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Decision-making, human cognition, and equanimity of mind

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Abstract

Background: Decision-making is one of the most puzzling issues in modern neuro-cognitive dynamics. It depends on how the brain behaves at that particular instance and identifies and responds to a signal among myriads of noises that are present in the surroundings (called external noise) as well as in the neurons themselves (called internal noise). The ability to predict the outcome of future events is, arguably, the most universal and significant of all global brain functions. The ability to anticipate the outcome of a given action depends on sensory stimuli from the outside world and previously learned experience and/or inherited instincts. So, there is a need to formulate a theory of inference using prior knowledge for decision-making and judgment, as well as, new empirical evidences.

Aims: The current paper aims to shed new light on decision-making and judgment with the help of states of mind like neutral mind and equanimity. The paper also aims at highlighting the scientific aspects of these states, which are conducive to proper decision making by an individual.

Method: The current paper makes use of methods of mathematical modeling based on a generalized version of probability argument in the Bayesian framework, which includes prior knowledge for decision making and human judgment, as well as, quantum theory in order to model the cognitive domain.

Result: The states of mind like neutral mind and equanimity may help an individual to take correct decision with unbiased judgment, and accomplish right cognition.

Conclusion: The general Bayesian framework when coupled with quantum theory may help us to understand states of mind like neutral mind and equanimity, in which decision-making happens with unbiased judgment. The current paper also opens up a new dialog between modern science and Indian philosophy as the latter is likely to offer an explanation to the superposed state that has been studied by the scientific community in quantum theory.

Key Words: Decision-making, Eastern approaches, neutral mind, equanimity, human cognition

INTRODUCTION

For more than 200 years, mathematicians and philosophers have been using probability theory to describe the ambiguity or uncertainty in decision-making and judgment. Recently, through several experiments with human subjects (Aerts,

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Aerts & Gabora, 2009; Busemeyer & Trueblood, 2011), violation of traditional probability theory is clearly revealed in several cases. Literature survey clearly suggests that classical probability theory fails to model human cognition in relation to decision-making. The major problem seems to be the presence of epistemic uncertainty and its effect on cognition at any time point. Moreover, the stochasticity in the model arises due to the unknown path or trajectory (definite state of mind at each time point) a person is following. A generalized version of probability theory borrowing the idea from quantum paradigm may be a plausible approach. Quantum theory allows a person to be in an indefinite state (superposition state) of mind at each moment of time. A person may be in an indefinite state that allows all these states to be potentially (probability

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amplitude) expressed at each moment (Heisenberg, 1958). Thus, a superposition state seems to provide a better representation of the conflict, ambiguity, or uncertainty that a person experiences at each moment (Busemeyer & Trueblood, 2011). Conte et al. (2009) demonstrated that mental states follow quantum mechanics during perception and cognition of ambiguous figures.

However, the framework of quantum probability considering the superposition of mental states is an abstract framework devoid of material content like the concept of elementary particle, various fundamental constants in nature like the Planck constant, the speed of light, and the gravitational constant in modern physics. So, this framework can be applied to any branch of science dealing with decision-making, such as in biology, social science, etc. The proposition of superposition of mental states needs to be addressed in the context of brain function. Very few attempts have been done so far in this direction.

AIMS

The current paper aims to shed new light on decision-making and judgment with the help of states of mind like neutral mind and equanimity. The paper also aims at highlighting the scientific aspects of these states, which are conducive to proper decision making by an individual.

METHODS

The current paper makes use of methods of mathematical modeling based on a generalized version of probability argument in the Bayesian framework, which includes prior knowledge for decision making and human judgment, as well as, quantum theory in order to model the cognitive domain.

RESULTS & DISCUSSION

The superposition of mental states is linked with the neutral mind as well as to the equanimity of mental state as discussed in Indian philosophy (both the Hindu and the Buddhist). However, in Buddhist philosophy, there is a subtle difference between neutral mind and equanimity. In the state of neutral mind, there is a scope of decision-making, whereas in the state of equanimity, there is no such scope. It is expected that the states of mind like neutral mind and equanimity may help an individual to take correct decision with unbiased judgment, and accomplish right cognition. In order to see how this is possible, let us first discuss the new empirical evidences and their implications in cognitive science.

Empirical evidences in cognitive science
Various group of scientists (Busemeyer & Trueblood, 2011) made attempts to show the inadequacy of the classical

paradigm of probability to explain the new evidences related to modeling the cognitive domain. This cognition spectrum of human mind is usually classified into six categories as follows:
(1) Disjunction effect
(2) Categorization – decision interaction
(3) Perception of ambiguous figures
(4) Conjunction and disjunction fallacies
(5) Overextension of category membership
(6) Memory recognition over-distribution effect. Fallacies over-distribution effect

The data collected from various experiments related to these six categories clearly indicate the inadequacy of classical probability theory (Savage, 1972). For example, let us consider the first one, that is, the disjunction effect. Tversky and Shafir (1992) discovered a phenomenon called the disjunction effect in the process of testing a rational axiom of decision theory called the sure thing principle that was proposed by Savage (1954, 1972). According to the sure thing principle, if under the state of the world X you prefer action A over B, and if under the complementary state of the world XC you also prefer action A over B, then you should prefer action A over B even when you do not know the state of the world. Tversky and Shafir (1992) experimentally tested this principle by presenting 98 students with a two-stage gamble, that is, a gamble which can be played twice. Classical probability theory says that always $P(A) > P(B)$ where, $P(A)$ indicates probability of the event A occurring, say winning, and $P(B)$ is the probability of the complementary event B occurring, say losing the game. However, the data from this study revealed that in the event of uncertainty of outcome, there was a disjunction effect, which was contrary to the sure thing principle. This meant that during uncertainty, instead of definitely being in the win or loss state, students entered a superposition state that prevented them from finding a reason to play in the second stage of the gamble.

Let us look at Tversky and Shafir's (1992) study in detail. In the first stage of the study, if the students won they would get Rs. 2.0, but if they lost they would lose Rs. 1.0. The key point in this experiment was the decision for the second stage of play after the first stage of play. The three conditions that were set for the second stage of the experiment were: first, the students were informed that they won the first stage of the gamble; second, the students were informed that they lost the gamble; third, the rest of the students were not told the outcome of the first stage. Results revealed that 69% of the students who were told they won the game, 59% of the students who were told they lost, and 36 % of the students who were not told whether they won or lost wanted to play again. The explanations given for the above findings were: in the first group, the students who were told they won had extra money and, therefore, wanted to play again; in the second group, the students who were told

they lost were interested to play again in order to recover the losses; in the case of the third group of students who did not know the outcome, very few were interested to play again. It is important to ask why the two reasons given by the first and second groups to play again did not emerge in the minds of the third group as there could not be any other condition other than gain or loss and the reasons to play thereof. In order to answer the question, the probabilities of various outcomes were calculated and it was found that the simple additivity fails for probability law, that is, P(A + B) is not equal to P(A) + P(B). However, they can be explained with the probability rule of quantum framework, that is, P(A + B) = P(A) + P(B) + interference term. This is a clear indication of violation of classical probability theory. The interference effect of quantum framework can be related to the decision-making associated with the superposed states of mind. It is similar to the interference term associated with the superposition of wave functions in the double-slit experiment in quantum theory, where if one wants to detect one aspect of micro-particles, say wave aspect, then the other complementary aspect, that is, particle aspect will not be detected. But the total probability of two complementary aspects occurring will not be simply summation of two individual probabilities. At this point there is a need to emphasize that in all the above six categories of the empirical evidences, similar interference effects have been detected (Savage, 1972). This clearly shows the inadequacy of classical probability theory in the cognitive domain. Now, let us not discuss any more technical details here, but instead will discuss the implications in the cognitive domain.

Equanimity of mind

The challenging issue in modern neuroscience is how the neurons in the brain operate, so as to interpret the above kind of intermediate state which gives rise to the superposition of two complementary aspects. For example, it is possible to understand the operation yes or no with the operations performed by neurons. But if there exists interference term due to superposed states of mind, then one can think of an intermediate term corresponding to a state like: a |HAPPINESS> + b |UNHAPPINESS>, where a and b are positive constants. Here |HAPPINESS> and |UNHAPPINESS> are two vectors representing the happy and unhappy states of mind, respectively. According to the superposition principle, one can think of a state as neither happy nor unhappy. How brain interprets this operation at cellular level (i.e. at the level of neuron) is hard to think of.

In quantum theory, such superposed states have been discussed and have raised lot of interest in the scientific community. The famous physicist Schrödinger, (1983) formulated this problem as "Cat Paradox," that is, one can think of a superposed state of the living state and the dead state of a cat. Only if one observes, it will be either in living or dead state. The observation procedure is considered as a classical process, and hence the superposed state or the wave function collapses to either of the states. Shimony (1993) proposed a "potentiality interpretation," that is, the superposed state function has the potentiality to be in either of the complementary states. This is a state of mind where the mind is capable of decision-making even while remaining in a state superposed of two complementary aspects.

This type of issue has been debated in Eastern philosophy, especially in Hindu and Buddhist philosophy, many centuries ago. In the Hindu text, Bhagavad Gita (Sivananda, 2000), the concept of equanimity is described as yoga in the following way:

Perform action, O Arjuna, being steadfast in yoga, abandoning attachment and balanced in success or failure. Such equanimity is called yoga.

Swami Sivananda (2000) analyzed the situation in detail as:

Samatvam is equanimity of mind and outlook, equipoise. It is being able to keep the mind steady and balanced in all the conditions of life. It is the ability to be forever serene, contented, calm and peaceful. Samatvam is having the ability to remain cheerful in adverse conditions, to have fortitude in meeting danger, and to have the presence of mind and forbearance to bear insult, injury and persecution. Samatvam means being able to go through the routine of life, amidst the din and clamour of the world, patiently and joyfully.

In Buddhist tradition, the term "equanimity" (Upeksha in Sanskrit and Upekkha in Pali) has been defined in various ways – the core of this definition rests on "gazing upon" or "observing without interference." In the Theravadan Buddhist School, two main usages of the term "equanimity" are used. The first one refers to "neutral feeling" – a mental experience that is neither happy nor unhappy. This first usage of equanimity corresponds to the Western psychological notion of "neutral valence" and is commonly experienced throughout any ordinary day. In this state, mind is considered to be capable of taking decision and making judgment. The second usage of the term "equanimity" refers to a state of mind that cannot be "swayed by biases and preferences" (Anuruddha, 2000). It is to be noted that Buddhist as well as Hindu philosophies agree on the issue that one needs practice to achieve the state of mind called "equanimity." The future developments of cognitive neuroscience and modeling in the cognitive domain may help to understand decision-making and judgment without biases and/or preferences.

CONCLUSION

The general Bayesian framework when coupled with quantum theory may help us to understand states of mind like neutral mind and equanimity, in which decision-making

happens with unbiased judgment. The current paper also opens up a new dialog between modern science and Indian philosophy as the latter is likely to offer an explanation to the superposed state that has been studied by the scientific community in quantum theory.

REFERENCES

Aerts, D., Aerts, S., & Gabora, L. (2009). Experimental evidence for quantum structure in cognition. In P. D. Bruza, D. Sofge, W. Lawless, C. J. van Rijsbergen & M. Klusch (Eds.), *Proceedings of QI 2009-Third International Symposium on Quantum Interaction, Book series: Lecture Notes in Computer Science, 5494*, (pp. 59-70). Berlin, Heidelberg: Springer.

Anuruddha, A. (2000). *A comprehensive manual of Abhidhamma: The philosophical psychology of Buddhism*. In B. Bodhi, (Ed.). Onalasaka, WA: BPS Pariyatti Editions.

Busemeyer, J. R., & Trueblood, J. S. (2011). Theoretical and empirical reasons for considering the application of quantum probability theory to human cognition. *In Quantum Cognition Meets TARKII workshop*. Groningen, Netherlands: University of Groningen.

Conte, E., Khrennikov, A. Y., Todarello, O., Federici, A., Mendolicchio, L., & Zbilut, J. P. (2009). Mental states follow quantum mechanics during perception and cognition of ambiguous figures. *Open Systems and Information Dynamics, 16*(1), 85-100.

Heisenberg, W. (1958). *Physics and philosophy: The revolution in modern science*. [1st ed.] New York: Harper and Row.

Savage, L. J. (1954). *The foundations of statistics*. New York, NY: John Wiley.

Savage, L. J. (1972). *The foundations of statistics* (2nd ed.). New York, NY: Dover.

Schrödinger, E. (1983). The present situation in quantum mechanics: A translation of Schrödinger's "Cat Paradox" paper (J. D. Trimmer, Trans.). In J. A. Wheeler, & W. H. Zurek, (Eds.) *Quantum theory and measurement*. Princeton, NJ: Princeton University Press.

Shimony, A. (1993). *Search for a naturalistic world view: Natural science and metaphysics* (Vol. 2). New York, NY: Cambridge University Press.

Sivananda, S. (2000). *Bhagavad Gita*. Retrieved from http://www.dlshq.org/download/bgita.htm

Tversky, A., & Shafir, E. (1992). The disjunction effect in choice under uncertainty. *Psychological Science, 3*(5), 305-309.