ASTRONOMY WINTER SCHOOL HYDERABAD 2017



LIFE IN THE UNIVERSE MARTIN ZINKE-ALLMANG WESTERN UNIVERSITY

Thomas Huxley (1825 – 1895)

The truth value of certain metaphysical and religious propositions is unknown or unknowable. Examples: God, Soul, Fate

Karl Popper (1902 – 1994)

A scientific statement has a truth value only if it can be falsified

What is Life?

(A) An organismic state characterized by capacity for metabolism, growth, reaction to stimuli and reproduction
(B) The sequence of physical and mental experiences that make up the existence of an individual



(C) Unfortunately, defining life is surprisingly difficult, even when we consider only life on Earth (Life in the Universe, Bennett & Shostak, Pearson Ed. Ltd.) An organismic state characterized by capacity for metabolism, growth, reaction to stimuli and reproduction + Follows the scientific method from observation to model + Falsifiable due to new species and microbial world (virus?) – Descriptive not functional (e.g., Anatomy versus Physiology) – Entries not disjunctive, e.g., ability to adapt (epigenetics)?

– Entries not apodictic, e.g., man after vasectomy, mule

The sequence of physical and mental experiences that make up the existence of an individual Unfortunately, defining life is surprisingly difficult, even when we consider only life on Earth



An organismic state characterized by capacity for metabolism, growth, reaction to stimuli and reproduction

The sequence of physical and mental experiences that make up the existence of an individual

- + Follows the scientific method from self-observation to model
- + Falsifiable e.g. through study of memory-loss patients
- + Functional (even hinting towards meaning of individual life)
 Limited to vertebrates or even more narrowly humans

Unfortunately, defining life is surprisingly difficult, even when we consider only life on Earth



An organismic state characterized by capacity for metabolism, growth, reaction to stimuli and reproduction The sequence of physical and mental experiences that make up the existence of an individual

- Unfortunately, defining life is surprisingly difficult, even when we consider only life on Earth
- Non-scientific, purely speculation-based ("want to include what we don't know, so leave wide open")
- Biased by ulterior motives (Astrobiology funding)



Cell is Functional Unit of Plant Life (1837)

Matthias von Schleiden (1804 - 1881)

Cell is Functional Unit of Animal Life

Theodor Schwann (1810 - 1882)



Life comes from Life 1857

Rudolf Virchow (1821 - 1902)



Eukaryotic Cell (specific: animal cell)



Evolution by means of Natural Selection (1859)

Charles Darwin (1809 – 1882)





Nebular Theory



← Condensation: Nucleation and growth of solid particles

← Accretion Coalescence into larger particles

← Star ignites, clears gases, accretion
 leftovers: asteroids (metal/
 rock) and comets (ice rock)

Moon Formation

Tidal Waves and Tidal Slowing in Moon-Earth System



Earth's Differentiation



Earth's Magnetic Field





Atmosphere

Volcanic Outgassing Carbon-dioxide Water Nitrogen Sulfur-compounds No Oxygen





Plate Tectonics and Carbon-dioxide Storage

Carbon-dioxide Cycle Self-Regulating





living stromatolites Shark Bay, Western Australia knee-high mats

Mars: a world like ours – a world to colonialize?



To sustain life, liquid water is needed To have liquid water, an atmosphere is needed





Mauretania





Basic Mars Data

Average Distance from Sun perihelion distance aphelion distance **Orbital Period Equatorial Radius** Mass (Earth = 1) **Rotation** Period Axis Tilt Surface Gravity (Earth = 1) **Atmospheric Composition**

Average Surface Temperature Average Surface Pressure

1.52 AU 206 million km 249 million km 1.881 Earth yr 3397 km 0.107 24 hr 37 min 25° 0.3895% CO₂, 2.7% N₂, 1.6% Ar -50°C 0.006 atm





Mars One – Artistic Sketch



Colour-Enhanced Sunset on Mars
Does "to be intelligent" mean "to be human"?

Neanderthals did:

Use tools Draw cave-paintings Bury their dead Hunt as a team with weapons

Does "to be intelligent" mean "to belong to genus homo"?

Does "to be intelligent" mean "to be a primate"?

Merriam-Webster: Intelligence

The ability to learn or understand or to deal with new or trying situations, the skilled use of reason

Merriam-Webster's Collegiate Dictionary TENTH EDITION

► The ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria

Ability to learn, proven through the ability to apply new knowledge = not memorize but comprehend!

(1) Logical distinction: category of quantity — Life: not a composite (e.g., two halves) Intelligence: a continuously measurable quantity



(2) Logical distinction: category of relation — Definition of life grounded in uniqueness of Earth's environment and history, but definition of intelligence not grounded in life



TRANSCENDENTAL IDEALISM

Idealism holds that ultimate reality lies in the realm transcending objects and phenomena, i.e., that the essential nature of reality lies in consciousness and reason. It holds therefore that only mental states or entities are knowable.

Transcendental in Kantian philosophy refers to that which lies beyond all possible experience.

Immanuel Kant (1724 – 1804)



Object cognition starts



Example of Sense: Vision Evolution of the Eye







Light converted into nerve signals in rods and cones Psychophysics Gustav Fechner (1801 - 1887)



Data Analysis

- Edges and corners
 Edge orientation
- ► Colours

Object

matter

Signal

form

essence

Motion Inner intuition serves as timing pulse generator









Edge Recognition: Detection with Receptive Fields



On-Center/Off-Surround Receptive Field of a Bipolar Cell

Edge Recognition: Detection with Receptive Fields



The most effective way of maximizing the firing of an on-center or off-center cell is to completely illuminate either the "on area" or the "off area" of its receptive field.



If both areas of a cell's receptive field are illuminated together, there is little reaction from the cell.

Edge Recognition: Analyzed in Visual Cortex





Colour Detection: Young-Helmholtz Model



Ideal: continuous evolution in time



Left: Sensitivity of the three types of cones (physical) Right: Chromaticity Diagram (this chart must exist in your brain, i.e., as a non-verbal dictionary)



Motion Detection: Changes in time series, initially between neighbouring Receptive Fields









Do I recognize the face? What is blue, what is yellow? What do the edges enclose? What moved?

Attention leads to apprehending in Imagination

Dorsal and Ventral Streams: Two Theories and What They Predict



"Where" vs. "What" Theory

Dorsal stream specializes in visual spatial perception Ventral stream specializes in visual pattern recognition

Predicts

- Damage to dorsal stream disrupts visual spatial perception
- Damage to ventral stream disrupts visual pattern recognition

"Control of Behavior" vs. "Conscious Perception" Theory

Dorsal stream specializes in visually guided behavior Ventral stream specializes in conscious visual perception

Predicts

- Damage to dorsal stream disrupts visually guided behavior but not conscious visual perception
- Damage to ventral stream disrupts conscious visual perception but not visually guided behavior





Whose face is it? **Diderot, because of prior experience** What is blue, what is yellow? What do the edges enclose? Diderot's jacket, his chair What moved? It is a painting (Diderot is long dead) so I moved

Past experiences and ideas for fast comparison

form

essence










How does the brain deal with timing? Sensation to Perception: 100 millisec. = 0.1 second TV/movies: 25 frames/s (or 0.04 seconds per frame)









Ideas are the result of reasoning

Object

matter

form

essence







The strong man is the one who is able to intercept at will the communication between the senses and the mind

Napoleon Bonaparte





Empirical > Transcendental Illusion: Spatial Disorientation Trusting sense input despite rational evidence to the contrary



JF Kennedy, Jr. – 16 July 1999





Kennedy's intended route

A plane piloted by John F. Kennedy Jr., carrying his wife and her sister, disappeared Friday night en route to Martha's Vineyard. Luggage and debris from the aircraft was found and search parties continue to look for more evidence of a crash.





Instruments (artificial horizon) – Learned (comprehended) experience







Inner Ear Corpuscies (Semicircular Canals) – A subconscious experience

ACCELERATION OF HEAD

Viking Mission: NASA 1975 – 1983 Life detection experiments

An expensive example of Confirmation Bias, haunting Mars exploration to this day!

Transcendental Illusion: Confirmation Bias Looking only for information that confirms what we believe to be true



Varig Flight 254 – 3 Sept 1989





Actual Route: Initially Due West

270° W Е Air Crash Investigation Mayday S14E03: Vanishing Act - Varig Flight 254 Belem Macapa Altamira Maraba Rio herazot Tocantins Santaram Carajas olit Palmas Tapajós RIO nBulX

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Take-off into the setting sun



Flying into the sunset







IQ Tests and the Flynn Effect

