SCIENTIFIC DISCOVERY: *a priori BIAS or* OBSERVATIONAL LEARNING?

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ABSTRACT

In this article, the concept of discovery is introduced by articulating the contemporary schools of thought, that the general process can be the logical end manifestation of either an *a priori* bias or an observational learning. The influence of prior knowledge on concept acquisition is discussed to bring out the unique process of discovery or cognition by scientists as well as laypersons. Arguing that the scientific discovery is an evolutionary phenomenon the patterns of scientific reasoning and the essential elements of scientific methods, namely, *a priori* bias (hypothesis generation) and observational learning (hypothesis evaluation - characterizations, predictions, and experiments) are highlighted. An overview of some of the important classic and recent scientific investigations is presented in order to bring out how the prevalent culture, history and environment have indubitably affected the outcome of the investigations and resultant scientific discoveries. A historical overview of Indian scientific discoveries since the early civilizations is presented along with the conundrum - *Why there were no significant scientific discoveries from India since the 15th century, in spite of India spearheading the scientific revolution for fifteen long centuries?* Finally it is argued that both, *a priori bias* as well as *observational learning*, are complementary and are required for affecting 'scientific discoveries' – as ingrained in our ancient Indian philosophies of *Sankhya* (Analysis), *Nyaya* (Logic), *Vaiseshikha* (Atomism) and *Mimamsa* (Exegesis). The article concludes with the author advocating the necessity to reorient the path of scientific inquiry by capitalizing on the tenets of ancient Indian philosophies, in order to achieve higher scientific stature in the world.

Science and Discovery

'Science' and 'discovery' are two of the popular words frequently used with connotations to *knowledge* and *learning*. The importance of science and discovery in our every day lives is well acknowledged and understood - as scientific discoveries bring about significant advances and technological breakthroughs, transforming the world we live in and our lives. However, if one were to cogently define *what* these frequently used popular words are, and explain *how* scientific discovery is brought about? Then, these questions certainly implore one to ponder and probe for meaningful answers. To simple minds, these are banal questions which do not brook much thought for explanation, as the words probably bring to mind not science or discovery *per se*, but the fruits of science and discovery, the pervasive complex of technology that transform our lives.

Paradox of Scientific Discovery

Discovery forms the backbone of any scientific endeavor - heralding progress, ushering in insights, opening new pathways and uncovering the various mysteries of the world around us. But, *how do discoveries occur? How are the new discoveries brought about?* These are questions that border on paradox and mystique. Discovery is a very slippery concept, especially for a rational analysis. To produce a valuable observation, one has to have an idea of what to observe – *a preconception of what is possible*. As the name suggests, '*discovery*' has a connotation with something that is new. What is new is what you do not know *or* do not understand *and* do not expect to occur. Therefore, scientific discovery deals with inconsistency. This means that the patterns of scientific reasoning need to deal with a number of inconsistencies, unexpected results or observations, and therefore requires '*incongruity resolution*'- an uncanny ability for resolving out of place or unexpected observations. Scientific advances come from uncovering a hitherto unseen aspect of things as a result not so much of using new instruments, but rather looking at objects from a different angle. This is what the philosophers call as *teleological thinking* – thinking out of the box. Scientific discovery therefore, comes from testing theories by logically deducing hypotheses from them, using experiment and careful observation to test the hypotheses, and revising theories that lead to incorrect predictions. Therefore the answers, to the simple questions posed, "*What is science and discovery and, how scientific discoveries are brought about*?" are ironically not so simple enough. If one were to serenely introspect and delve deep into the thought processes, the questions become rather complex, abstract and mind boggling, bordering on paradox for which there can be no simple answers. Therefore the 'simple' questions would elicit complex answers.

The well known 'Meno Paradox', named after the protagonist in one of Plato's play sums up the complexity and confounding nature of process of inquiry in general, which eventually should lead to new discoveries.

"*Either you know what you are searching for, or you do not. If you know, you already have it, whence inquiry is pointless. And if you do not know, you would not recognize it even if you stumbled on it accidentally, hence again, inquiry is impossible.*"

The paradox is especially interesting from the point of view of scientific discovery. *I*s it possible to understand the process of scientific discovery? Is there any reasoned procedure or method which can be inferred from the present knowledge to acquire new knowledge? Or, are the method and novelty two incompatible horns of a 'Menoan' situation?

How Science Works?

In order to understand how scientific discovery is brought about, it is imperative to get insights into *what science is*? And, *whether there is any established method for doing science*? Starting from Socrates, the idea has usually been to show that the Meno Paradox is paradox only seemingly – of course inquiry is possible, and we can learn something new. But what shows the profundity of this question is the fact that there are various different kinds of solutions suggested to this paradox.

Scientific method, as envisaged by one of its early exponents, Isaac Newton - is fundamental to the investigation and acquisition of new knowledge based upon physical evidence. Scientists use observations, hypotheses, and logic to propose explanations for natural phenomena in the form of theories - *hypothesis generation*. Predictions from these theories that can be reproducibly tested by experiment are the basis for developing new technology. The element of observation includes the elements of hypothesis development, prediction, and experimental testing. All these elements are typically necessary for observation and are categorized as *hypothesis evaluation*. Scientists use the scientific method to build a supportable, evidence-based understanding of our world. However, there is often disagreement in scientific communities over the various aspects of these understandings. In philosophical circles scientific method has been the source of much controversy. Philosophers and historians of science have not only questioned the nature of scientific method, but also its supposed efficacy. It is now generally agreed that scientific method is not a recipe; rather it involves intelligence, imagination, creativity and is constantly changing, *i.e.*, the scientific method is evolutionary in character.

Evolutionary Nature of Science

Science gains reality when it is viewed not as an abstraction, but as the concrete sum of work of scientists, past and present, living and dead. As Isaac Asimov pointed out, 'not a single element of science can exist in itself. Each scientific thought, observation and statement has been ground out of the industrious efforts of some person, and unless you know the person and the world in which the person lived and worked; the assumptions accepted as truths; the concepts considered untenable; you cannot fully understand that scientific statement or observation or thought'.

Science progresses on the basis of the innate use of knowledge gained by others to acquire new knowledge. This unique characteristic of '*standing on the shoulders of giants'* to acquire new knowledge is fundamental to the advance of science. The history of science teaches us that, since science originated as the product of men and not as a revelation, it may develop further as the continuing product of men. Once it is grasped that scientific truth is limited and not absolute, scientific truth becomes capable of further refinement. Until that is understood, scientific research has no meaning. Moreover, of all the stereotypes that has plagued scientists, the one that is most pernicious, is to portray the scientist as always right. It should always be borne in mind, that scientists share with all human beings the great and inalienable privilege of being completely wrong at times. Therefore, science itself can be wrong in this aspect or that. Ironically, it is this knowledge that scientist can be wrong, that ensures science from disaster and helps in scientific progress. When an individual theory collapses, it need not carry with it one's faith, hope and innocent joy. Once we learn to expect theories to collapse and be supplanted by more useful generalizations, the collapsing theory becomes not the grey remnant of a broken today, but the dawn of a new and brighter tomorrow.

Scientist and the Layman

Although the process of acquisition of knowledge by a scientist and a layperson is more or less similar, the scientist's knowledge acquisition is based on a *structured process* which not only should appeal to the person but also to the scientific peers and community at large. However, for the layperson it is sufficient if it appeals to the personal self. That is, the scientist indulges in systemized learning and the layperson in personal learning. The systemized learning is based on an organized structure of facts and figures, which may most likely introduce *a priori* bias in the scientist, and the outcome sometimes may result mostly in scientific rhetoric. While for the layperson, unbiased evaluation of evidence is part of the personal learning process, which is specific to each individual and therefore to each it would be the incontrovertible evidence – certain and appealing to the personal self to a much greater degree than any law of science.

Philosophy of Science

Philosophers from time immemorial were concerned about the scientific process and discovery. In fact, till the 18th century 'scientists' were alluded to as natural philosophers. The term 'scientist' was a 19th century shift. Of the many philosophers who wondered how science works, the trio who made ever lasting impressions by contributing immensely to the present day understanding of the scientific process and discovery were Francis Bacon in 1870s, Karl Popper in 1930s and Thomas Kuhn in 1960s.

Francis Bacon believed that science progresses only when the scientist is a 'disinterested' observer. In short, the scientist should not have any *a priori* bias which may influence the scientific observations and results. In order not to have any *a priori* bias the scientists should neither be aware of what had already been established in science, nor should the scientist consider the progresses made so far. The scientist should be a disinterested observer of nature, collecting observations with a mind cleansed of harmful preconceptions that might cause errors to creep into the scientific record. Once enough observations have been gathered, Bacon believed that patterns will emerge from them, giving rise to truths about nature.

Karl Popper who put forth '*the logic of scientific discovery*' was deeply influenced by Einstein's theory of relativity which shattered the predominance of Newtonian physics. Karl Popper argued that the process of scientific inquiry should be logical and rational, emphasizing that, "*What we call as scientific knowledge is only hypothetical and often not true, let alone certainly or probably true*". In contrast to Bacon, Popper believed that all science begins with a prejudice or perhaps more politely, a thesis or a hypothesis. Nobody can say where the theory comes from. Formulating the theory is the creative part of science, and it cannot be analyzed within the realm of philosophy. However, once the theory is in hand, Popper tells us, it is the duty of the scientists to extract from it logical but unexpected predictions that, if they are shown by experiment not to be correct, will serve to render the theory invalid. In other words a scientist needs to be extremely cautious and *skeptical* about the results. Thus, Bacon's disinterested observer of nature is replaced by Popper's skeptical theorist.

Popperian philosophy dominated the scientific thinking from the thirties to the sixties, until Thomas Kuhn, a physicist, philosophized about the structure of scientific revolutions. Kuhn argued that the process of scientific inquiry is heuristic not rational, and therefore psychologically or sociologically biased. Kuhn believed that very often the successful scientist must simultaneously display the characteristics of the traditionalist and of the iconoclast. It is Kuhn who popularized the word *paradigm*, which has come to seem so inescapable. A *paradigm* for Kuhn is a sort of consensual world view within which scientists work. It comprises an agreed upon set of assumptions, methods, language, and everything else needed to do science. Within a given paradigm, scientists make steady, incremental progress, doing what Kuhn calls "normal science". Kuhn's relativistic vision of shifting paradigms advocated that science is similar to any other human activity like art or philosophy, only more specialized, perhaps. The idea that science proceeds by periods of normal activity punctuated by shattering breakthroughs that make scientists rethink the whole problem is an appealing one, especially to scientists themselves, who know from personal experience that it really happens that way.

Kuhn's modern relativistic vision of shifting paradigms triumphed over Popper's positivistic belief in science's revolutionary potential to falsify society's dogmas. Nevertheless, Kuhn's theory does suffer from a number of shortcomings as an explanation for how science works. One of them is that it contains no measure of how big the change must be in order to count as a revolution or paradigm shift. Another difficulty is that even when a paradigm shift is truly profound, the paradigms it separates are not necessarily incommensurate. The 'new' sciences of quantum mechanics and relativity, for example, did indeed show that Newton's laws of mechanics were not the all encompassing fundamental laws of nature. However, they did not show that they were wrong. Quite the contrary, they showed why Newton's laws were right: Newton's laws arose out of new laws that were even deeper and that covered a wider range of circumstances unimagined by Newton and his followers, that is, things as small as atoms, or nearly as fast as light, or as dense as black holes. In more familiar realms of experience, Newton's laws go on working just as well as they always did. Thus, there is no ambiguity at all about which paradigm is better. The new laws of quantum mechanics and relativity subsume and enhance the older Newtonian world.

None of the philosophies advocated by Bacon, Popper and Kuhn could give us a perfect description of what science is or how it works; nevertheless all three helped us gain a much deeper understanding of it all.

Scientific Discovery – *apriori Bias or Observational Learning*

The central problem of scientific discovery is to find scientific regularity in experimental observations. In recent years, philosophers have started, more, to analyze the processes of discovery rather than worry about the philosophy of science *per se*. In general, any technique may be employed, from wild guesses to careful explorations of mathematical models to discover possible scientific explanations. Historically, inspired guessing has been the predominate technique, but with the massive data sets being now available with the advances in technology, more disciplined ways of searching for underlying laws are being used. New conceptual models and tools have been developed which can be used for this purpose, *e.g.,* the interrogative model of inquiry and new conceptualizations of inference. The background supposition is that there is the area of *heuristics* that is not strictly rational but neither is totally blind, and it is possible to develop conceptual and methodological (and even strictly logical) models for heuristic procedures. This supposition about heuristics would suggest that conceptual structures and a historical perspective should not be seen as opposites; rather "grammar" should embrace historical perspective. Many other areas of research have taken the issue of discovery much more seriously than philosophy. There are various models, *e.g.,* in education, in artificial intelligence, in cognitive sciences, and in business sciences that have been proposed to capture *processes of discovery*. In these areas it is felt that in order to genuinely understand modern "knowledge society," it is important to conceptualize dynamic processes of knowledge advancement and knowledge creation, and not just to analyze how already existing knowledge is justified or acquired. For example, learning, in genuine and deep sense, can be understood as analogous to processes of innovative inquiry. This means that learning is seen as a collaborative effort to advance knowledge and understand things more thoroughly, *i.e.,* to *discover* something new. The model of *progressive inquiry* is based on the idea that various conceptual means that have been developed in philosophy of science and in cognitive science can be used to model the "epistemological infrastructure" of learning. The contemporary school of thought is that the general process of scientific discovery (or cognition) can be the logical end manifestation of '*scientific inquiry'* whose foundation is either an *a priori bias* or *observational learning*.

Theory Laden Observations – *Apriori Bias*

The interrogative approach to inquiry is one important way of explaining how research process can be based on bee-like activities – like the bee feeding on nectar it gathers, digesting it, and so transmuting it into the purest honey. Menoan horns are avoided when it is noticed that we can know things in some sense, and at the same time, not know them in another sense; so knowledge comes from a combination of knowledge and ignorance. However, the interrogative approach emphasizes that prior information and background knowledge impose constraints on and at the same time, anticipate admissible answers.

Observation Laden Theories – *Observational Learning*

It is also true that observations can yield clues for theories; theories are often searched for in order to explain observational phenomena. However, one should emphasize that '*seeing*' is always '*seeing as*'. We see things through gestalts or patterns. The challenge for scientific inquiry is to reason from surprising data to an explanation. But are we not in a vicious circle? Observations are supposed to be theory laden and theories are observation laden. This is the essential tension in scientific discovery, but not a contradiction or an empty circle. The various other tensions in scientific discovery often result in dichotomies, *i.e.,* to the idea that one has to chose between, for example, discovery and justification or between product and process. But these tensions also give an opportunity to understand the dynamic process of inquiry.

Dynamics of Scientific Inquiry

Many claims and requirements that seem to be controversial are often connected to the idea of scientific inquiry. There are lots of examples: scientific discoveries are often described as sudden moments of insight, but on the other hand, they can be seen as a result of hard work and "perspiration". Or; creativity can be seen as a result of a "*divergent thinking*" and playfulness, which can break constraints and boundaries, set by old ways of thinking. But, on the other hand, creativity can be seen to be based on "*convergent thinking*" where it is important to know those constraints, which older theories and paradigms require.

Discoveries are almost by definition something unique, but often, in the history of science, similar discoveries are made at the same time. It can also be claimed that in order to find something new, it is important to be able to assess various possibilities impartially and critically, but on the other hand, it seems that discoverers often highly emotionally defend their favorite ideas even without much evidence. Innovativeness seems also to require that things are seen from many perspectives, but on the other hand, it is important to have a firm ground which does not change continually. The acts of creation seem to be often individual achievements where previous barriers of thought are transcended. But, on the other hand, it seems that they are the result of social interaction where the individual achievements are almost inevitable results of those resources that culture offers.

It could be argued that creativity and discovery by their nature are concepts that border on paradox. In discovery you almost have to *try* to have your cake and eat it too! Various models and characterizations of discovery are instructive because they often try to avoid dichotomies by emphasizing the dynamic way of thinking. In discoveries it is *not* the case that one should choose between insights and hard work, or between tradition and innovation, or between individual and community, or between logic and emotion. In productive models of discovery, it is both of these.

Various models of learning and knowledge advancement, which emphasize the aspect of knowledge creation, also border on paradoxes. The models of innovative knowledge communities nowadays often are based on the idea that knowledge creation is very fundamentally a collaborative and social process. But at the same time they emphasize individual initiative in processes of inquiry and learning.

Individual actions are embedded in social interaction, and both of these aspects must be taken into account. The models are also based on the idea that knowledge should be seen more broadly than just as propositional or conceptual knowledge.

Influence of Culture, Environment and History on Scientific Discoveries

Looking at the history of science, one would observe many instances when the prevalent culture, history and environment have indubitably affected the outcome of scientific investigations and resultant scientific discoveries. This is to be expected as the process of inquiry is fundamentally dependent on the 'prepared' mind of the inquirer. Although philosophically it is possible to have a Baconian disinterested nature, in practice the inquirer's mind would be befuddled with biases from the environment one is surrounded with and the prevalent scientific culture. Pertinent examples of how biases stonewalled the acceptance of scientific observations are many – a classic example being the proof for the existence of Gravitational Lens Effect because this was against Newtonian Physics. Arthur Eddington, in 1919, eventually proved the existence of gravitational lens effect by his observations during a solar eclipse, in spite of the prevalent biases existing due to the stature of Newtonian physics. Eddington's discovery had significant impact in denting the permanency of Newtonian Gravitation in the world of understanding physics, and ushering in the importance of Einstein's general relativity concepts. Similarly a more contemporary example (late 1980s) is the proof for the existence of Black Holes. The prevalent biases about the infallibility of Einsteinian physics influenced eminent scientists like Arthur Eddington from doggedly resisting the theory propounded by Subramanian Chandrasekhar on the existence of Black Holes in the cosmos. Nevertheless, Chandra was proved right eventually and was awarded the Nobel Prize for his outstanding contributions to the understanding of Black Holes.

Joseph Needham's Poser

Some of the most outstanding scientific discoveries in various disciplines like Mathematics, Astronomy, Physics, Chemistry, and Botany during the last few centuries are credited to people like Pythagoras, Copernicus, Galileo, Newton, Einstein, Dalton, Heisenberg and Linnaeus. This has led the British researcher Joseph Needham to wonder why China and India (*although having a long history and culture of science, and being in the forefront of scientific revolutions for fifteen long centuries)* have not contributed anything significant after the 15th century in various fields of science and discovery. Needham's poser evoked much debate and discussion which resulted in propounding a number of reasons for *our* (Indian) apparent failure to contribute significantly to modern day science and discovery. Of the many reasons suggested, the fact that we are weak in observation with a closed educational system brought about by Macaulay, and that we do have a culture of contentment from a philosophical perspective are probably, *what I feel,* are the most important reasons for our collective failures.

Interestingly, Narasimha (2005), had argued that axiomatism and computational positivism – *the two different mathematical cultures of the occidental and the oriental respectively* – may be the important reasons for Indians not contributing to science after 15th century, while the westerners benefited by marrying their model making skills with the ingenuity of Indian mathematics and progressing appreciably in science. Roddam Narasimha's argument seems very convincing if we look at the following quotes from some of the outstanding scientists of our times.

"The ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. The idea seems so simple nowadays that its significance and profound importance is no longer appreciated. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost amongst useful inventions." - **La Place,** on the Indian Numeral System.

"We owe a lot to Indians, who taught us how to count, without which no worthwhile scientific discovery could have been made." - **Albert Einstein,** on the Indian Numeral System.

"If I were asked under what sky the human mind has most fully developed some of its choicest gifts , has most deeply pondered on the greatest problems of life, and has found solutions, I should point out to India." - **Max Mueller,** on the Ancient Indian Science.

"After the conversations about Indian philosophy, some of the ideas of Quantum Mechanics that had seemed so crazy suddenly made much more sense." - **Heisenberg** on Atomic Physics.

Although many of the possible reasons discussed by Narasimha and others may seemingly be appropriate in the present day context, on serious contemplation one could also argue that our inability to perform well in the field of science, *perhaps,* stems from the fact that there has been a phenomenal change in the path of our scientific inquiry and in the way we do science; significantly influenced and transformed with the changes brought about in the language, environment and society, as a result of the invasions by the Moghuls and the Europeans, starting from the 15th century. Interestingly, this argument can be substantiated by looking at what Lord Macaulay had to say in the British Parliament on February 2, 1835 (Bharathiya Bouddhik Sampada, 2006).

"I have traveled across the length and breadth of India and I have not seen one person who is a beggar, who is a thief. Such wealth I have seen in this country, such high moral values, people of such caliber, that I do not think we would ever conquer this country, unless we break the very backbone of this nation, which is her spiritual and cultural heritage, and, therefore, I propose that we replace her old and ancient education system, her culture, for if the Indians think that all that is foreign and English is good and greater than their own, they will lose their self-esteem, their native self culture and they will become what we want them, a truly dominated nation." **- Lord Macaulay.**

Ancient Discoveries of India

Some of the amazing discoveries which have come from ancient India in various scientific fields are highlighted in the following section to emphasize the point that perhaps the *then* existing path of scientific inquiry, uninfluenced by the foreign invasions *and the resulting transmutation of the Indian psyche and thought process*, may have been responsible for the various discoveries brought about.

Psychology & Cosmology:

Kapil (3000 BC) had postulated in *Sankhya Philosophy* the secret levels of psyche, including mind, ego and intellect and how they relate to Soul or Atman – well before Sigmund Freud's time. Kapil's view of cosmos was that essential nature (*prakruti)* comes from the eternal (*purusha*) to develop all creation.

Aviation & Medicine (Ayurveda):

Bharadwaj (800 BC), recognized as the father of ayurveda and developer of aviation technology presented a treatise titled *Yantra Sarvasva*, in which astonishing discoveries in aviation and space sciences and flying machines were presented well before Leonardo Da Vinci's time.

Athreya (8 BC) had published a treatise called as *Charaka Samhita,* which is a compilation of all aspects of ayurvedic medicine including diagnoses, cures, anatomy, embryology, pharmacology and blood circulation.

Chemistry and Metallurgy:

The atomic theory of Kanad (600 BC) talks about atomic motion and chemical reactions. Kanad postulated that every object in creation is made of atoms that in turn connect with each other to form molecules nearly 2500 years before John Dalton's time.

Nagarjuna was credited for bringing out *Rasa Ratnakara*, a treatise on chemistry and how to develop alchemical metals for medicinal purposes. Ancient India was also famous for gold jewelry (3000 BC), brass and bronze (1300 BC), non-corroding iron pillar in Delhi believed to be 1200 years old; well before their entry into western world.

Astronomy and Mathematics:

Aryabhatta (476 BC) discovered the motions of planets and time of eclipses nearly 1000 years before Copernicus. In the treatise, *Shulaba Sutra* (600 BC), the topics of zero, pi, geometry and trignometry were presented well before Euclid and Pythagoras of the Greek era. In the book titled, *Surya Siddantha* (400 circa), Bhaskaracharya spoke about the law of gravity nearly 1200 years before Newton did. The decimal system, *i.e.*, decimal scale to base 10, was invented in India without which no counting can exist.

Medicine and Surgery:

Sushrutha (600 BC) was acknowledged as the father of surgery and developer of surgical instruments and processes. His treatise, *Sushruta Samhita,* was considered as the encyclopedia for surgical techniques and instruments.

Scientific Notation and Grammar:

Pannini (500 circa) was credited for his publication *Astaadhyayi,* which was a comprehensive and scientific theory of phonetics, phonology and morphology - a precursor to computer languages 1400 years before John Backus's Normal Form in 1959.

Astronomy, Botany and Animal Science:
Varahamihra (500 circa) was credited with his treatises, *Panchasiddhantha, Bruhad Samhita, Bruhad Jataka*, which describe geography, constellation science, botany and zoology in great detail.

Indian Philosophy and Scientific Inquiry

The Indian philosophy or way of thinking is a dynamic phenomenon punctuated by the Vedic period (1500 BC – 600 BC), the Epic period (600 BC – 200 AD), and the Sutra period (From 200 AD). The sutra period was governed by six philosophical systems *which in my view* basically propounded the process of scientific inquiry. The six philosophical systems being *Nyaya* (Logic), Vaiseshika (Atomism), *Sankhya* (Analysis), *Yoga*(Method), *Purva Mimamsa* (Exegesis) and U*ttara Mimamsa* or *Vedanta.*

The amazing discoveries of ancient India were perhaps brought about by the time tested efficacy of the process of scientific inquiry ingrained in our six ancient Indian philosophical systems. It is argued that this process and path of scientific inquiry in India was transformed and subsequently lost to the modern day scientist in India after the Indian invasions starting from 15th century. The argument, in a way, resonates with Thomas Kuhn's philosophy that the process of scientific inquiry is psychologically and sociologically biased. The suggestion being that, there was a significant change in the path and process of scientific inquiry in India after the Mughal and European invasions of India. As a result our (Indian) scientific achievements and stature have come down, not at all commensurate with our numbers and intellect. Therefore, it is strongly felt that it is time we shed our '*colonial*' way of thinking and revert back to the scientific processes and inquiry as ingrained in our ancient Indian philosophy to regain our lost stature in the world of science and discovery.

Conclusions

The paradoxical nature of scientific discovery and the importance of the process of scientific inquiry were stressed; summarizing that scientific discovery can be brought about by both a *priori* bias as well as observational learning as was ingrained in our ancient Indian philosophical systems. It is advocated that we re-orient our path of scientific inquiry by following the tenets of the six Indian philosophical systems of *Nyaya* (Logic), Vaiseshika (Atomism), *Sankhya* (Analysis), *Yoga* (Method), *Purva Mimamsa* (Exegesis) and U*ttara Mimamsa* or *Vedanta* in order to regain our lost scientific stature in the world and perhaps effect great new scientific discoveries.

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