



COGNITIVE STATUS OF SCIENTIFIC THEORIES

“All things, from Brahma the creator down to a single blade of grass, are... simply appearances and not real.”

- Shankara, Hindu philosopher

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INTRODUCTION

○ Cognition

- process of how we perceive and experience reality.
- how we perform experiments, which are the basis for judging the best of scientific theories.

○ In this presentation we would deal with

- Some problems in understanding Cognition
- Cognition in Quantum Mechanics
- Cognition and 'the larger picture'



COGNITION AND REALITY

- Cognitive abilities – our windows to view reality.
- Cognition and Scientific Experiments
 - Experiments in historical times did not require a lot more than sensory observation followed by rational deduction or verification of a prior hypothesis.
 - Even when sophisticated instruments are used, the ultimate idea is to bring out a projection of some real phenomena onto a plane where we can directly observe it. (Eg. Microscope)
- How good a theory is depends on its empirical results
 - Thus role of Cognition becomes very important.



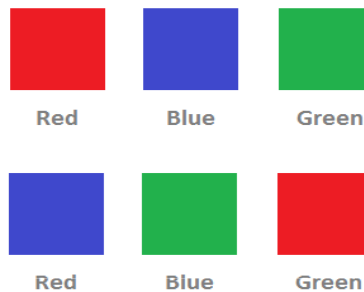
PROBLEMS WITH UNDERSTANDING COGNITION

- Absolute cognition is relative to an individual.
 - Eg:
 - You learn to associate “entities” that you can sense with “concepts” that are taught to you in primary school
 - The Perception of Colors



PERCEPTION OF COLOR

- Colors are taught in primary school.



- For example, what if a nursery child saw what is seen as the second row ?
 - Teacher views the colors as Row 1. Child as Row 2.
 - Teacher makes him associate them with same color name, as is known by the teacher.
 - “**blue**” for the Child now is actually “*green*” with respect to the teacher.
 - He sees “*red*” trees and a “*green*” sky.
 - He would still call leaves “**green**” and the sky “**blue**” as is clear by the illustrations which follow.



RELATIVE COGNITION OF COLOR



AS SEEN BY US



AS SEEN BY THE NURSERY CHILD



EXAGGERATION OR POSSIBILITY?



- Possible explanation of subjective choices?
 - Colors
 - Shapes
 - Sounds (Music)



COGNITION AND MODERN SCIENTIFIC THEORIES

- Quantum mechanics
 - Cornerstone of modern physics.
 - Very good empirical theory
- Observer plays an important role.
 - The act of measurement.



QUANTUM MECHANICS

1. Possible states of a system are represented as vectors in Hilbert space.
2. Observable properties are associated with linear operators which act on the vector representing the system, to give out the required property.
3. The dynamics of the system can be in two ways :
 - i. **Linear Dynamics:** If no measurement is carried out, the system, as a superimposition of possible states, continuously evolves according to deterministic dynamics depending upon the energy properties of the system and its environment.
 - ii. **Collapse Dynamics:** If a measurement is made on the system, the system randomly acquires a particular state.



DYNAMICS OF A QUANTUM SYSTEM

○ Linear Dynamics

- Required to study the continuous evolution of a system which has not been measured.
- System exists as a superimposition of many states.
- Deterministic, continuous, linear.

○ Collapse Dynamics

- Required to study a system after a measurement has been carried out.
- System attains a particular state.
- Provides us with the statistical predictions which when tallied with experiments, make quantum theory a successful empirical theory.



POPPING OF THE WAVEFUNCTION

- An undisturbed quantum system deterministically evolves as a wavefunction.
- When a measurement is carried out on the system, the wavefunction ceases to exist and the state of the system is fixed.
- Eg. Measurement of the Position of an Electron.
Opening the box to view the cat.



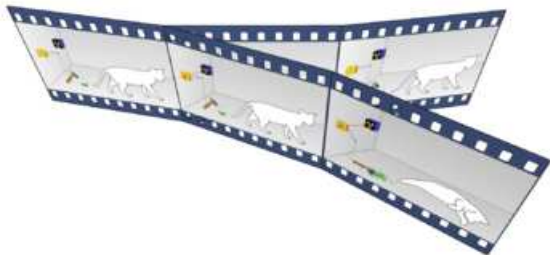
THE SPECIAL ROLE OF MEASUREMENT

- The problem lies in defining measurement.
 - What is measurement ?
 - Measuring Instruments are also physical systems governed by continuous linear dynamics.
 - Why are they different, such they they lead to “popping of the wave function” ?
- No prescription for using either of the two dynamics unless measurement is not defined.



THE SPECIAL ROLE OF MEASUREMENT

- Why should the collapse lead to some random value ?
 - Why does God play dice ?
- How is such a value determined ?
- Led to alternate formulations of collapse dynamics.
 - A radical example:
 - DeWitt's splitting world's theory which explains the "popping of the wavefunction" by stating that whenever an act of measurement is carried out, the universe splits into an infinite number of parallel universes. In each universe, the system assumes a different state, from the given superimposition of states initially.



WITHOUT MEASUREMENT ?

- The only way we observe real phenomena is through collapse dynamics.
- So what is the reality of wave functions themselves?
 - Does a wavefunction exist by itself?
 - *“there is nothing really “out there”. Detecting an electron at a certain position “creates” the position of this electron.”*
– Bohr.
 - outrageous claim
 - real objective world is a delusion
 - contradiction with both our immediate experience and everything most of us were ever taught



THE EVER MORE IMPORTANT ROLE OF COGNITION

- Role cognition in earlier scientific theories was limited to observation and experiment,
- Quantum mechanics has made the role of cognition ever more relevant.
- We no more study an already existing world by carrying out some experiments.
 - The very act of experimenting or measurement results in the creation of reality!
- The measuring devices themselves are quantum systems
 - follow deterministic Linear dynamics
 - Is reading out properties from the display of these devices the act of measurement which creates reality?
- Aren't humans quantum systems as well?
- Eventually, it all comes down to that little window through which we observe the physical world – which defines a measurement!

OUTLOOK

- Quantum mechanics is guiding us towards a very important realization.
 - Under its context, the observer is extremely special.
 - It is only when the observer pops the wave of probability that a dice is tossed in heaven and reality is realized.
- A theory for the observer's cognition missing out from current form of the physical law.
- **A Theory of cognition and consciousness** would be an integral part of the **theory of everything**, if we are ever to find one.
- Does the brain observe reality or **create reality**?
- *“One who has control over the mind is tranquil in heat and cold, in pleasure and pain, and in honor and dishonor; and is ever steadfast with the Supreme Self” – Bhagvad Geeta*



REFERENCES

- **“The Emperors New Mind”** – Roger Penrose
- **“A Historical Introduction to the Philosophy of Science”** – John Loose
- **“Nagel on the Cognitive Status of Scientific Theories.”** – Henry Byerly
- **Wikipedia** (<http://www.wikipedia.org/>)
- **Stanford Encyclopaedia on Philosophy** (<http://plato.stanford.edu/>)

