Why the Arabic World Turned Away from Science

On the lost Golden Age and the rejection of reason

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Contemporary Islam is not known for its engagement in the modern scientific project. But it is heir to a legendary "Golden Age" of Arabic science frequently invoked by commentators hoping to make Muslims and Westerners more respectful and understanding of each other. President Obama, for instance, in his June 4, 2009 speech in Cairo, praised Muslims for their historical scientific and intellectual contributions to civilization:

> It was Islam that carried the light of learning through so many centuries, paving the way for Europe's Renaissance and Enlightenment. It was innovation in Muslim communities that developed the order of algebra; our magnetic compass and tools of navigation; our mastery of pens and printing; our understanding of how disease spreads and how it can be healed.

Such tributes to the Arab world's era of scientific achievement are generally made in service of a broader political point, as they usually precede discussion of the region's contemporary problems. They serve as an implicit exhortation: the great age of Arab science demonstrates that there is no categorical or congenital barrier to tolerance, cosmopolitanism, and advancement in the Islamic Middle East.

To anyone familiar with this Golden Age, roughly spanning the eighth through the thirteenth centuries A.D., the disparity between the intellectual achievements of the Middle East then and now — particularly relative to the rest of the world — is staggering indeed. In his 2002 book ***What Went Wrong?***, historian Bernard Lewis notes that "for many centuries the world of Islam was in the forefront of human civilization and achievement." "Nothing in Europe," notes Jamil Ragep, a professor of the history of science at the University of Oklahoma, "could hold a

candle to what was going on in the Islamic world until about 1600." Algebra, algorithm, alchemy, alcohol, alkali, nadir, zenith, coffee, and lemon: these words all derive from Arabic, reflecting Islam's contribution to the West.

Today, however, the spirit of science in the Muslim world is as dry as the desert. Pakistani physicist Pervez Amirali Hoodbhoy laid out the grim statistics in a 2007 *Physics Today* article: Muslim countries have nine scientists, engineers, and technicians per thousand people, compared with a world average of forty-one. In these nations, there are approximately 1,800 universities, but only 312 of those universities have scholars who have published journal articles. Of the fifty most-published of these universities, twenty-six are in Turkey, nine are in Iran, three each are in Malaysia and Egypt, Pakistan has two, and Uganda, the U.A.E., Saudi Arabia, Lebanon, Kuwait, Jordan, and Azerbaijan each have one.

There are roughly 1.6 billion Muslims in the world, but only two scientists from Muslim countries have won Nobel Prizes in science (one for physics in 1979, the other for chemistry in 1999). Forty-six Muslim countries combined contribute just 1 percent of the world's scientific literature; Spain and India each contribute more of the world's scientific literature than those countries taken together. In fact, although Spain is hardly an intellectual superpower, it translates more books in a single year than the entire Arab world has in the past thousand years. "Though there are talented scientists of Muslim origin working productively in the West," Nobel laureate physicist Steven Weinberg has observed, "for forty years I have not seen a single paper by a physicist or astronomer working in a Muslim country that was worth reading."

Comparative metrics on the Arab world tell the same story. Arabs comprise 5 percent of the world's population, but publish just 1.1 percent of its books, according to the U.N.'s 2003 Arab Human Development Report. Between 1980 and 2000, Korea granted 16,328 patents, while nine Arab countries, including Egypt, Saudi Arabia, and the U.A.E., granted a combined total of only 370, many of them registered by foreigners. A study in 1989 found that in one year, the United States published 10,481 scientific papers that were frequently cited, while the

entire Arab world published only four. This may sound like the punch line of a bad joke, but when *Nature* magazine published a sketch of science in the Arab world in 2002, its reporter identified just three scientific areas in which Islamic countries excel: desalination, falconry, and camel reproduction. The recent push to establish new research and science institutions in the Arab world — described in these pages by Waleed Al-Shobakky (see "Petrodollar Science," Fall 2008) — clearly still has a long way to go.

Given that Arabic science was the most advanced in the world up until about the thirteenth century, it is tempting to ask what went wrong — why it is that modern science did not arise from Baghdad or Cairo or Córdoba. We will turn to this question later, but it is important to keep in mind that the decline of scientific activity is the rule, not the exception, of civilizations. While it is commonplace to assume that the scientific revolution and the progress of technology were inevitable, in fact the West is the single sustained success story out of many civilizations with periods of scientific flourishing. Like the Muslims, the ancient Chinese and Indian civilizations, both of which were at one time far more advanced than the West, did not produce the scientific revolution.

Nevertheless, while the decline of Arabic civilization is not exceptional, the reasons for it offer insights into the history and nature of Islam and its relationship with modernity. Islam's decline as an intellectual and political force was gradual but pronounced: while the Golden Age was extraordinarily productive, with the contributions made by Arabic thinkers often original and groundbreaking, the past seven hundred years tell a very different story.

Original Contributions of Arabic Science

A preliminary caution must be noted about both parts of the term "Arabic science." This is, first, because the scientists discussed here were not all Arab Muslims. Indeed, most of the greatest thinkers of the era were not ethnically Arab. This is not surprising considering that, for several centuries throughout the Middle East, Muslims were a minority (a trend that only began to change at the end of the tenth century). The second caution about "Arabic science" is that it was not science as we are familiar with it today. Pre-modern science, while not blind to utility, sought knowledge primarily in order to understand philosophical questions concerned with meaning, being, the good, and so on. Modern science, by contrast, grew out of a revolution in thought that reoriented politics around individual comfort through the mastery of nature. Modern science dismisses ancient metaphysical questions as (to borrow Francis Bacon's words) the pursuit of pleasure and vanity. Whatever modern science owes to Arabic science, the intellectual activity of the medieval Islamic world was not of the same kind as the European scientific revolution, which came after a radical break from ancient natural philosophy. Indeed, even though we use the term "science" for convenience, it is important to remember that this word was not coined until the nineteenth century; the closest word in Arabic — *ilm* — means "knowledge," and not necessarily that of the natural world.

Still, there are two reasons why it makes sense to refer to scientific activity of the Golden Age as Arabic. The first is that most of the philosophical and scientific work at the time was eventually translated into Arabic, which became the language of most scholars in the region, regardless of ethnicity or religious background. And second, the alternatives — "Middle Eastern science" or "Islamic science" — are even less accurate. This is in part because very little is known about the personal backgrounds of these thinkers. But it is also because of another caution we must keep in mind about this subject, which ought to be footnoted to every broad assertion made about the Golden Age: surprisingly little is known for

certain even about the social and historical context of this era. Abdelhamid I. Sabra, a now-retired professor of the history of Arabic science who taught at Harvard, described his field to the *New York Times* in 2001 as one that "hasn't even begun yet."

That said, the field has advanced far enough to convincingly demonstrate that Arabic civilization contributed much more to the development of science than the passive transmission to the West of ancient thought and of inventions originating elsewhere (such as the numeral system from India and papermaking from China). For one thing, the scholarly revival in Abbasid Baghdad (751-1258) that resulted in the translation of almost all the scientific works of the classical Greeks into Arabic is nothing to scoff at. But beyond their translations of (and commentaries upon) the ancients, Arabic thinkers made original contributions, both through writing and methodical experimentation, in such fields as philosophy, astronomy, medicine, chemistry, geography, physics, optics, and mathematics.

Perhaps the most oft-repeated claim about the Golden Age is that Muslims invented algebra. This claim is largely true: initially inspired by Greek and Indian works, the Persian al-Khwarizmi (died 850) wrote a book from whose title we get the term algebra. The book starts out with a mathematical introduction, and proceeds to explain how to solve then-commonplace issues involving trade, inheritance, marriage, and slave emancipations. (Its methods involve no equations or algebraic symbols, instead using geometrical figures to solve problems that today would be solved using algebra.) Despite its grounding in practical affairs, this book is the primary source that contributed to the development of the algebraic system that we know today.

The Golden Age also saw advances in medicine. One of the most famous thinkers in the history of Arabic science, and considered among the greatest of all medieval physicians, was Rhazes (also known as al-Razi). Born in present-day Tehran, Rhazes (died 925) was trained in Baghdad and became the director of two hospitals. He identified smallpox and measles, writing a treatise on them that became influential beyond the Middle East and into nineteenth-century Europe.

Rhazes was the first to discover that fever is a defense mechanism. And he was the author of an encyclopedia of medicine that spanned twenty-three volumes. What is most striking about his career, as Ehsan Masood points out in ***Science and Islam***, is that Rhazes was the first to seriously challenge the seeming infallibility of the classical physician Galen. For example, he disputed Galen's theory of humors, and he conducted a controlled experiment to see if bloodletting, which was the most common medical procedure up until the nineteenth century, actually worked as a medical treatment. (He found that it did.) Rhazes provides a clear instance of a thinker explicitly questioning, and empirically testing, the widely-accepted theories of an ancient giant, while making original contributions to a field.

Breakthroughs in medicine continued with the physician and philosopher Avicenna (also known as Ibn-Sina; died 1037), whom some consider the most important physician since Hippocrates. He authored the ***Canon of Medicine***, a multi-volume medical survey that became the authoritative reference book for doctors in the region, and — once translated into Latin — a staple in the West for six centuries. The *Canon* is a compilation of medical knowledge and a manual for drug testing, but it also includes Avicenna's own discoveries, including the infectiousness of tuberculosis.

Like the later European Renaissance, the Arabic Golden Age also had many polymaths who excelled in and advanced numerous fields. One of the earliest such polymaths was al-Farabi (also known as Alpharabius, died ca. 950), a Baghdadi thinker who, in addition to his prolific writing on many aspects of Platonic and Aristotelian philosophy, also wrote on physics, psychology, alchemy, cosmology, music, and much else. So esteemed was he that he came to be known as the "Second Teacher" — second greatest, that is, after Aristotle. Another great polymath was al-Biruni (died 1048), who wrote 146 treatises totaling 13,000 pages in virtually every scientific field. His major work, ***The Description of India***, was an anthropological work on Hindus. One of al-Biruni's most notable accomplishments was the near-accurate measurement of the Earth's circumference using his own trigonometric method; he missed the correct

measurement of 24,900 miles by only 200 miles. (However, unlike Rhazes, Avicenna, and al-Farabi, al-Biruni's works were never translated into Latin and thus did not have much influence beyond the Arabic world.) Another of the most brilliant minds of the Golden Age was the physicist and geometrician Alhazen (also known as Ibn al-Haytham; died 1040). Although his greatest legacy is in optics — he showed the flaws in the theory of extramission, which held that our eyes emit energy that makes it possible for us to see — he also did work in astronomy, mathematics, and engineering. And perhaps the most renowned scholar of the late Golden Age was Averroës (also known as Ibn Rushd; died 1198), a philosopher, theologian, physician, and jurist best known for his commentaries on Aristotle. The 20,000 pages he wrote over his lifetime included works in philosophy, medicine, biology, physics, and astronomy.

Why Arabic Science Thrived

What prompted scientific scholarship to flourish where and when it did? What were the conditions that incubated these important Arabic-speaking scientific thinkers? There is, of course, no single explanation for the development of Arabic science, no single ruler who inaugurated it, no single culture that fueled it. As historian David C. Lindberg puts it in ***The Beginnings of Western Science*** (1992), Arabic science thrived for as long as it did thanks to "an incredibly complex concatenation of contingent circumstances."

Scientific activity was reaching a peak when Islam was the dominant civilization in the world. So one important factor in the rise of the scholarly culture of the Golden Age was its material backdrop, provided by the rise of a powerful and prosperous empire. By the year 750, the Arabs had conquered Arabia, Iraq, Syria, Lebanon, Palestine, Egypt, and much of North Africa, Central Asia, Spain, and the fringes of China and India. Newly opened routes connecting India and the Eastern Mediterranean spurred an explosion of wealth through trade, as well as an agricultural revolution.

For the first time since the reign of Alexander the Great, the vast region was united politically and economically. The result was, first, an Arab kingdom under the Umayyad caliphs (ruling in Damascus from 661 to 750) and then an Islamic empire under the Abbasid caliphs (ruling in Baghdad from 751 to 1258), which saw the most intellectually productive age in Arab history. The rise of the first centralized Islamic state under the Abbasids profoundly shaped life in the Islamic world, transforming it from a tribal culture with little literacy to a dynamic empire. To be sure, the vast empire was theologically and ethnically diverse; but the removal of political barriers that previously divided the region meant that scholars from different religious and ethnic backgrounds could travel and interact with each other. Linguistic barriers, too, were decreasingly an issue as Arabic became the common idiom of all scholars across the vast realm.

The spread of empire brought urbanization, commerce, and wealth that helped spur intellectual collaboration. Maarten Bosker of Utrecht University and his colleagues explain that in the year 800, while the Latin West (with the exception of Italy) was "relatively backward," the Arab world was highly urbanized, with twice the urban population of the West. Several large metropolises — including Baghdad, Basra, Wasit, and Kufa — were unified under the Abbasids; they shared a single spoken language and brisk trade via a network of caravan roads. Baghdad in particular, the Abbasid capital, was home to palaces, mosques, joint-stock companies, banks, schools, and hospitals; by the tenth century, it was the largest city in the world.

As the Abbasid empire grew, it also expanded eastward, bringing it into contact with the ancient Egyptian, Greek, Indian, Chinese, and Persian civilizations, the fruits of which it readily enjoyed. (In this era, Muslims found little of interest in the West, and for good reason.) One of the most important discoveries by Muslims was paper, which was probably invented in China around A.D. 105 and brought into the Islamic world starting in the mid-eighth century. The effect of paper on the scholarly culture of Arabic society was enormous: it made the reproduction of books cheap and efficient, and it encouraged scholarship, correspondence, poetry, recordkeeping, and banking.

The arrival of paper also helped improve literacy, which had been encouraged since the dawn of Islam due to the religion's literary foundation, the Koran. Medieval Muslims took religious scholarship very seriously, and some scientists in the region grew up studying it. Avicenna, for example, is said to have known the entire Koran by heart before he arrived at Baghdad. Might it be fair, then, to say that Islam itself encouraged scientific enterprise? This question provokes wildly divergent answers. Some scholars argue that there are many parts of the Koran and the *hadith* (the sayings of Muhammad) that exhort believers to think about and try to understand Allah's creations in a scientific spirit. As one *hadith* urges, "Seek knowledge, even in China." But there are other scholars who argue that "knowledge" in the Koranic sense is not scientific knowledge but religious

knowledge, and that to conflate such knowledge with modern science is inaccurate and even naïve.

The Gift of Baghdad

But the single most significant reason that Arabic science thrived was the absorption and assimilation of the Greek heritage — a development fueled by the translation movement in Abbasid Baghdad. The translation movement, according to Yale historian and classicist Dimitri Gutas, is "equal in significance to, and belongs to the same narrative as … that of Pericles' Athens, the Italian Renaissance, or the scientific revolution of the sixteenth and seventeenth centuries." Whether or not one is willing to grant Gutas the comparison, there is no question that the translation movement in Baghdad — which by the year 1000 saw nearly the entire Greek corpus in medicine, mathematics, and natural philosophy translated into Arabic — provided the foundation for inquiry in the sciences. While most of the great thinkers in the Golden Age were not themselves in Baghdad, the Arabic world's other cultural centers likely would not have thrived without Baghdad's translation movement. For this reason, even if it is said that the Golden Age of Arabic science encompasses a large region, as a historical event it especially demands an explanation of the success of Abbasid Baghdad.

The rise to power of the Abbasid caliphate in the year 750 was, as Bernard Lewis put it in ***The Arabs in History*** (1950), "a revolution in the history of Islam, as important a turning point as the French and Russian revolutions in the history of the West." Instead of tribe and ethnicity, the Abbasids made religion and language the defining characteristics of state identity. This allowed for a relatively cosmopolitan society in which all Muslims could participate in cultural and political life. Their empire lasted until 1258, when the Mongols sacked Baghdad and executed the last Abbasid caliph (along with a large part of the Abbasid population). During the years that the Abbasid empire thrived, it deeply influenced politics and society from Tunisia to India.

The Greek-Arabic translation movement in Abbasid Baghdad, like other scholarly efforts elsewhere in the Islamic world, was centered less in educational

institutions than in the households of great patrons seeking social prestige. But Baghdad was distinctive: its philosophical and scientific activity enjoyed a high level of cultural support. As Gutas explains in ***Greek Thought, Arabic Culture*** (1998), the translation movement, which mostly flourished from the middle of the eighth century to the end of the tenth, was a self-perpetuating enterprise supported by "the entire elite of Abbasid society: caliphs and princes, civil servants and military leaders, merchants and bankers, and scholars and scientists; it was not the pet project of any particular group in the furtherance of their restricted agenda." This was an anomaly in the Islamic world, where for the most part, as Ehsan Masood argues, science was "supported by individual patrons, and when these patrons changed their priorities, or when they died, any institutions that they might have built often died with them."

There seem to have been three salient factors inspiring the translation movement. First, the Abbasids found scientific Greek texts immensely useful for a sort of technological progress — solving common problems to make daily life easier. The Abbasids did not bother translating works in subjects such as poetry, history, or drama, which they regarded as useless or inferior. Indeed, science under Islam, although in part an extension of Greek science, was much less theoretical than that of the ancients. Translated works in mathematics, for example, were eventually used for engineering and irrigation, as well as in calculation for intricate inheritance laws. And translating Greek works on medicine had obvious practical use.

Astrology was another Greek subject adapted for use in Baghdad: the Abbasids turned to it for proof that the caliphate was the divinely ordained successor to the ancient Mesopotamian empires — although such claims were sometimes eyed warily, because the idea that celestial information can predict the future clashed with Islamic teaching that only God has such knowledge.

There were also practical religious reasons to study Greek science. Mosque timekeepers found it useful to study astronomy and trigonometry to determine the direction to Mecca (*qibla*), the times for prayer, and the beginning of

Ramadan. For example, the Arabic astronomer Ibn al-Shatir (died 1375) also served as a religious official, a timekeeper (*muwaqqit*), for the Great Mosque of Damascus. Another religious motivation for translating Greek works was their value for the purposes of rhetoric and what we would today call ideological warfare: Aristotle's *Topics*, a treatise on logic, was used to aid in religious disputation with non-Muslims and in the conversion of nonbelievers to Islam (which was state policy under the Abbasids).

The second factor central to the rise of the translation movement was that Greek thought had already been diffused in the region, slowly and over a long period, before the Abbasids and indeed before the advent of Islam. Partly for this reason, the Abbasid Baghdad translation movement was not like the West's subsequent rediscovery of ancient Athens, in that it was in some respects a continuation of Middle Eastern Hellenism. Greek thought spread as early as Alexander the Great's conquests of Asia and North Africa in the 300s B.C., and Greek centers, such as in Alexandria and the Greco-Bactrian Kingdom (238-140 B.C., in what is now Afghanistan), were productive centers of learning even amid Roman conquest. By the time of the Arab conquests, the Greek tongue was known throughout the vast region, and it was the administrative language of Syria and Egypt. After the arrival of Christianity, Greek thought was spread further by missionary activity, especially by Nestorian Christians. Centuries later, well into the rule of the Abbasids in Baghdad, many of these Nestorians — some of them Arabs and Arabized Persians who eventually converted to Islam — contributed technical skill for the Greek-Arabic translation movement, and even filled many translation-oriented administrative posts in the Abbasid government.

While practical utility and the influence of Hellenism help explain why science *could* develop, both were true of most of the Arabic world during the Golden Age and so cannot account for the Abbasid translation movement in particular. As Gutas argues, the distinguishing factor that led to that movement was the attempt by the Abbasid rulers to legitimize their rule by co-opting Persian culture, which at the time deeply revered Greek thought. The Baghdad region in which the Abbasids established themselves included a major Persian population, which

played an instrumental role in the revolution that ended the previous dynasty; thus, the Abbasids made many symbolic and political gestures to ingratiate themselves with the Persians. In an effort to enfold this constituency into a reliable ruling base, the Abbasids incorporated Zoroastrianism and the imperial ideology of the defunct Persian Sasanian Empire, more than a century gone, into their political platform. The Abbasid rulers sought to establish the idea that they were the successors not to the defeated Arab Umayyads who had been overthrown in 750 but to the region's previous imperial dynasty, the Sasanians.

This incorporation of Sasanian ideology led to the translation of Greek texts into Arabic because doing so was seen as recovering not just Greek, but Persian knowledge. The Persians believed that sacred ancient Zoroastrian texts were scattered by Alexander the Great's destruction of Persepolis in 330 B.C., and were subsequently appropriated by the Greeks. By translating ancient Greek texts into Arabic, Persian wisdom could be recovered.

Initially, Arab Muslims themselves did not seem to care much about the translation movement and the study of science, feeling that they had "no ethnic or historical stake in it," as Gutas explains. This began to change during the reign of al-Mamun (died 833), the seventh Abbasid caliph. For the purposes of opposing the Byzantine Empire, al-Mamun reoriented the translation movement as a means to recovering Greek, rather than Persian, learning. In the eyes of Abbasid Muslims of this era, the ancient Greeks did not have a pristine reputation — they were not Muslims, after all — but at least they were not tainted with Christianity. The fact that the hated Christian Byzantines did not embrace the ancient Greeks, though, led the Abbasids to warm to them. This philhellenism in the centuries after al-Mamun marked a prideful distinction between the Arabs — who considered themselves "champions of the truth," as Gutas puts it — and their benighted Christian contemporaries. One Arab philosopher, al-Kindi (died 870), even devised a genealogy that presented Yunan, the ancestor of the ancient Greeks, as the brother of Qahtan, the ancestor of the Arabs.

Until its collapse in the Mongol invasion of 1258, the Abbasid caliphate was the greatest power in the Islamic world and oversaw the most intellectually productive movement in Arab history. The Abbasids read, commented on, translated, and preserved Greek and Persian works that may have been otherwise lost. By making Greek thought accessible, they also formed the foundation of the Arabic Golden Age. Major works of philosophy and science far from Baghdad — in Spain, Egypt, and Central Asia — were influenced by Greek-Arabic translations, both during and after the Abbasids. Indeed, even if it is a matter of conjecture to what extent the rise of science in the West depended on Arabic science, there is no question that the West benefited from both the preservation of Greek works and from original Arabic scholarship that commented on them.

Why the Golden Age Faded

As the Middle Ages progressed, Arabic civilization began to run out of steam. After the twelfth century, Europe had more significant scientific scholars than the Arabic world, as Harvard historian George Sarton noted in his ***Introduction to the History of Science*** (1927-48). After the fourteenth century, the Arab world saw very few innovations in fields that it had previously dominated, such as optics and medicine; henceforth, its innovations were for the most part not in the realm of metaphysics or science, but were more narrowly practical inventions like vaccines. "The Renaissance, the Reformation, even the scientific revolution and the Enlightenment, passed unnoticed in the Muslim world," Bernard Lewis remarks in ***Islam and the West*** (1993).

There was a modest rebirth of science in the Arabic world in the nineteenth century due largely to Napoleon's 1798 expedition to Egypt, but it was soon followed by decline. Lewis notes in *What Went Wrong?* that "The relationship between Christendom and Islam in the sciences was now reversed. Those who had been disciples now became teachers; those who had been masters became pupils, often reluctant and resentful pupils." The civilization that had produced cities, libraries, and observatories and opened itself to the world had now regressed and become closed, resentful, violent, and hostile to discourse and innovation.

What happened? To repeat an important point, scientific decline is hardly peculiar to Arabic-Islamic civilization. Such decline is the norm of history; only in the West did something very different happen. Still, it may be possible to discern some specific causes of decline — and attempting to do so can deepen our understanding of Arabic-Islamic civilization and its tensions with modernity. As Sayyid Jamal al-Din al-Afghani, an influential figure in contemporary pan-Islamism, said in the late nineteenth century, "It is permissible … to ask oneself why Arab civilization, after having thrown such a live light on the world, suddenly

became extinguished; why this torch has not been relit since; and why the Arab world still remains buried in profound darkness."

Just as there is no simple explanation for the success of Arabic science, there is no simple explanation for its gradual — not sudden, as al-Afghani claims — demise. The most significant factor was physical and geopolitical. As early as the tenth or eleventh century, the Abbasid empire began to factionalize and fragment due to increased provincial autonomy and frequent uprisings. By 1258, the little that was left of the Abbasid state was swept away by the Mongol invasion. And in Spain, Christians reconquered Córdoba in 1236 and Seville in 1248. But the Islamic turn away from scholarship actually preceded the civilization's geopolitical decline — it can be traced back to the rise of the anti-philosophical Ash'arism school among Sunni Muslims, who comprise the vast majority of the Muslim world.

To understand this anti-rationalist movement, we once again turn our gaze back to the time of the Abbasid caliph al-Mamun. Al-Mamun picked up the pro-science torch lit by the second caliph, al-Mansur, and ran with it. He responded to a crisis of legitimacy by attempting to undermine traditionalist religious scholars while actively sponsoring a doctrine called Mu'tazilism that was deeply influenced by Greek rationalism, particularly Aristotelianism. To this end, he imposed an inquisition, under which those who refused to profess their allegiance to Mu'tazilism were punished by flogging, imprisonment, or beheading. But the caliphs who followed al-Mamun upheld the doctrine with less fervor, and within a few decades, adherence to it became a punishable offense. The backlash against Mu'tazilism was tremendously successful: by 885, a half century after al-Mamun's death, it even became a crime to copy books of philosophy. The beginning of the de-Hellenization of Arabic high culture was underway. By the twelfth or thirteenth century, the influence of Mu'tazilism was nearly completely marginalized.

In its place arose the anti-rationalist Ash'ari school whose increasing dominance is linked to the decline of Arabic science. With the rise of the Ash'arites, the ethos in the Islamic world was increasingly opposed to original scholarship and any

scientific inquiry that did not directly aid in religious regulation of private and public life. While the Mu'tazilites had contended that the Koran was *created* and so God's purpose for man must be interpreted through reason, the Ash'arites believed the Koran to be coeval with God — and therefore unchallengeable. At the heart of Ash'ari metaphysics is the idea of occasionalism, a doctrine that denies natural causality. Put simply, it suggests natural necessity cannot exist because God's will is completely free. Ash'arites believed that God is the only cause, so that the world is a series of discrete physical events each willed by God.

As Maimonides described it in ***The Guide for the Perplexed***, this view sees natural things that appear to be permanent as merely following habit. Heat follows fire and hunger follows lack of food as a matter of habit, not necessity, "just as the king generally rides on horseback through the streets of the city, and is never found departing from this habit; but reason does not find it impossible that he should walk on foot through the place." According to the occasionalist view, tomorrow coldness might follow fire, and satiety might follow lack of food. God wills every single atomic event and God's will is not bound up with reason. This amounts to a denial of the coherence and comprehensibility of the natural world. In his controversial 2006 University of Regensburg address, Pope Benedict XVI described this idea by quoting the philosopher Ibn Hazm (died 1064) as saying, "Were it God's will, we would even have to practice idolatry." It is not difficult to see how this doctrine could lead to dogma and eventually to the end of free inquiry in science and philosophy.

The greatest and most influential voice of the Ash'arites was the medieval theologian Abu Hamid al-Ghazali (also known as Algazel; died 1111). In his book ***The Incoherence of the Philosophers***, al-Ghazali vigorously attacked philosophy and philosophers — both the Greek philosophers themselves and their followers in the Muslim world (such as al-Farabi and Avicenna). Al-Ghazali was worried that when people become favorably influenced by philosophical arguments, they will also come to trust the philosophers on matters of religion, thus making Muslims less pious. Reason, because it teaches us to discover, question, and innovate, was the enemy; al-Ghazali argued that in assuming necessity in nature, philosophy

was incompatible with Islamic teaching, which recognizes that nature is entirely subject to God's will: "Nothing in nature," he wrote, "can act spontaneously and apart from God." While al-Ghazali did defend logic, he did so only to the extent that it could be used to ask theological questions and wielded as a tool to undermine philosophy. Sunnis embraced al-Ghazali as the winner of the debate with the Hellenistic rationalists, and opposition to philosophy gradually ossified, even to the extent that independent inquiry became a tainted enterprise, sometimes to the point of criminality. It is an exaggeration to say, as Steven Weinberg claimed in the *Times* of London, that after al-Ghazali "there was no more science worth mentioning in Islamic countries"; in some places, especially Central Asia, Arabic work in science continued for some time, and philosophy was still studied somewhat under Shi'ite rule. (In the Sunni world, philosophy turned into mysticism.) But the fact is, Arab contributions to science became increasingly sporadic as the anti-rationalism sank in.

The Ash'ari view has endured to this day. Its most extreme form can be seen in some sects of Islamists. For example, Mohammed Yusuf, the late leader of a group called the Nigerian Taliban, explained why "Western education is a sin" by explaining its view on rain: "We believe it is a creation of God rather than an evaporation caused by the sun that condenses and becomes rain." The Ash'ari view is also evident when Islamic leaders attribute natural disasters to God's vengeance, as they did when they said that the 2010 eruption of Iceland's Eyjafjallajökull volcano was the result of God's anger at immodestly dressed women in Europe. Such inferences sound crazy to Western ears, but given their frequency in the Muslim world, they must sound at least a little less crazy to Muslims. As Robert R. Reilly argues in ***The Closing of the Muslim Mind*** (2010), "the fatal disconnect between the creator and the mind of his creature is the source of Sunni Islam's most profound woes."

A similar ossification occurred in the realm of law. The first four centuries of Islam saw vigorous discussion and flexibility regarding legal issues; this was the tradition of *ijtihad*, or independent judgment and critical thinking. But by the end of the eleventh century, discordant ideas were increasingly seen as a problem, and

autocratic rulers worried about dissent — so the "gates of *ijtihad*" were closed for Sunni Muslims: *ijtihad* was seen as no longer necessary, since all important legal questions were regarded as already answered. New readings of Islamic revelation became a crime. All that was left to do was to submit to the instructions of religious authorities; to understand morality, one needed only to read legal decrees. Thinkers who resisted the closing came to be seen as nefarious dissidents. (Averroës, for example, was banished for heresy and his books were burned.)

Why Inquiry Failed in the Islamic World

But is Ash'arism the deepest root of Arabic science's demise? That the Ash'arites won and the Mu'tazilites lost suggests that for whatever reason, Muslims already found Ash'ari thought more convincing or more palatable; it suited prevailing sentiments and political ideas. Indeed, Muslim theologians appeared receptive to the occasionalist view as early as the ninth century, before the founder of Ash'arism was even born. Thus the Ash'ari victory raises thorny questions about the theological-political predispositions of Islam.

As a way of articulating questions that lie deeper than the Ash'arism-Mu'tazilism debate, it is helpful to briefly compare Islam with Christianity. Christianity acknowledges a private-public distinction and (theoretically, at least) allows adherents the liberty to decide much about their social and political lives. Islam, on the other hand, denies any private-public distinction and includes laws regulating the most minute details of private life. Put another way, Islam does not acknowledge any difference between religious and political ends: it is a religion that specifies political rules for the community.

Such differences between the two faiths can be traced to the differences between their prophets. While Christ was an outsider of the state who ruled no one, and while Christianity did not become a state religion until centuries after Christ's birth, Mohammed was not only a prophet but also a chief magistrate, a political leader who conquered and governed a religious community he founded. Because Islam was born outside of the Roman Empire, it was never subordinate to politics. As Bernard Lewis puts it, Mohammed was his own Constantine. This means that, for Islam, religion and politics were interdependent from the beginning; Islam needs a state to enforce its laws, and the state needs a basis in Islam to be legitimate. To what extent, then, do Islam's political proclivities make free inquiry — which is inherently subversive to established rules and customs — possible at a deep and enduring institutional level?

Some clues can be found by comparing institutions in the medieval period. Far from accepting anything close to the occasionalism and legal positivism of the Sunnis, European scholars argued explicitly that when the Bible contradicts the natural world, the holy book should not be taken literally. Influential philosophers like Augustine held that knowledge and reason precede Christianity; he approached the subject of scientific inquiry with cautious encouragement, exhorting Christians to use the classical sciences as a handmaiden of Christian thought. Galileo's house arrest notwithstanding, his famous remark that "the intention of the Holy Ghost is to teach us how one goes to heaven, not how heaven goes" underscores the durability of the scientific spirit among pious Western societies. Indeed, as David C. Lindberg argues in an essay collected in ***Galileo Goes to Jail and Other Myths about Science and Religion*** (2009), "No institution or cultural force of the patristic period offered more encouragement for the investigation of nature than did the Christian church." And, as Baylor University sociologist Rodney Stark notes in his book ***For the Glory of God*** (2003), many of the greatest scientists of the scientific revolution were also Christian priests or ministers.

The Church's acceptance and even encouragement of philosophy and science was evident from the High Middle Ages to modern times. As the late Ernest L. Fortin of Boston College noted in an essay collected in ***Classical Christianity and the Political Order*** (1996), unlike al-Farabi and his successors, "Aquinas was rarely forced to contend with an anti-philosophic bias on the part of the ecclesiastical authorities. As a Christian, he could simply assume philosophy without becoming publicly involved in any argument for or against it." And when someone like Galileo got in trouble, his work moved forward and his inquiry was carried on by others; in other words, institutional dedication to scientific inquiry was too entrenched in Europe for any authority to control. After about the middle of the thirteenth century in the Latin West, we know of no instance of persecution of anyone who advocated philosophy as an aid in interpreting revelation. In this period, "attacks on reason would have been regarded as bizarre and unacceptable," explains historian Edward Grant in ***Science and Religion, 400 B.C. to A.D. 1550***.

The success of the West is a topic that could fill — indeed, has filled — many large books. But some general comparisons are helpful in understanding why Islam was so institutionally different from the West. The most striking difference is articulated by Bassam Tibi in ***The Challenge of Fundamentalism*** (1998): "because rational disciplines had not been institutionalized in classical Islam, the adoption of the Greek legacy had no lasting effect on Islamic civilization." In ***The Rise of Early Modern Science***, Toby E. Huff makes a persuasive argument for why modern science emerged in the West and not in Islamic (or Chinese) civilization:

> The rise of modern science is the result of the development of a civilizationally based culture that was uniquely humanistic in the sense that it tolerated, indeed, protected and promoted those heretical and innovative ideas that ran counter to accepted religious and theological teaching. Conversely, one might say that critical elements of the scientific worldview were surreptitiously encoded in the religious and legal presuppositions of the European West.

In other words, Islamic civilization did not have a culture hospitable to the advancement of science, while medieval Europe did.

The contrast is most obvious in the realm of formal education. As Huff argues, the lack of a scientific curriculum in medieval madrassas reflects a deeper absence of a capacity or willingness to build legally autonomous institutions. Madrassas were established under the law of *waqf*, or pious endowments, which meant they were legally obligated to follow the religious commitments of their founders. Islamic law did not recognize any corporate groups or entities, and so prevented any hope of recognizing institutions such as universities within which scholarly norms could develop. (Medieval China, too, had no independent institutions dedicated to learning; all were dependent on the official bureaucracy and the state.) Legally autonomous institutions were utterly absent in the Islamic world until the late nineteenth century. And madrassas nearly always excluded study of anything besides the subjects that aid in understanding Islam: Arabic grammar, the Koran, the hadith, and the principles of sharia. These were often referred to as

the “Islamic sciences,” in contrast to Greek sciences, which were widely referred to as the “foreign” or “alien” sciences (indeed, the term “philosopher” in Arabic — *faylasuf* — was often used pejoratively). Furthermore, the rigidity of the religious curriculum in madrassas contributed to the educational method of learning by rote; even today, repetition, drill, and imitation — with chastisement for questioning or innovating — are habituated at an early age in many parts of the Arab world.

The exclusion of science and mathematics from the madrassas suggests that these subjects “were institutionally marginal in medieval Islamic life,” writes Huff. Such inquiry was tolerated, and sometimes promoted by individuals, but it was never “officially institutionalized and sanctioned by the intellectual elite of Islam.” This meant that when intellectual discoveries were made, they were not picked up and carried by students, and did not influence later thinkers in Muslim communities. No one paid much attention to the work of Averroës after he was driven out of Spain to Morocco, for instance — that is, until Europeans rediscovered his work. Perhaps the lack of institutional support for science allowed Arabic thinkers (such as al-Farabi) to be bolder than their European counterparts. But it also meant that many Arabic thinkers relied on the patronage of friendly rulers and ephemeral conditions.

By way of contrast, the legal system that developed in twelfth- and thirteenth-century Europe — which saw the absorption of Greek philosophy, Roman law, and Christian theology — was instrumental in forming a philosophically and theologically open culture that respected scientific development. As Huff argues, because European universities were legally autonomous, they could develop their own rules, scholarly norms, and curricula. The norms they incorporated were those of curiosity and skepticism, and the curricula they chose were steeped in ancient Greek philosophy. In the medieval Western world, a spirit of skepticism and inquisitiveness moved theologians and philosophers. It was a spirit of “probing and poking around,” as Edward Grant writes in ***God and Reason in the Middle Ages*** (2001).

It was this attitude of inquiry that helped lay the foundation for modern science. Beginning in the early Middle Ages, this attitude was evident in technological innovations among even unlearned artisans and merchants. These obscure people contributed to the development of practical technologies, such as the mechanical clock (circa 1272) and spectacles (circa 1284). Even as early as the sixth century, Europeans strove to invent labor-saving technology, such as the heavy-wheeled plow and, later, the padded horse collar. According to research by the late Charles Issawi of Princeton University, eleventh-century England had more mills per capita than even the Ottoman lands at the height of the empire's power. And although it was in use since 1460 in the West, the printing press was not introduced in the Islamic world until 1727. The Arabic world appears to have been even slower in finding uses for academic technological devices. For instance, the telescope appeared in the Middle East soon after its invention in 1608, but it failed to attract excitement or interest until centuries later.

As science in the Arabic world declined and retrogressed, Europe hungrily absorbed and translated classical and scientific works, mainly through cultural centers in Spain. By 1200, Oxford and Paris had curricula that included works of Arabic science. Works by Aristotle, Euclid, Ptolemy, and Galen, along with commentaries by Avicenna and Averroës, were all translated into Latin. Not only were these works taught openly, but they were formally incorporated into the program of study of universities. Meanwhile, in the Islamic world, the dissolution of the Golden Age was well underway.

A Gold Standard?

In trying to explain the Islamic world's intellectual laggardness, it is tempting to point to the obvious factors: authoritarianism, bad education, and underfunding (Muslim states spend significantly less than developed states on research and development as a percentage of GDP). But these reasons are all broad and somewhat crude, and raise more questions than answers. At a deeper level, Islam lags because it failed to offer a way to institutionalize free inquiry. That, in turn, is attributable to its failure to reconcile faith and reason. In this respect, Islamic societies have fared worse not just than the West but also than many societies of Asia. With a couple of exceptions, every country in the Middle Eastern parts of the Muslim world has been ruled by an autocrat, a radical Islamic sect, or a tribal chieftain. Islam has no tradition of separating politics and religion.

The decline of Islam and the rise of Christianity was a development that was and remains deeply humiliating for Muslims. Since Islam tended to ascribe its political power to its theological superiority over other faiths, its fading as a worldly power raised profound questions about where a wrong turn was made. Over at least the past century, Muslim reformers have been debating how best to reacquire the lost honor. In the same period, the Muslim world tried, and failed, to reverse its decline by borrowing Western technology and sociopolitical ideas, including secularization and nationalism. But these tastes of "modernization" turned many Muslims away from modernity. This raises a question: Can and should Islam's past achievements serve as a standard for Islam's future? After all, it is quite common to imply, as President Obama did, that knowledge of the Golden Age of Arabic science will somehow exhort the Islamic world to improve itself and to hate the West less.

The story of Arabic science offers a window into the relationship between Islam and modernity; perhaps, too, it holds out the prospect of Islam coming to benefit from principles it badly needs in order to prosper, such as sexual equality, the rule

of law, and free civil life. But the predominant posture among many Muslims today is that the good life is best approximated by returning to a pristine and pious past — and this posture has proven poisonous to coping with modernity. Islamism, the cause of violence that the world is now agonizingly familiar with, arises from doctrines characterized by a deep nostalgia for the Islamic classical period. Even today, suggesting that the Koran isn't coeternal with God can make one an infidel.

And yet intellectual progress and cultural openness were once encouraged among many Arabic societies. So to the extent that appeals to the salutary classical attitude can be found in the Islamic tradition, the fanatical false nostalgia might be tamed. Some reformers already point out that many medieval Muslims embraced reason and other ideas that presaged modernity, and that doing so is not impious and does not mean simply giving up eternal rewards for materialistic ones. On an intellectual level, this effort could be deepened by challenging the Ash'ari orthodoxy that has dominated Sunni Islam for a thousand years — that is, by asking whether al-Ghazali and his Ash'arite followers really understood nature, theology, and philosophy better than the Mu'tazilites.

But there are reasons why exhortation to emulate Muslim ancestors may also be misguided. One is that medieval Islam does not offer a decent political standard. When compared to modern Western standards, the Golden Age of Arabic science was decidedly not a Golden Age of equality. While Islam was comparatively tolerant at the time of members of other religions, the kind of tolerance we think of today was never a virtue for early Muslims (or early Christians, for that matter). As Bernard Lewis puts it in ***The Jews of Islam*** (1984), giving equal treatment to followers and rejecters of the true faith would have been seen not only as an absurdity but also an outright "dereliction of duty." Jews and Christians were subjected to official second-class sociopolitical status beginning in Mohammed's time, and Abbasid-era oppressions also included religious persecution and the eradication of churches and synagogues. The Golden Age was also an era of widespread slavery of persons deemed to be of even lower class. For all the

estimable achievements of the medieval Arabic world, it is quite clear that its political and social history should not be made into a celebrated standard.

There is a more fundamental reason, however, why it may not make much sense to urge the Muslim world to restore those parts of its past that valued rational and open inquiry: namely, a return to the Mu'tazilites may not be enough. Even the most rationalist schools in Islam did not categorically argue for the primacy of reason. As Ali A. Allawi argues in ***The Crisis of Islamic Civilization*** (2009), "None of the free-thinking schools in classical Islam — such as the Mu'tazila — could ever entertain the idea of breaking the God-Man relationship and the validity of revelation, in spite of their espousal of a rationalist philosophy." Indeed, in 1889 the Hungarian scholar Ignaz Goldziher noted in his essay "The Attitude of Orthodox Islam Toward the 'Ancient Sciences'" that it was not only Ash'arite but Mu'tazilite circles that "produced numerous polemical treatises against Aristotelian philosophy in general and against logic in particular." Even before al-Ghazali's attack on the Mu'tazilites, engaging in Greek philosophy was not exactly a safe task outside of auspicious but rather ephemeral conditions.

But more importantly, merely popularizing previous rationalist schools would not go very far in persuading Muslims to reflect on the theological-political problem of Islam. For all the great help that the rediscovery of the influential Arabic philosophers (especially al-Farabi, Averroës, and Maimonides) would provide, no science-friendly Islamic tradition goes nearly far enough, to the point that it offers a theological renovation in the vein of Luther and Calvin — a reinterpretation of Islam that challenges the faith's comprehensive ruling principles in a way that simultaneously convinces Muslims that they are in fact returning to the fundamentals of their faith.

There is a final reason why it makes little sense to exhort Muslims to their own past: while there are many things that the Islamic world lacks, pride in heritage is not one of them. What is needed in Islam is less self-pride and more self-criticism. Today, self-criticism in Islam is valued only insofar as it is made as an appeal to be more pious and less spiritually corrupt. And yet most criticism in the Muslim

world is directed outward, at the West. This prejudice — what Fouad Ajami has called (referring to the Arab world) "a political tradition of belligerent self-pity" — is undoubtedly one of Islam's biggest obstacles. It makes information that contradicts orthodox belief irrelevant, and it closes off debate about the nature and history of Islam.

In this respect, inquiry into the history of Arabic science, and the recovery and research of manuscripts of the era, may have a beneficial effect — so long as it is pursued in an analytical spirit. That would mean that Muslims would use it as a resource within their own tradition to *critically* engage with their philosophical, political, and founding flaws. If that occurs, it will not arise from any Western outreach efforts, but will be a consequence of Muslims' own determination, creativity, and wisdom — in short, those very traits that Westerners rightly ascribe to the Muslims of the Golden Age.

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