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Towards a Scientific Approach for Integrating Science's Outputs and Islamic Concepts – Part 1

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Abstract
The intellectual Muslim community is living in a dichotomy between faith and science. On the one hand, Islamic teaching tells us that knowledge brings us closer to God and substantiates our faith with rational evidence. On the other hand, the predominant western culture in the modern scientific community rejects the notion of believing in the unseen and sidelines it under the topic of metaphysics, with all the negative connotations associated with it. As a result, the path of living according to faith and the path of scientific investigation diverged further from each other, seemingly with no point of convergence. This article is aimed at removing the obstacles erected by the

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empiricist outlook in the scientific methodologies, which hinders the integration of religious knowledge and scientific output in a unified framework. Our discussion on the scientific methodologies from the Islamic perspective shows that rational and empirical faculties can be utilised to their fullest potential in a complementary manner. Emerging from the understanding that religion and science are the two valuable engines of human civilisation, an ideology-based approach for the study of natural systems can be adopted. In this part of the article, the tenets of empiricism and Karl Popper's notion of falsification are contrasted with the Islamic concept of certainty (*yaqīn*).

Keywords
Bacon, certainty, empiricism, experimentation, falsification, induction, Islamic theology, Popper, scientific method.

Introduction

The claim of incompatibility between science and religion is negatively influencing the Muslim community. While the Islamic teaching promotes the notion that knowledge provides the rational justification for faith, Western scientists acknowledge only tangible facts. Even though many intellectual disciplines overlap, scientists are very reluctant to address the metaphysical dimension of the subject under investigation.[1] In the modern age, the big gap between religious scholars and natural scientists is quite evident, with no foreseeable reconciliation in the near future.

The literature of Islamic theology states that knowledge is a vehicle for certainty.[2] Some fundamental concepts in Islamic

1. Zakī Najīb Maḥmūd, *Mawqif min al-Mītāfīzīqā* (Cairo: Dār al-Shurūq, 1982), 69–109.
2. Masʿūd ibn ʿUmar Al-Taftāzānī, *Sharḥ al-Maqāsid* (Beirut: ʿĀlam al-Kutub, 1989), 187–197.

theology are based on the definitive proofs which stand formidable against all sorts of falsification. However, from the Western perspective, the theories that constitute the crops of scientific knowledge can be falsified with a single counter-evidence, but can never be considered indubitably certain irrespective of the large number of supportive evidence in their favour.

In the antiquity, nature-related theories used to stem from ideological beliefs. For example, Aristotle believed in geocentrism, which assumes that the earth is the centre of the universe owing to the status of Man who inhabits it.[3] Francis Bacon (1561–1626) dismissed this approach as an infertile means for capturing nature and termed it "nature anticipation."[4] Instead, Bacon promoted "nature interpretation" which is observing and recording natural phenomena using unbiased, quantitative figures.[5] In simple terms, theories should not be the outcomes of personally or ideologically-shaped perception; rather they should match the reality of nature. Bacon's proposal has been widely accepted by Western scientists and recognised as the modern scientific method. Although Bacon's method contributed to eliminating, at least in principle, delusions and personal inclinations from scientific research, it also restricted one of the most important elements of the human intellect: the power of inference and deduction.

The main objective of this article is to define a coherent framework for deduction and induction to work in a complementary manner, as well as to link the outcomes of scientific investigation to the metaphysical dimension of human knowledge. In this part, the principles of empiricism are discussed by analysing the views of its prominent figures, then a critical review of empiricism follows to show the restrictive nature of

3. Stephen Hawking, *A Brief History of Time* (New York: Bantam Books, 1996), 2–3.
4. Lisa Jardine, *Francis Bacon Discovery and the Art of Discourse* (Cambridge: Cambridge University Press, 1974), 120–132.
5. Peter Urbach, *Francis Bacon's Philosophy of Science* (Illinois: Open Court Publisher, 1987), 160–182.

this method in relation to the rational and imaginative faculties. Then, the method of falsification, as suggested by Karl Popper (1902–1994), is analysed in a way that shows its anti-dogmatic root. Finally, the question of achieving certitude in religious studies and in applied sciences is addressed from the Islamic point of view.

Prominent Figures of Empiricism

Francis Bacon and the Inductive Method

To prevent the influence of religion and traditional beliefs, Francis Bacon introduced a method for conducting scientific investigation which relies on sensible observations and experimentation. According to Bacon, scientific investigation should begin with a mass of factual data, which are derived from observations and later confirmed by experiments. This data should include varied, and heterogeneous samples, presumably to capture the various aspects of the phenomenon being studied. Upon collecting all relevant data —called "histories" by Bacon—the process of determining the "forms" should follow. Since Bacon did not forward a concrete definition of his forms, other thinkers have forwarded their own views. According to Mary B. Hesse (1924–2016), a form is a property that must accompany another property in an object.[6] Determining the forms should follow a virtually automatic process which is aimed at excluding the irrelevant properties, one after the other, until a single possibility remains, which then represents the required form. In the preface of the *New Organon*, Bacon emphasises the mechanical nature of this process, saying, about the mind, that: "[it] should be guided at every step; and the business be done as if by machinery."[7]

6. D. J. O'Connor, *A Critical History of Western Philosophy* (New York: Macmillan Publishing, 1964), 141–152.
7. Fulton Anderson, *Bacon: The New Organon*, ed. (New York: Macmillan Publishing, 1960), 34.

Other thinkers pointed out the mechanical mode of operating the Baconian method as a fundamental feature of this method. Ellis, for instance, says: "Absolute certainty and a mechanical mode of procedure such that all men should be capable of employing it, are … two great features of the Baconian method."[8] In order for the inductive process to yield positive results, Bacon based it on an important assumption that nature is finite and that every possibility as to the true explanation of a particular phenomenon can be surveyed in advance. He says: "Regard a body as a troop or collection of simple natures. In gold, for example, the following properties meet. It is yellow in color; heavy up to a certain weight; … and so on for the other natures which meet in gold."[9]

The above description suggests that not only is the power of experimentation overrated by Bacon, but also the contribution of deduction and inference is undervalued, and perhaps totally ignored. In other words, induction plays the role of a single hero in Bacon's method. Bacon describes the far-reaching power of induction, saying: "But places all wits and understanding nearly on a level."[10]

Before proceeding further, let us summarise the salient features of Bacon's method in the following points. First, Bacon implicitly assumed that all properties of matter are detectable by experimentation. Secondly, human observations can yield data that is free from biasing and the influence of preconceived notions. Thirdly, he portrayed the interpretation process as an application of a set of procedural rules that can be operated by most men. These points will be revisited later in our critique of the Baconian method and the empirical approach in general.

The work of William Gilbert (1544–1603) is usually cited as an example of how well the inductive approach can

8. Robert Ellis, *General Preface to Philosophical Works,* vol. 1 (Cambridge: Cambridge University Press, 2011), 23–24.
9. Bacon used the term a "simple nature" to refer to a property, see: Anderson, *Bacon: The New Organon*, 124.
10. Ibid., 58.

work.[11] Gilbert conducted extensive experiments that led him to conclude that the earth is a magnetic body, and its core is iron, which directs the compass's needle to point towards the magnetic north. His experiments also revealed many of the properties of magnets, such as when a magnet is cut into several pieces, each one becomes a magnet having its own north and south poles. It was claimed that due to the well-designed experiments conducted by Gilbert, he discovered all the fundamental properties of magnetism such that until today very few information can be added to the understanding of magnetism.[12] Galileo Galilei (1564–1642) considered Gilbert to be the true founder of the experimental method, and as such was deeply influenced by his approach.

John Locke and the Blank Slates

Bacon was considered a prominent figure of empiricism mainly due to the fact that his work zoomed in on the practices of scientific research. For instance, in the last chapter of his *New Organon*, Bacon provided an illustrative example of how to characterise heat based on surveying its qualities in a tabulated format.[13] However, to understand the epistemic origin of empiricism, we have to turn our attention to another philosopher who laid down, correctly or otherwise, the principles of empirical thinking. This philosopher was John Locke (1632–1704). Locke asserted that we come to life with souls receiving no innate principles, and with minds like blank slates. It is only through the senses that data are gathered and through mental acts that knowledge is being built. Locke did not confine his denial of innate ideas to matters related to natural systems, but he also rejected innate ideas as they pertain to morality and the

11. It should be noted that Gilbert passed away before publishing the *Novum Organum* in 1620.
12. William Whewell, *History of the Inductive Sciences from the Earliest to the Present Time*, vol. 2 (London: John Parker, 1859), 127.
13. Anderson, *New Organon*, 130 onwards.

knowledge of God. In the following, we primarily discuss his denial of innate principles pertaining to perceiving the universe.

To provide a justified account for his rejection of innate ideas, Locke had to explain how all types of knowledge can be developed without relying on previously established ideas in the mind. In order to achieve this, Locke proposed the notion of primary and secondary qualities. To set the stage for his thesis, he first defined qualities as things that really exist in the body and ideas as our perceptions of these qualities.[14] As such, qualities exist in bodies and ideas exist in our minds. He further subdivided qualities into primary and secondary ones with the following distinction.[15] Primary qualities are what we perceive from the physical world. Extension (size), figure (shape), motion, solidity, and number are listed by Locke as primary qualities, which are mind-independent, in the sense that they continue to exist whether we observe them or not. On the other hand, secondary qualities, like colour and taste, draw their existence from our experience of them. According to Locke, the quality of sweetness of sugar only holds while one tastes sugar. He also claimed that primary qualities have the power to generate the secondary ones in our minds. After forming ideas, our mind gathers the simple ideas into more complex ones in the course of building our knowledge. Our mind also compares ideas and abstracts them from the objects they are assigned to as a preliminary step to make a generalisation.

John Stuart Mill and the Inductive Logic

John Stuart Mill (1806–1873) is an important figure in the inductive approach. He popularised the Baconian method and based it on deeper philosophical arguments that constitute a whole theory of epistemology. Mill thought that humans can only acquire knowledge through empirical observations and

14. John Locke, *An Essay Regarding Human Understanding* (Pennsylvania: Pennsylvania State University Press, 1999), 116–117.
15. Ibid., 117–118.

reasoning that directly addresses these observations. Mill held that such observations form the original data prior to which we cannot have any genuine knowledge and endorsed only a limited class of reasoning, which is the inductive generalisation. Upon seeing ten white swans at different stages of our life, we tend to think that an eleventh swan would be white too. Moreover, this generalisation strikes us as a true, reasonable one. According to Mill, inductive reasoning is the sole instrument that we should use to infer unobserved facts. Narrowing down the scope of valid reasoning by Mill resulted in a serious stance: the hypothetical method is not a valid approach for learning about the world as only empirical observations can interpret the empirical ones. The role of unobserved hypothesis should be merely suggestive, for they do not have the power to make us believe in a particular entity.

Mill's main contribution to the inductive approach was his formulation of the methods used in the inference of inductive arguments. In Mill's *A System of Logic*, he introduced five techniques, mostly eliminative in nature, for determining the cause of a phenomenon out of several possible circumstances.[16] To enable a close examination of these methods, we will briefly describe them in the next paragraph, associated with an example for each.[17]

The method of agreement seeks to discover the circumstance that is common to all the cases of a phenomenon and label it as the likeliest cause of this phenomenon. Suppose that the customers of a restaurant, eating different combinations of dishes, fell ill with food poisoning. The method of agreement would identify the common dish as the cause of food poisoning.[18]

16. John Stuart Mill, *A System of Logic* (London: Longmans, Green, and Co, 1889), 253–266.
17. An analysis of these methods with well-designed contemporary examples is given in Irving Copi and Carl Cohen, *Introduction to Logic,* Thirteenth Edition (New Jersey: Pearson Education, 2009), 519–546. Our presentation in the upcoming paragraph is based on this section.
18. Ibid., 520–522.

The method of difference seeks to discover the circumstance whose presence (or absence) leads to the occurrence of a phenomenon, whereas its absence (or presence) leads to the disappearance of this phenomenon.[19] Suppose that the diet of a group of animals was changed to include a higher salt intake for several months, after which the normal diet was resumed. During the period of the higher salt intake, the animals experienced high blood pressures. After this period, the animals resumed their normal blood pressure. The method of difference would suggest that high salt intake is a cause for high blood pressure.

The joint method of agreement and difference combines the two previous methods, which increases the probability that the cause is determined correctly.[20]

The method of residues seeks to determine an *additional* antecedent for a part of the phenomenon, which is not accounted for by other known antecedents. For example, when the trajectory of a space craft cannot be fully explained by the impact of the gravitational force, this method could be used to determine the unknown force causing the deviation from the calculated trajectory.[21]

The method of concomitant variation seeks to determine the cause for an increase or a decrease of a phenomenon, rather than the cause for its mere existence. For example, a study showed that eating one meal of fish per week reduces the risk of heart attack by 50 percent.[22]

Although the inductive logic can also be operated through other methods, the above five methods illustrate how it works. Induction attempts to identify the probable cause, out of many others, of a phenomenon, or a part of it. Mill introduced the above techniques as canons of induction and the way for establishing causal connections. However Irving Copi and

19. Ibid., 525–528.
20. Ibid., 532–533.
21. Ibid., 536–537.
22. Ibid., 540–543.

Carl Cohen, among others, reject Mill's formulation, saying: "Inductive techniques are indeed of very great importance, but their role in science is more limited than Mill supposed."[23]

In our discussion of "Deduction vs. Induction" in the second part, we will discuss the reasons behind their stand.

The Inductive Method through Critical Eyes

It is undeniable that we learn through our senses.[24] It is also beyond doubt that scientists have to rely on a substantial amount of data before forwarding a scientific claim that deserves to earn a serious consideration. As God says in the Holy Qur'ān: "Say, travel through the land and observe how He began creation. Then Allah will produce the final creation. Indeed Allah, over all things, is competent,"[25] indicating that different types of evidence, from different parts of the world, have to be gathered in order to establish a theory about how the creation was started. However, what distinguishes man over other creatures is man's ability to deduce and infer a more intelligent layer of knowledge on top of what is directly observed (the mere facts). Perhaps, it is for this reason that the second part of the Quranic verse explains how God will reproduce creation for the second time upon commencing the Day of Judgment. The two parts of the verse refer to Man's ability to predict what is coming based on what has already occurred. Scientific knowledge in its final form is the outcome of a long series of data processing, culminated in the producing of knowledge. The main flaw with the empirical approach is that it undervalues deduction and reasoning in general. Accordingly, it deprives the scientific method from the most creative mental faculties.

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23. Ibid., 547.
24. Imam al-Ghazālī presented a beautiful elaboration of how senses, including sight and hearing, are important means for achieving piety, which opens the door to acquiring useful knowledge. See Al-Ghazālī, *Minhāj al-ʿAbidīn īlā Jannat Rabb al-ʿĀlamīn* (Beirut: Dar Al-Minhāj, 2006), 104–108.
25. *Al-ʿAnkabūt* (29):20.

Invalid Assumptions of the Baconian Method

The Baconian method is an instance of the restrictive framework of empiricism. In the following, we discuss some of the assumptions made by Bacon in his proposed scientific method. Firstly, by adopting experimentation as a sole means for learning about nature, Bacon assumes that all properties of matter are detectable by experimentation. Later discussion will explore that only very little information about atomic structures and distant celestial objects, for example, can be known through experiments. In such areas, the role of hypotheses becomes more critical in building theories. As previously mentioned, Bacon's method severely restricts hypotheses. Secondly, Bacon portrayed the interpretation process as an application of a set of procedural rules that can be operated by most men. This approach may only work on phenomena with obvious physical effect, like magnetism, and would fail to capture the inner structure and subtle aspects of the phenomena.[26] Our later discussion on Popper's view on constructing theories also shows that the rational and abstract nature of theories cannot be ignored. Thirdly, empiricists like Bacon exalt human objectivity beyond its merit by assuming that human observations can yield data, free from biases and the influences of preconceived notions. On the contrary, Popper argued that all observations are theory-laden, as shall be discussed later. Furthermore, Ibn al-Haytham showed that human observations are subject to errors in perception and interpretations, and also shall be discussed later. Ibn al-Haytham dedicated considerable research to techniques for safeguarding against such errors as efficient as possible. He added a final remark that filtering out errors might not be possible in a perfect manner after all.[27]

26. Urbach, *Francis Bacon's Philosophy of Science*, 12.
27. Al-Hasan ibn al-Haytham, *Kitāb al-Manāẓir* (Kuwait: The National Council for Culture, Arts, and Letters, 1983), 62.

John Locke's Denial of Innate Ideas

Our previous discussion of Locke's epistemic theory of knowledge shows that he used the notion of primary and secondary qualities to assign the task of knowledge acquisition to pure sensory channels. He also claimed that our minds are like blank slates—not containing any prior existing texture of patterns— at the time we come to life. With that, Locke denied pre-existing knowledge since he denied pre-existing mental contents and innate ideas, as opposed to his earlier contemporary philosopher, René Descartes (1596–1650).[28] Apparently, Locke focused his attack on the rational approach in knowledge acquisition by rejecting the concept of innate ideas, because these ideas were regarded as the ground for believing in God by the predominately Christian community in Europe during his time. However, the denial of innate ideas does not necessarily eliminate the possibility of the later development of the mental abilities such as inference, deduction, insight, and intuition.

In this context, we differentiate between the concepts of innate ideas and pre-existing mental patterns. The latter concept refers to accepted notions and feelings, which are not originated from, or supported by, logic that men, in general, acknowledge and express, such as the experience of the inferiority of man which urges him to seek God, and the desire to explore the surrounding environment. On the other hand, the former concept refers to the principles that govern the way our minds work. We limit this discussion to the former concept because of its relevance to this article. In our view, pre-existing mental patterns are true realities. Each sense detects specific properties. For example, sight detects light and motion, while hearing detects sounds. Furthermore, different components in our eyes sense light and motion. If no sense is tuned to the spectrum of a property, it would go undetected. X-rays are beyond our senses because

28. Rene Descartes, *Principles of Philosophy* (Dordrecht: D. Reidel Publishing Company, 1983), 7–8.

they are located in a higher part of the light spectrum than the visible light. As properties need tuned senses for their detection, reasoning constructs also need tuned mental compartments to capture them. We call such compartments pre-existing mental patterns. These patterns are the initial structures that process human reasoning and through which our intelligence is developed. Our experience throughout our lives capitalises on these mental patterns.

The Holy Quran depicts senses and rational abilities as complementary tools for acquiring knowledge. In a reminder of how we gain knowledge after coming to life while being totally devoid of it, God says: "It is He Who brought you forth from the wombs of your mothers when you knew nothing; and He gave you hearing and sight and mind: That you may give thanks."[29] Fakhr al-Dīn al-Rāzī (1148–1211) commented saying that the senses perceive the basic elements of our knowledge,[30] such as objects, e.g. tree and apple, and qualities, e.g. red and sweet. In the terminology of logic, the senses capture the subject and the predicate of categorical propositions.[31] The mind establishes the relationship between these elements, which elevates our knowledge from the level of dispersed elements to the level of a coherent fabric of relevant data. Obviously, if the human mind lacks the appropriate mental patterns, the learning process would not start in the first place.

With regard to the concept of primary and secondary qualities, it does not stand the close examination of Locke's critics. For brevity, we suffice ourselves by a few remarks. First, the claim that primary qualities are mind-independent is not valid. For example, one would perceive a sky-scraper as gigantic when looking at it from a short distance. However, the same tower would look minute within a panoramic photo of the

29. *Al-Naḥl* (16):78.
30. Fakhr al-Dīn al-Rāzī, *Mafātīḥ al-Ghayb*, vol.7 (Beirut: Dār al-Fikr, 2005), 4147.
31. Copi and Cohen, *Introduction to Logic*, 182.

whole town. Secondly, primary qualities do not generate the secondary ones, at least in a direct manner. One would have to develop a very obscure argument to show how taste, which is a chemical property, is triggered in our mind based on any of the primary qualities listed by Locke.[32]

Discovery and Chance

Empiricists usually mention that many discoveries took place by coincidence, rather than through a systematic deductive research. Although stating a fact, this statement is rather misleading because it ignores the role of preliminary efforts exerted by the discoverers, as it ignores their extraordinary talents which enabled them to capture the subtle meaning behind their observations. Two examples are given below to show that coincidence would not lead lay people to the respective discoveries.[33] Readers will undoubtedly notice the deep insight underlying the endeavor of scientists.

In 1928, Alexander Fleming (1881–1955) was growing a type of bacterial colonies, called *Staphylococcus*. While sorting through his dishes, Fleming noticed that the colonies died in some spots in one dish, around which a blob of mold grew. The normal reaction was to dispose the dish in which the bacteria did not grow as desired, especially it is known that some bacteria inhibits the growth of others. However, Fleming did not rush for this quick reaction. Rather, he carefully pursued the observation of this dish to discover that the mold, which was later identified as a strain of Penicillin, was capable of killing a wide range of harmful bacteria. With such discovery, the era of antibiotics, which is perhaps the most useful therapeutic medicine, has begun.

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32. See how the taste system works in Bruce Goldstein, *Sensation and Perception*, Eighth Edition, (Belmont: Cengage Learning, 2010), 366–371.
33. These examples are cited in many books, see for example William Beveridge, *The Art of Scientific Investigation* (New York: W. W. Norton & Company, 1957), 160–168.

In 1820, Hans Christian Ørsted (1777-1851), who was looking for a relation between electricity and magnetism for years, was delivering one of his lectures. He unintentionally positioned a wire connected to a battery in a parallel orientation on top of a compass needle and noticed that the needle deflected. With a fast wit and to confirm his guess, he reversed the polarity of the battery to watch the needle deflecting in the opposite direction. With that, Ørsted was the first to discover the relationship between electricity and magnetism, paving the way for Michael Faraday (1791–1867) to later design the electric motor and generator. Louis Pasteur (1822–1895) commented on the discovery of Ørsted saying: "In the field of observation, chance favors only the prepared mind."[34]

Is Empiricism a Mere Scientific Approach or an Anti-Religion Stance?

We would like to conclude our discussion about empiricism by discussing the fundamental issue of whether empiricism just introduced is a restrictive method for seeking knowledge or it also included anti-religion concepts. It might be more accurate to conduct this discussion on two levels, the level of the Baconian method as a tool for scientific research and the level of the empirical approach in its totality. A cursory look at the Baconian method does not reveal explicit disagreements with religion. Probably, that was the reason that Bacon was not persecuted by the Church since his views did not directly attack the core beliefs held by the Church. However, a more careful review of Bacon's method shows that it was a step towards the shift of the European society to secularism. To put things in perspective, during Bacon's time, science was a branch of philosophy, and scientists used to be called natural philosophers whose aim was to strive for the truth of natural phenomena. Bacon called for separating scientific research from philosophy and giving science a different direction and a different aim.

34. Ibid., 32.

According to Bacon, science should be applied toward improving the economic condition of the society, rather than as a way for searching the truth in contemplation of God.[35] Additionally, Bacon attempted to eliminate the role of insight and intuition in scientific research as he attempted to put aside the deductive style of reasoning. Interestingly, Bacon attempted to restrain the very same cognitive abilities that religion works to develop and enhance. As expected, this gave rise to a progressive divergence between the mindset of scientists with that of the theologians.

If we consider empiricism in general, especially as Locke portrayed it, we can find even more points of disagreements between empiricism and religion. Locke denied that ethical standards are grounded on innate principles, which opened the door for questioning the universality of moral values. This in turn led to challenging ethical positions adopted by religion. Legalising abortion in modern societies is an outcome of the empiricism-afflicted society. Empiricism paved the way to Marxism and prepared the Western society to become more rebellious and hostile against religion. While empiricism did not explicitly call for eliminating religion from life, Marxism calls for obliteration of all religious symbols. Marxism regards religion as a deterrent of social change for the common good and as a source of illusory happiness, trying to substitute it with the "real" happiness associated with the fulfilling of economic needs. Marxism capitalises on the success of empiricism in Western societies by pushing religion into isolation and considers a robust economy a self-sufficient target.

Falsification as a Tool of Doubt

Karl Popper (1902–1994), a famous philosopher of science, was a vigorous opponent of the induction method and for the whole philosophy of empiricism to which this method belongs.

35. Bertrand Russell, *History of Western Philosophy* (Woking: Unwin Brothers Ltd., 1947), 565.

Popper repudiated the inductive approach on the account of its incompatibility with the abstract nature of theories. He highlighted the theoretical framework that every theory must have. Before collecting data, we must have a 'frame of reference' that tells us where to look and which aspects to observe. We use the same frame of reference to interpret the collected data. Because humans are pattern-seekers, they tend to look for persistent patterns across the data in the context of their expectations. This is in clear contradiction to Locke's notion of the blank slates. Furthermore, our experimental apparatus inevitably includes many variables, some of which are deemed relevant to the purpose of the experiment while others are not deemed so. It is the same frame of reference that determines this relevancy or otherwise. It is thus unrealistic to assume that we, as observers of nature, stand neutral while observing natural systems.

Popper's arguments against the induction method may be interpreted as a recognition of the coherence and explanatory power possessed by theories, which enable them to explain many phenomena by a single law.[36] Such a recognition would naturally lead a philosopher to the conclusion that theories could be confirmed, within the proper framework of assumptions and conditions. Puzzlingly enough, Popper did not reach this conclusion. Instead, he asserted that a scientific theory can never be confirmed; it would rather gather more experimental evidence in its favour without reaching the status of final acceptance. On the other hand, a single counter evidence is adequate to discredit the theory. Since the possibility of a counter evidence is always valid, a theory will always be subject to invalidation.[37]

36. See the insightful analysis of Kuhn on how the Newtonian theory of motion replaced the three laws of Kepler and confirmed the hypothesis of Galileo about friction, in Thomas Kuhn, *The Structure of Scientific Revolution*, Fourth Edition (Chicago: The University of Chicago Press, 2012), 30–31.
37. Karl Popper, *The Logic of Scientific Discovery* (London: Routledge Classics, 2007), 17–20.

Following Popper's logic, one might wonder if Popper considered death an unconfirmed reality despite the billions of people who experienced it since one person may turn out to be immortal!

It is intriguing that despite Popper's rejection of empiricism, the sense of doubt is remarkably more manifested in his philosophy than in classical empiricism. Popper's philosophy suggests that accumulation of knowledge does not necessarily removes confusion and conjectures, even in part, but may instead take us through a cycle of perpetual doubt in response to the emergence of conflicting instances of evidence pertinent to the theory. Seemingly, Popper wanted scientists to stay open to the idea that any belief may turn out to be wrong. Due to the unavoidable preconceived notions that every human has, a confirmation of a theory can always be obtained if one was initially inclined to this theory. For this reason, a true scientist should instead try to falsify the theory. Failing to do so would mean that the theory is still valid, but only up to the current moment. Popper considered this attitude a positive indicator of continuous search for the truth.[38] In short, Popper wanted scientists to abandon dogmatic thinking where one believes that some ideas are immune against challenges, and to rather adopt critical thinking that constantly doubts all claims.

Popper substantiated his argument of the endless falsifiability of theories by the criterion of demarcation between science and pseudoscience. A scientific point, Popper holds, has to be testable with a possibility that it is invalid. Accordingly, Popper termed the theories of psychoanalysis non-scientific because they are crafted in such a way that defeats all attempts of refutation. By the same token, he also termed evolution non-scientific because it refers to unknown histories that cannot be proven or disproven. Nevertheless, after recognising such a major flaw in the logical structure of evolution and according to his

38. Idem, *Science: Conjectures and Refutations*, in Martin Curd and J. Cover, *Philosophy of Science: The Central Issues* (New York: W. W. Norton & Company, 1998), 7.

habit of stumbling nearly before reaching the right conclusion and diverting to an orthogonal one, Popper described evolution as being of great scientific interest!

Apart from Popper's view on the credibility of scientific theories, he maintained a more reasonable stand on other fronts. First, he acknowledges the role of insight and imagination in constructing theories. He saw the need for imagination as a consequence of the need for a mental leap beyond the currently existent knowledge in order to solve anomalies that earlier theories could not solve. Secondly, he questioned that the starting point of a theory should be pure observations because all observations are theory-laden in the sense that they can be interpreted in various ways in accordance with the mindset of the observer. Thirdly, Popper stressed that the logical character of a theory has to be distinguished from the empirical elements. In doing so, the scientist should form the axioms and develop a tentative hypothesis, out of which conclusions are to be inferred.[39] Fourthly, he incorporated deductive testing as an indispensable element in confirming theories. In deductive testing, the scientist contrasts conclusions against each other and against other relevant accepted facts to ensure their consistency.[40]

Dogmatic Thinking: A Foundation or Misleading Direction?

Popper belonged to the school of rationalism, which upholds deductive thinking and maintains the value of insight. On the other hand, Bacon was a proponent of the inductive method, which solely acknowledges facts and concludes results as direct consequences of these facts. Even though the two schools stand on diametrical and contending terms, they share a common trend. Both schools strived to demolish dogmatic thinking. In this type of thinking, investigators assume unquestionable facts

39. Ibid., 51–54.
40. Ibid., 9.

and conduct their research in line with such facts. Obviously, the frustrating experience that scientists had with the Church resulted in their outright rejection of its authority. During the Renaissance era, the Church took unreasonable positions in condemning scientific views and persecuting their promoters based on biblical texts. In response, Western scientists called for sidelining the Church from the scientific enterprise which eventually led to separating the Church from the state.

The conflict between the Church and scientists[41] does not necessarily mean that there is an inherent conflict between science and religion. Actually, religious knowledge and scientific knowledge are valuable components of human knowledge and critical engines that drive human civilisations. The frustrating experience between the Church and scientists in the West should not be generalised to all religions. As will be seen in our analysis of Ibn al-Haytham's accomplishments in the second part, religion can be an enabler in spearheading the development of science. If we turn our attention to Muslim civilisations, even during their times of weakness, we would not find incidents of persecuting scientists. We would rather find scientists who adhere to religious teachings and seek a longer-term reward for their scientific works.

In our view, scientific research should add up to human knowledge just as it should respect and observe moral standards. Science should not be used as a justification for conducting immoral experiments and endeavors which disturb social harmony and challenge established ethical principles. Science should operate within the ethical parameters set by religion. If science is to be given unrestrained freedom to question any principle and to challenge any law, it would be acting as a destructive tool. Furthermore, if no principle or law is immune against the scientific attack, our knowledge would not have

41. For examples of the conflicts between scientists and the church, see Michael Allaby and Derek Gjertsen, *Makers of Science*, vol. 1 (Oxford: Oxford University Press, 2002), 18, 30.

concrete and established foundation, but rather fuzzy and shaky claims. In order for science, and human knowledge in general, to steadily grow, there must be a clear hierarchy of acceptable concepts and laws on top of which science should add. However, thinkers should watch out for the pitfall of making unjustifiable conclusions from the divine texts without basing these conclusions on firm grounds. The Catholic Church fell into this pitfall when members of the clergy did not lay clear boundaries between words of God and their own personal views.

Certainty in Islamic Theology

After discussing the Western perspective of science and the level of assurance of our understanding of the cosmos that science can yield, we now discuss the Islamic views of the same issues. To avoid ambiguity, we first set up the terminology that will be used in composing our arguments. In Western philosophy of science, science is defined as the outcomes (postulates and theories) of investigating natural systems that can be tested and possibly discredited, or according to Popper falsified.[42]

In the circle of Muslim scientific community, science is often a translation for the term *ʿilm* in Arabic.[43] Unfortunately, there is an inherent contention of using this translation. Muslim theologians use the term *ʿilm* as a type of knowledge that produces certain findings, particularly in relation to God's existence and divine attributes. Thus, *ʿilm* and its corresponding term, science, refer to two different types of knowledge, with different expectations. To resolve such entangled meanings, we have the option to either use science in reference to all branches of human knowledge including practical branches, such as

42. Lisa Bortolotti, *An Introduction to the Philosophy of Science* (Malden: Polity Press, 2008), 1–3.

43. For a good discussion of the meaning of *ʿilm* in Islamic sciences, and whether it is equivalent to *maʿrifah*, or knowledge, see Najm al-Dīn al-Ṭūfi, *Sharh Mukhtasar al-Rawḍah*, vol. 1 (Beirut: Mu'assasat al-Risālah, 1998), 168–175.

physics, which renders science and knowledge as synonyms, or to confine science to the study of natural systems and use knowledge, in a broader context, as referring to all the branches of human investigations. We prefer the second option, which regards science as a subclass of knowledge.

It is a fundamental argument in Islamic theology that knowledge (*ʿilm*) leads to certainty.[44] It is important to identify the topics meant by knowledge in this context and the logical tools used for reaching this certainty. Abū Ḥamid Muḥammad ibn Muḥammad al-Ghazālī (1058–1111) affirmed that people can develop certain findings about stationary aspects of life and cosmos, which are not subject to alteration in nature or change of state, such as the existence of God and divine attributes.[45] However, subjective and speculative views, such as political, legal, and social views, and temporally valid data, such as the populations of different towns and financial figures, are not subject to developing certain views.[46] Al-Ghazālī described certain knowledge as the type of knowledge that uncovers all unknown aspects of the subject matter such that all traces of doubt are removed and the possibility of error and delusion is eliminated.[47]

Certain findings are developed through reasoning. Al-Rāzī defined reasoning as the process of generating new arguments from already known ones.[48] To clarify the role of reasoning in acquiring knowledge, al-Rāzī drew a parallel between sight and reasoning. The eye, as a tool of sight, looks at objects for capturing

44. This argument is usually discussed in the introductory chapters of theology literature upon defining the meaning of *ʿilm*. See for example, Al-Sharīf al-Jurjānī, *Sharḥ al-Mawāqif,* vol. 1 (Beirut: Dār al-Kutub al-ʻilmiyah, 1998), 68–93.

45. See the proof of the existence of God in al-Ghazālī, *al-Iqtiṣād fī al-Iʿtiqād* (Beirut: Dār Qutaybah, 2003), 41–49.

46. Al-Ghazālī, *Miʿyār al-ʿIlm fī al-Mantiq* (Beirut: Dār al-Kutub al-ʻilmiyah, 1990), 243–246.

47. Al-Ghazālī, *Al-Munqidh min al-Ḍalāl*, 32.

48. Fakhr al-Dīn al-Rāzī, *Muhassal Afkār al-Mutaqaddimīn wa al-Mutaʾkhkhirīn (Cairo: Makt*abāt al-Kulliyāt al-Azhariyah, NM), 40–42.

their images. Similarly, the brain, as a tool of reasoning, processes accepted arguments to develop new ones. Al-Razi's definition of reasoning makes it obvious that he is referring to deduction.

Categorical syllogisms represent the logical tool that can lead to certainty. A categorical syllogism is a type of deductive arguments consisting of three categorical propositions, which are composed and arranged in a particular order.[49] Deductive logic is usually practiced through syllogisms.[50] The correctness of the two premises of a syllogism and the connection between the two entails the correctness of the conclusion. Once one concurs with the correctness of the two premises, he must consequently concur with the conclusion. Certainty, as defined above by al-Ghazālī, can be attained through a syllogism whose premises rely on innate, unacquired knowledge. In his commentary on the Aristotelian logic, Averroes, or Ibn Rushd, (1126–1198) indicated that when we seek a formidable conclusion that is beyond all sorts of doubt, the premises must be at the highest level of soundness too, which requires them to be based on innate knowledge.[51] To understand the reason behind this stipulation, let us briefly discuss the types of knowledge as classified by Muslim theologians.

Human knowledge can be classified into two main categories, innate and acquired.[52] Innate knowledge is the type of knowledge that we do not consciously seek to acquire, nor can we remove it from our minds. This includes direct observations, such as sun is bright; internal feelings, such as hunger and happiness; common elements of nature, such as mountains and seas; basic logical principles, such as two opposites like brightness and darkness cannot coexist at the same point; intuitive arguments, such as the whole is bigger than the

49. Copi and Cohen, *Introduction to Logic*, 224.
50. Ibid., 225–228.
51. Ibn Rushd, *Naṣṣ Talkhīṣ Manṭiq Arisṭū* (Beirut: Dār al-Fikr al-Lubnānī, 1992), 388–389.
52. Al-Sharīf al-Jurjānī, *Sharḥ al-Mawāqif*, vol. 1, 98.

part; common and established experience, such as chocolate sometimes causes allergy and the healing effect of acupuncture; and overwhelmingly accepted reports, such as knowing about the city of Makkah.[53] Some of the elements of innate knowledge are developed during early infancy while others are developed during late childhood. Upon browsing through these elements, it is straightforward to realise that innate knowledge, as defined by Muslim theologians, is different from that defined by Descartes, and denied by Locke, which refers to principles people are born with. Muslim theologians termed Descartes's innate knowledge as "preliminary aptitude and inclinations" (*al-istiʿdādāt al-fiṭriyyah*). Due to the inseparable nature of innate knowledge from human understanding, Muslim theologians require the premises of a syllogism to be based on it, when certainty is sought.

Certainty of Natural Theories

We are now in a position to respond to Popper's view that theories can never reach certainty. Using categorical syllogisms, with premises founded on innate knowledge, some theories could lead to definite arguments, and should thereby be marked as certain knowledge. Our previous discussion of innate knowledge shows that it includes direct observations, which can be obtained from natural systems or simulated systems that are consistently reproduced through experiments. For example, magnetism is fully characterised since Gilbert until today, using countless direct observations of natural elements and the electric devices that utilise this phenomenon such as motors and generators. Also, the phenomenon of photoelectric effect—which shall be discussed in the second part—and its spectral behaviour in response to different light stimuli are established using numerous experiments in many laboratories around the world. Such discoveries which later developed into theories surely constitute part of our certain knowledge.

53. Ibid., vol. 1, 102, and Tāj al-Dīn al-Subkī, *Rafʿ al-Ḥājib an Mukhtaṣar ibn al-Ḥājib*, vol. 1 (Beirut: ʿAlam al-Kutub, 1999), 309–310.

Moreover, some indicators can be identified to signify certain knowledge. One of these indicators is the successful functioning of complex devices which operates in its relevant theories. For example, microprocessors used in latest smart phones contain more than 100 million transistors. They conduct billions of arithmetic and logical operations per second successfully over their lifetime (about twenty years). It is therefore absurd to question the certainty of the theory of conductivity, electricity, etc. which operate semiconductor processors.

On the other hand, we do not have such level of confidence about many other theories such as the energy distribution and orbital configurations of heavy atoms. This is expected since human knowledge is never complete. In such cases of uncertainty, instead of doubting the whole domain of knowledge, it is more accurate to define the known aspects, associated with the conditions and assumptions. In these cases, scientists are cautioned against unfounded generalisations. Had Isaac Newton (1643–1727) accurately described the range of speeds for his laws of motion, Albert Einstein (1879–1955) would not be able to invalidate these laws when the concerned speed approaches the speed of light. As research grows, the known aspects will expand until a point is reached where a complex device functions exactly as expected. For example, the study of luminescence and fluorescence started in the 1930s. It took about five decades to obtain consistent and coherent results of these phenomena, which eventually led to the introduction of liquid crystal displays (LCD) currently used in electronic tablets and computers. That way, small sanctuaries for certain findings are built within the ocean of the unknown. These sanctuaries will be waiting for new investigators to expand and declare full mastery over a scientific area.

Popper used the influence of preconceived notions on directing scientist's minds toward a particular conclusion as a justification for his call to falsify theories rather than to confirm them. Popper stated that if we seek a confirmation, we will find it, in reference to the influence of preconceived notions on the research direction. Although we believe that falsification should be part of the testing plan and we also acknowledge that scientists may personally prefer an outcome over the other, we do not think that falsifiability should continue forever. We also remind that scientists should be trained to neutralise their personal inclinations while researching. Max Planck (1858–1947), a theoretical physicist, was not inclined to, or even aware of, the quantum nature of matter.[54] However, when the results of his experiments on black body radiation did not fit into classical physics, he switched his line of thinking, though reluctantly, to the quantum interpretation.[55]

Conclusion

This article has discussed one of the most fundamental issues that puts Western experimental science in conflict with Islamic theology, namely the reliance of scientific investigation on pure sensible observations and the refusal to address the transcendental aspects of physical systems. Our analysis of Bacon's inductive approach and Popper's notion of falsification showed that both were driven by the reluctance of accepting a religious authority, which justified their stance on dogmatic thinking. Accordingly, empiricism set the stage for Marxism to call for the obliteration of religious values and prepared the European society to the shift to secularism.

We also discussed the concept of certainty in Islamic theology within an epistemic framework. Capitalising on this discussion, it was proven in logical terms that reaching certainty about some natural theories is possible. Moreover, the notion of "sanctuaries for certain findings" was introduced for handling uncertain aspects of a phenomenon within the borders of relevant assumptions and conditions.

54. Max Planck, *The Universe in the Light of Modern Physics* (London: George Allen & Unwin Ltd., 1931).
55. Planck was the first to introduce the concept of quantised energy in relation to black body radiation in 1900 for which he won the Nobel Prize in 1918. Later, Einstein extended the energy quanta to light.

Our discussion will not be complete until an integrative framework for induction and deduction is laid down. Also, the role of abstraction and insight in building theories has to be investigated. More importantly is the enrichment of our understanding of the cosmos through addressing the transcendental dimension of the behaviour of physical systems. These are the aims of the second part of this article.

References

Allaby, Michael and Derek Gjertsen, Derek. *Makers of Science*, vol. 1. Oxford: Oxford University Press, 2002.

Anderson, Fulton. *Bacon: The New Organon*, ed. New York: Macmillan Publishing, 1960.

Beveridge, William. *The Art of Scientific Investigation*. New York: W. W. Norton & Company, 1957.

Bortolotti, Lisa. *An Introduction to the Philosophy of Science*. Malden: Polity Press, 2008.

Copi, Irving and Cohen. *Introduction to Logic*, Thirteenth Edition. New Jersey: Pearson Education, 2009.

Curd, Martin and Cover, J. *Philosophy of Science: The Central Issues*. New York: W. W. Norton & Company, 1998.

Descartes, Rene. *Principles of Philosophy*. Dordrecht: D. Reidel Publishing Company, 1983.

Ellis, Robert. *General Preface to Philosophical Works*. Cambridge: Cambridge University Press, 2011.

Al-Ghazālī. *Al-Iqtiṣād fī al-Iʿtiqād*. Beirut: Dār Qutaybah, 2003.

________. *Miʿyār al-ʿIlm fī al-Mantiq*. Beirut: Dār al-Kutub al-ʿIlmiyah, 1990.

________. *Minhāj al-ʿAbidīn ilā Jannat Rabb al-ʿAlimīn*. Beirut: Dar Al-Minhāj, 2006.

________. *Al-Munqidh min al-Ḍalāl*. Alexaderia: Dār Ibn-Khuldūn, nd.

Hawking, Stephen. *A Brief History of Time*. New York: Bantam Books, 1996.

Ibn al-Haytham, al-Ḥasan. *Kitāb al-Manāẓir*. Kuwait: The National Council for Culture, Arts, and Letters, 1983.

Ibn Rushd. *Naṣṣ Talkhīṣ Manṭiq Arisṭū*. Beirut: Dār al-Fikr al-Lubnānī, 1992.

Jardine, Lisa. *Francis Bacon Discovery and the Art of Discourse*. Cambridge: Cambridge University Press, 1974.

Al-Jurjānī, Al-Sharīf. *Sharḥ al-Mawāqif*. Beirut: Dār al-Kutub al-ʿIlmiyah, 1998.

Kuhn, Thomas. *The Structure of Scientific Revolution*, Fourth Edition. Chicago: The University of Chicago Press, 2012.
Locke, John. *An Essay Regarding Human Understanding*. Pennsylvania: Pennsylvania State University Press, 1999.
Maḥmūd, Zakī Najīb. *Mawqif min al-Mītāfīzīqā*. Cairo: Dār al-Shurūq, 1982.
Mill, John Stuart. *A System of Logic*. London: Longmans, Green, and Co, 1889.
O'Connor, D. J. *A Critical History of Western Philosophy*. New York: Macmillan Publishing, 1964.
Planck, Max. *The Universe in the Light of Modern Physics*. London: George Allen & Unwin Ltd., 1931.
Popper, Karl. *The Logic of Scientific Discovery*. London: Routledge Classics, 2007.
________/ *Muḥāṣṣal Afkār al-Mutaqaddimīn wa al-Mutaʾakhkhīrīn*. Cairo: Maktabah al-Kulliyāt al-Azhariyah, nd.
Al-Rāzī, Fakhr al-Dīn. *Mafātīḥ al-Ghayb*. Beirut, Dār al-Fikr, 2005.
Russell, Bertrand. *History of Western Philosophy*. Woking: Unwin Brothers Ltd., 1947.
Al-Subkī. *Rafʿ al-Ḥājib ʿan Mukhtaṣar ibn al-Ḥājib*. Beirut: ʿĀlam al-Kutub, 1999.
Al-Taftāzānī, Masʿūd ibn ʻUmar. *Sharḥ al-Maqāṣīd*. Beirut: ʿĀlam al-Kutub, 1989.
Al-Ṭūfī, Najm al-Dīn. *Sharḥ Mukhtaṣar al-Rawḍah*, vol. 1. Beirut: Mu'assasah al-Risālah, 1998.
Urbach, Peter. *Francis Bacon's Philosophy of Science*. Illinois: Open Court Publisher, 1987.
Whewell, William. *History of the Inductive Sciences from the Earliest to the Present Time*. London: John Parker, 1859.