be explained from the viewpoint of evolution, i.e. human behavior is largely determined by our genome (sociobiology ante-litteram)

Altruism

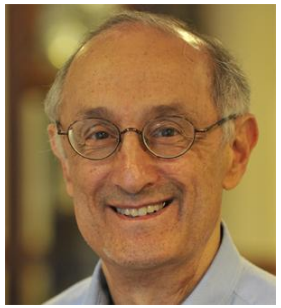
- Group selectionism
  - Vero-Copner Wynne-Edwards (1962)
    - It is groups (rather than single individuals) that adapt to the environment
  - David Sloan Wilson (1975)
    - Groups often behave like organisms
    - An organism can be viewed as a collection of genes that work together towards maximizing their common chances of survival
    - "Selfishness beats altruism within groups. Altruistic groups beat selfish groups."

Altruism

- Group selectionism
  - Robert Trivers (1971)
    - Individuals can benefit in the long term by trusting each other
  - Frans de Waal (1996)
    - Communities yield benefits to the individual, and that is the biological reason the individual will try to promote the community
  - Human morality is based on the idea of exchange
  - A member must be willing to sacrifice part of her individuality in order to be part of a society, which, in turn, increases her chances of survival.

Altruism

- Group selectionism
  - Robert Axelrod's "Tit for Tat" (1981)
  - Karl Sigmund and Martin Nowak (2005)
    - Competition leads to cooperation
    - Direct reciprocity : "You scratch my back, and I'll scratch yours"
    - Indirect reciprocity: "I help you and somebody else helps me"



Altruism

- Matt Ridley (1993)
  - Co-evolution with parasites
  - Evolution is accelerated even by apparent enemies like parasites
  - Organisms adopted sexual reproduction in order to cope with invasions of parasites: parasites have a harder time adapting to the diversity generated by sexual reproduction, whereas they would have devastating effects if all individuals of a species were identical (if the children were as vulnerable to the same diseases as the parents)
  - Plants reproduce with the help of insects
  - The need to fight competition often leads to cooperation

Summary

- The emphasis in evolutionary theories has traditionally been on competition, not cooperation, although it is through cooperation, not competition, that considerable jumps in behavior can be attained.
- In a sense, living beings, and humans in particular, have mastered altruism the same way they mastered tools that allowed them to extend their cognitive abilities
- Humans are able to deal with large groups of non-relatives
- De facto, those individuals are “used” as a tool to augment the mind: instead of having to solve problems alone, the mind can use an entire group.

Endosymbiosis

- Structural coupling: organisms are composites
  - The problem:
    - Darwinian variation alone is hardly capable of accounting for the extraordinarily complex assembly of a new organism
    - Gould's punctuated equilibrium is hard to explain if the forces at work are linear
    - Lateral gene transfer: genes are passed not only vertically from generation to generation but also horizontally from one species to another (e.g., eukaryotes evolved from archaea but with a little help from bacteria)

Endosymbiosis

- Structural coupling: organisms are composites
  - The solution:
    - Structural coupling creates more and more complex organisms
    - Humberto Maturana: "autopoiesis" is a process to generate progressively more and more complex organisms
    - Ben Goertzel (1993): organisms capable of effectively coupling with other organisms are more likely to survive
    - Darwinian evolution can occur much faster and can exhibit sudden jumps to higher forms

Endosymbiosis

- Konstantin Merezhkovsky (1909): symbiogenesis
  - One fateful day a mycoid managed to become the nucleus of an ameboid rather than its meal

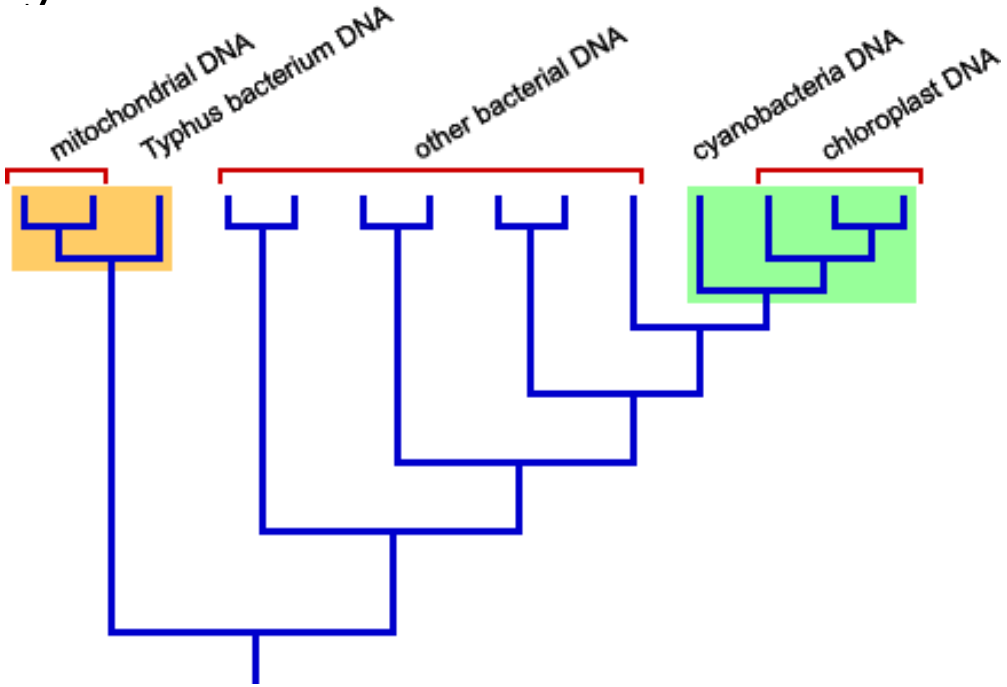
- Ivan Wallin (1927): endosymbiosis
  - Bacteria may represent the fundamental cause of the "origin of species"

Endosymbiosis

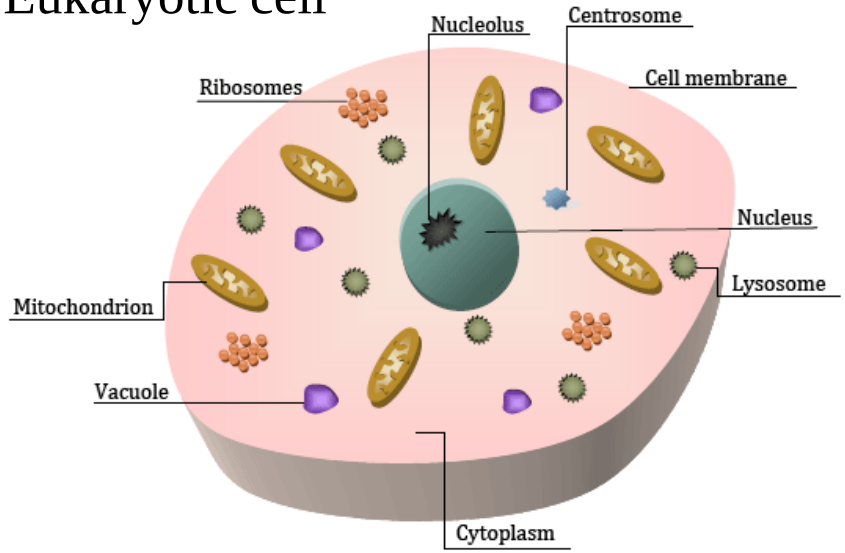
- Lynn Margulis (1966):
  - Mitochondria (that generate the energy required for metabolism in humans) look like bacteria
  - Mitochondria have their own DNA, separate from the DNA of the cell
  - Chloroplasts (that carry out photosynthesis in plant cells) look like bacteria
  - Bacteria can trade genes
  - Bacteria can reproduce at amazing rates
  - Endosymbiosis of bacteria is responsible for the creation of complex forms of life
  - Our multicellular bodies are amalgams of several different strains of bacteria

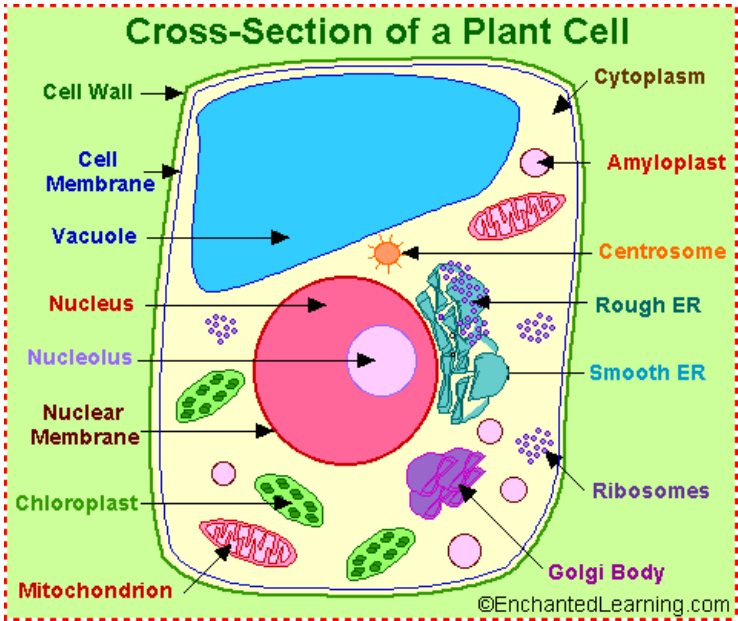
Endosymbiosis

- Endosymbiosis



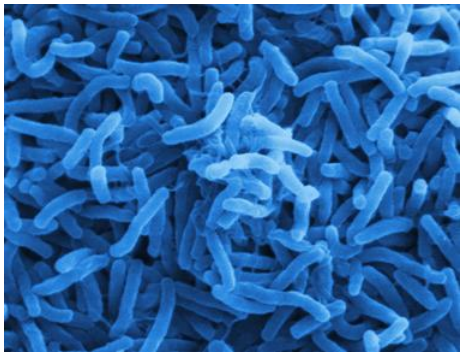
Eukaryotic cell





Endosymbiosis

- A world of bacteria
  - Life can be viewed as a plan for bacteria to exist forever
  - The biosphere is controlled mostly by bacteria
  - The biosphere is "their" environment, not ours
  - Even the geology of our planet is due to the work of bacteria (shaped by the work of bacteria over million of years)
  - We are allowed to live in it, thanks to the work of bacteria, which maintain the proper balance of chemicals in the air



Endosymbiosis

- A world of bacteria
  - More than 90% of the cells that make up the human body are not human: they are bacteria
  - Commensal bacteria are vitally important for our survival
  - There are more than 1000 species of bacteria in the human digestive system alone (and many more in the respiratory system, in the urogenital tract, on the skin, etc)
  - We are a superorganism, or, at least, a walking and thinking ecosystem

Endosymbiosis

- Luis Villarreal (2004)
  - A virus is a parasite that comes alive, and replicates, only while it feeds on host cells
  - The genetic instructions of the virus induce the host cell to manufacture the genes that the virus needs in order to assemble a copy of itself
  - Their fast replication continuously creates new genes, and that process of gene manufacturing takes place inside another organism
  - Some of those might get “transferred” permanently to the infected organism
  - Evolution by viral infection

Superbeings

- Collective beings
  - Single-celled bacteria form large colonies in countless ecosystems, particularly visible in seaside locations.
  - Soil amoebae join together in one huge organism that can react quickly to light and temperature to find food supplies.
  - Sponges are actually collections of single-celled organisms held together by skeletons of minerals
  - Ants and bees show that the difference between a multi-cellular organism and a society of organisms resides only in the type of internal communication

Superbeings

- Collective beings
  - Karl Von Frisch (1967)
    - The individual is an oxymoron: a bee cannot exist without the rest of the colony
    - The colony, on the other hand, constitutes a complex and precise self-regulating system
    - The hive exhibits a personality, the individual is totally anonymous

Superbeings

- Collective beings
  - Lewis Thomas (1974)
    - "I have been trying to think of the earth as a single organism, but…I cannot think of it this way. It is too big, too complex, with too many working parts….it is most like a single cell.“

Superbeings

- Guy Murchie (1978)
  - The entire Earth is an organism which uses as food the heat of the sun, breathes, metabolizes
  - The Earth's cognition is made of many tiny parts (organisms) that communicate, exchange energy, interact
  - All living organisms, along with all the minerals on the surface of the Earth, compose one giant integrated system that, as a whole, controls its behavior so as to survive
  - And so do galaxies
  - Everything constitutes a living superbeing
  - The question is not whether there is life outside our planet, but whether it is possible to have "non-life"

Superbeings

- James Lovelock (1979): Gaia
  - The entire surface of the Earth, including "inanimate" matter, is a living being
  - There is a gigantic cycle that involves the actions and structure of all matter and eventually yields "life" on this planet
  - The environment (volcanoes, rocks, sea water, sun, rain) is part of life
  - At the same time life creates the environment that it needs
  - Life creates the conditions for its own existence.

Superbeings

- Fritjof Capra (1996): the entire planet is a self-organizing network
- Deborah Gordon (1999): ants organize themselves like an organism

Superbeings

- Pierre Teilhard de Chardin (1925)
- Vladimir Vernadsk (1926)
  - "Noosphere“: the Earth is developing its own mind, the "noosphere", the aggregation of the cognitive activity of all its living matter.

Gene Selectionism

Richard Dawkins (1976)

- The gene is the fundamental unit of evolution: genes drive evolution and genes drive behavior
- Genes want to live forever
- A "replicator" is an entity that copies itself
- A "vehicle" is the organism that carries the replicator
- A replicator is preserved over time and spread over space

Gene Selectionism

Richard Dawkins (1976)

- Vehicles are merely “tests” of how good that information is
- Vehicles are the machines that replicators use to build copies of themselves
- Bodies will disappear
- Genes have a chance to survive forever
- What survives is not my body but my genes
- The mind itself is engineered to perpetuate DNA

Gene Selectionism

Richard Dawkins (1976)

- In order to maximize its chances of survival, a gene would cause one of its bodies (one of the bodies that contain that gene) to help its "kin" (bodies with the same gene)
- The macroscopic effect would be cooperation among organisms, while at the microscopic level that cooperation is truly an attempt by the gene to outsmart other genes, i.e. it is competition of the most cynical kind

Gene Selectionism

- Helena Cronin (1992)
  - "I" am not the subject, i am the object

Gene Selectionism

- Matt Ridley (1994)
  - Sex provides a way for a gene to participate in a lottery a number of times: each body is a participant in the lottery of survival.
  - The more bodies, the more chances to win the lottery.
  - Winning this lottery entails some work: creating and maintaining the organism
  - This work must be done jointly with other genes
  - Sex is the process by which a gene is chosen to work in a body together with other genes

Gene Selectionism

- I am but a product of my genes
- Genes represent a higher force than my will, a force that has been acting for millions of years
- Genes tell me what to will
- Genes tell me how to interact with other people and with the environment

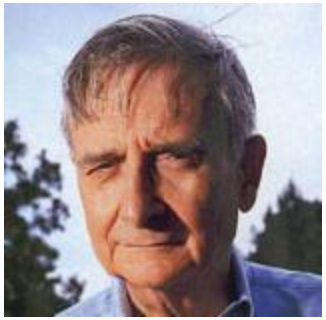
Gene Selectionism

- What a gene would say if teaching altruism
  - If you are a gene, you have no problem sacrificing some of your bodies to save some others
  - Your ultimate goal is to survive (you are the gene) and you can use any of those bodies as vehicles to continue your journey through time.

Summary

- Endosymbiosis
- Superbeings
- Gene selectionism

Sociobiology



- Edward Wilson (1975)
  - The biological basis of social behavior
  - Culturgenes
  - All aspects of human culture and behavior are coded in the genes and have been molded by natural selection
  - Culture is not unique to humans
  - A culture expresses itself through its "culturgens“, the cultural equivalent of genes
  - These are the basic units of inheritance in cultural evolution
  - Culturgens assemble the mind of an individual

Evolutionary Psychology

Prehistory of Evolutionary Psychology

- William Hamilton (1963): The Genetic Evolution of Social Behavior
- Angus Bateman (1948): natural selection has determined different male and female behaviors.
- George Williams (1966): the "sacrifice" required for reproduction is different for the female and the male
- Robert Trivers (1972): the investment required for reproduction (to increase the chances of survival of the offspring) is different between a male and a female, and that accounts for different attitudes towards the other sex and the offspring itself

Evolutionary Psychology

- Leda Cosmides and John Tooby (1992)
  - The biological origins of human behavior
  - For example, natural selection has molded the brains of men and women in different ways as a result of their different reproductive goals

Evolutionary Psychology

- Robert Wright
  - Freud's subconscious replaced with Darwin's natural selection as the engine of all adult behavior
  - Morality is simply the set of rules that increase the odds to pass one's genes to the next generation

Evolutionary Psychology

- Geoffrey Miller (2000)
  - The human mind is not a problem solver, but as a "sexual ornament".
  - The human brain's creative intelligence is too much if the only purpose is survival
  - Survival in the environment does not quite require the sophistication of Einstein's science or Michelangelo's paintings or Beethoven's symphonies
  - But these are precisely the kind of things that the human brain does a lot better than other animal brains.
  - The human brain is much more powerful than it needs to be.

Evolutionary Psychology

- Geoffrey Miller (2000)
  - Sexual selection is not driven by random environmental events but by a deliberate strategy to improve the "genetic quality of the offspring".
  - Sexual selection is as intelligent as we are, whereas natural selection is hardly intelligent at all
  - Sexual selection is a form of positive feedback, the kind of process that can explain the explosive growth of the human brain.

Evolutionary Psychology

- Geoffrey Miller (2000)
  - A fundamental function of the human mind is to display one's fitness to the other sex
  - Painting, singing and dancing are good indicator of physical and mental fitness, that women recognize, evaluate and reward with sex.
  - Males need to advertise their genes, and this need drives innovation.
  - Artistic activities developed because they contributed to sexual selection.

Evolutionary Psychology

- Geoffrey Miller (2000)
  - Darwin: men compete for women, and women choose men
  - Ronald Fisher : Evolution favors both pickier females and more attractive males
  - Sexual selection is a form of positive feedback, the kind of process that can explain the explosive growth of the human brain.

Evolutionary Psychology

- Leonard Shlain (2003)
  - Because of the explosion in size of the human brain, women a) did not want to have children (they would die by the thousands while giving birth) and b) they desperately needed iron (a key ingredient of brains).
  - The danger of giving birth led women to decouple sex and reproduction.
  - The search for iron led females to favor men who could hunt and bring meat, a form of concentrated iron.
  - Sex and reproduction are decoupled among humans to an extent unmatched by any other species

Evolutionary Psychology

- Leonard Shlain (2003)
  - The human female also decouple ovulation and copulation
  - The orgasm of the human female is nature's way to make a woman commit to the irrational act of having sex, an act that may cost her life when the baby is born

Memes

- Gregory Bateson (1972)
  - The mind is an aggregate of ideas.
  - Ideas populate the mind and continuously evolve. Ideas evolve in a Darwinian fashion, the most useful ones surviving while useless ones decay and die away.
  - The mind is the theater of a natural selection and evolution of ideas.
  - Our conscious life “is” that evolutionary process.

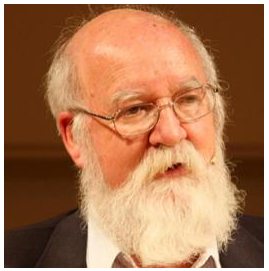
Memes

- Richard Dawkins (1976)
  - Meme: the cultural counterpart of the gene
  - A meme is the unit of cultural evolution, just like a gene is the unit of biological evolution
  - Ideas exhibit variation (copying with mistakes) and selection (pruning the ineffective ones)
  - A meme is an idea that reproduces itself like a parasite
  - When a meme enters a mind, it parasitically alters the mind's process so that a new goal of the mind is to propagate the meme to other minds

Memes

- Richard Dawkins (1976)
  - Just like genes use bodies as vehicles to spread, so memes use minds as vehicles to spread
  - Memes form an ecosphere of ideas.
  - The mind is a machine for copying memes, just like the body is a machine to copy genes

Memes

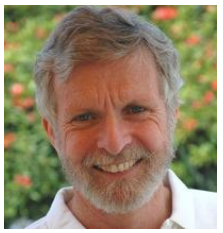
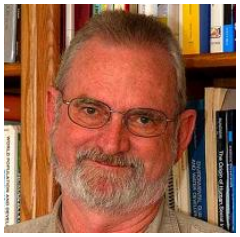


- Daniel Dennett (1995)
  - Memes (culture) have created the mind, not the other way around
  - Just like it is genes that drive evolution, it is memes that drive thought

Memes

- Susan Blackmore (1999)
  - Each mind is but a meme machine
  - A "memeplex" is a group of memes that band together for some mutual advantage.
  - The memeplex as a whole becomes stronger and stronger and each participating meme benefits.
  - Religions and ideologies are memeplexes.
  - Minds are invaded by memes all the time
  - We can never stop thinking.
  - We do not think, we are thought by the memes that invade us.

Memes

- Robert Boyd and Peter Richerson (1985)
  - The single most important difference between humans and other species is the ability of transmitting culture
  - Cultural evolution happens at a much faster pace than genetic evolution

Memes

- William Durham (1991)
  - Human behavior is due to two main information systems, one genetic and one cultural
  - Both the genetic system and culture are information systems that instruct phenotypes
  - Cultural evolution exhibits a unique property: self-selection
  - The cultural system can influence the direction and rate of its own evolution: memes influence human decisions that influence memes.
  - The cultural fitness of an “allomeme” (a variant of a meme) depends on the meme itself

Memes

- The body is attacked all the time by viruses
- The body is defended by an immune system
- Strong immune systems repel most viruses
- The mind is attacked all the time by memes (mind viruses)
- Is there an immune system for the mind that defends the mind from mind viruses?
- Are there stronger “mind immune systems” that protect the mind from memes such as religions, ideologies, pop music, Hollywood movies, …

Empathy

- David Premack and Guy Woodruff (1978)
  - Children are prewired with the distinction between "minds" and non-minds, i.e. between sentient beings and inanimate matter.
  - Children treat differently objects that move by themselves and objects that move only when someone moves them.
  - Children tend to see a "motive" behind self-propelled objects.
  - It is a built-in ability to guess the state of mind of another being.
  - Face perception might be the most developed visual skill in humans.

Empathy

- Empathy and Mirror Neurons
  - Laughter is contagious. Panic is contagious too.
  - Each mind contains a theory of other minds
  - This "theory of mind" is a physical representation inside my brain of the neural state of somebody else's brain.
  - This explains the empathy: I feel your joy or your pain because my brian physically "duplicates" that brainstate and therefore makes me feel what you are feeling.
  - "Mirror neurons“ (Giacomo Rizzolatti, 1996) may explain altruism: the most powerful motivation to help someone in trouble is that I can feel their pain and the only way to stop feeling it is to help them get out of trouble. Then I will feel their joy.

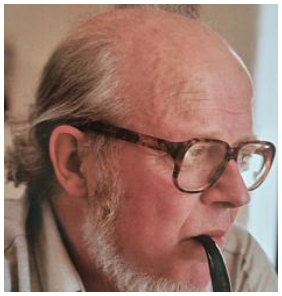
Theory of Mind

- We can't help building theories of mind whenever we look at somebody

Theory of Mind

- We can't help building theories of mind whenever we look at somebody

The Symbolic Revolution



- Jacques Cauvin (1994)
  - “Symbolic revolution” to refer to the sudden change in art and society that took place in the neolithic, notably the transition from hunting and gathering to agriculture and domestication of animals, with the consequent transition from nomadic life to settled life
  - Agriculture and domestication of animals were a by-product of a change in mental life: first the mind underwent the symbolic revolution, and then this new mind conceived of agriculture and domestication.
  - The change in mental life must have originated from a physical modification of the brain, from a mutation of sorts.

Summary

- Memes
- Culturgenes
- Evolutionary Biology

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