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Ottoman Science in the Maghrib: Islamic Medicine and the Translation into Local Maghribi Contexts of Dawud al-Antaki's *Tadhkira*

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This is the story of two physicians, one Ottoman and one Moroccan, separated by four hundred years and the Mediterranean yet connected by a medical text. Dawud ibn 'Umar al-Antaki (d. 1599) was a blind physician from Ottoman Antioch who became chief physician in Ottoman Cairo during the "transitional period" of Ottoman medicine, the 16th-17th centuries. Antaki authored the great medical compendium *Tadhkira awla al-albab wa al-jamia' li'ajbi al-'ajab,* best known for its alphabetical chapters of pharmacological remedies. The *Tadhkira* became enormously popular in North Africa and the Mediterranean—parts of it were even translated into English in 1659[1]—and physicians in Tunisia, Algeria and Morocco edited versions of Antaki's text in local dialects.[2] Among them was the Moroccan physician 'Abd as-Salam ibn Muhammad ibn Ahmad al-'Alami (d. 1895) of Fez, who wrote a popularization of Antaki's text, *Diya an-nibras fi hal mufradat al-antaki bi-lugha Fas,* or *Light of the Lamp in the Vocabulary of Antaki in the Language of Fez* (*hajariyya* ed. Fez, 1318/1900). Al-Antaki and Al-'Alami each lived at turning points in the historical narrative of scientific modernization in Islamic lands. Their connection puts to question our assumptions about Islam, modernity, and medical theory and practice.

Antaki lived at a time when classical Arabic medicine was "Ottomanized" as Miri Shefer writes, and a new, state-sponsored scientific milieu emerged.[3]

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1 "The nature of the drink kauhi, or coffee, and the berry of which it is made, described by an Arabian physician,"([Early English Books Online] Oxford: Henry Hall, 1659).

2 For example, Muhammad Mahfuz, *Tafsir mufradat al-Antaki bi al-Lahjah al-Tunisiyyah,* (Beirut: Dar al-Gharb al-Islami,1996), and Algerian Abd ar-Razzaq al-Jaza'iri, *Kashaf ar-Ramuz,* which was edited in French, Lucien Leclerc, *Kachef er-Roumouz (Révélation des énigmes) d'Abd er-Rezzaq ed-Djezairy ou Traité de Matière médical arabe d'Abd er-Razzaq l'Algérien, traduit et annoté par Dr. Lucien Leclerc,* (Paris: Bailliére, 1874).

3 Miri Shefer, "The 'Ottomanisation' of Arab-Muslim Medicine: Reproduction of local medical

Ekmeleddin İhsanoğlu and Tuncay Zorlu have described the medical *medrese* founded by Sultan Süleyman I in 1555-6, the *Daru't-Tibb*, and the cosmopolitan nature of its science.[4] Antaki's *Tadhkira* is its exemplar--based on the humoral physiology of Galenic medicine, Antaki engages Arabic, Persian, and "Christian" medical authors, a rich, trans-national pharmacy, and a deep knowledge of Islamic concepts. Antaki began his text in 1568; the edition we consider was published in Beirut (n.d.) with a second text, Antaki's *Al-Nuzha al-Mubhija,* printed in its margins. The contents of the *Tadhkira* are: Part 1 (medicine and physiology), Part 2 (simples and composed medicines), Part 3 (alphabetic list of 1712 remedies), Part 4 ("a detailed description of various diseases, an exhaustive statement of their causes and symptoms, as well as the special methods of their treatment," including *lemmata* on geography, mathematics, astronomy, fevers, pregnancy, and talismans *'alm al-jadwal),* and Part 5, (A marginalia to section 1 on the order of the sciences).[5] In his marginalia *al-Nuzha*, Antaki offers an Islamic theory of the sciences, a schema that provides a rationale for amulets in medicine and for the "open system" of knowledge operative in Ottoman hospitals.

The widespread dissemination of Antaki's text in Morocco suggests the importance of Ottoman science to North Africa even outside Ottoman lands, and the persistence of Greco-Islamic science in Morocco in the nineteenth century. 'Abd al-Salam al-'Alami (1830-1895) was the consummate Moroccan physician, with a foot in both Western and Islamic medicines. He completed an *ijaza* at the Qarawiyyine University in Fez, then was sent by Sultan Mawlay Hasan to study Western medicine at the Qasr al-'Aini medical school in Ottoman Cairo under the physician Bartholomé Clot ("Clot-Bey"). Before "translating" Antaki's *Tadhkira*, al-

knowledge and its translation from Arabic to Ottoman in the Sixteenth and Seventeenth Centuries," in *Istanbuler Almanach*, (5: 2001): 105-107.

4 Ekmeleddin İhsanoğlu, "Ottoman Science: The Last Episode in Islamic Scientific Tradition and the Beginning of European Scientific Tradition," in eds. Ekmeleddin İhsanoğlu, Ahmed Djebbar and Feza Günergun, *Science, Technology and Industry in the Ottoman World,* (Turnhout, Belgium: Brepols, 2000): 11-48, Tuncay Zorlu, "The Medical *Medrese* of Suleymaniye," in *International Congress on Learning and Education in the Ottoman World: Istanbul, 12-15 April 1999* (6, 2001): 63-87.

5 Basim Musallam notes that the recent reprints of the *Tadhkira* have another text by Antaki, *Al-Nuzha al-Mubhija.* However, here I refer to the marginalia in part 1, not this new text, which is in part 4. Musallam, 74.

'Alami he began (but did not finish) a dictionary of Western medical terms in Arabic, the *Asrar al-muhakkama fi hall rumuz al-kutub al-mutarjama.*[6] That al-'Alami should edit Antaki's four hundred year-old text speaks for its utility—French doctors saw that it was the preferred text of Moroccan healers during the Protectorate (1912-1956)[7] and pharmacologist Jamal Bellakhdar attests to its use in Morocco today.[8] But the *Tadhkira* also provided an Islamic theory of the sciences. After French Orientalist Ernest Renan declared" in his notorious 1883 Sorbonne address that "Islam killed science,[9] Muslim interlocutors from Jamal ad-Din al-Afghani to Namık Kemal tried to demonstrate the compatibility of Islam with modern science.[10] But the modernizers walked a fine line between reconciling Islam with science and collapsing Islam into secular science.[11] Al-'Alami chose Al-Antaki's text, as part of a larger, nineteenth-century Moroccan project to adopt useful European sciences yet preserve Islamic cosmology and the sovereignty of the Moroccan state.

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6 Ellen Amster, "'Abd al-Salam b. Muhammad b. Ahmad al- Hasani al- 'Alami al- Fasi," in eds. Marc Gaborieau, Gudrun Krämer, John Nawas and Everett Rowson, *The Encyclopedia of Islam 3* (Brill).

7 There are more manuscript copies of the *Tadhkira* in the National Library of Rabat and libraries of Moroccan mosques than any other medical text, and the *Tadhkira* was excerpted in physicians' compilations of manuscript for practical use. See also H.P.J. Renaud and G.S. Colin, *Documents marocains pour servir à l'histoire du "Mal franc," textes arabes, publiés et traduits avec une introduction, par H.P.J. Renaud et G.S. Colin,* (Paris: Publications de l'Institut des hautes études marocaines, 1935), D. Arnaud, ""L'Oeuf de faon," ou la survivance inattendue du bézoard," *Maroc Médical,* 58 (Nov. 15, 1926): 305-311.

8 Jamal Bellakhdar, *La Pharmacopée marocaine traditionelle: médecine arabe ancienne et savoirs populaires,* (Ibis Press, 1997).

9 Renan, *L'islamisme et la science... (Conférence à la Sorbonne, 29 mars). L'équivoque contenu dans ces mots: science arabe, philosophie arabe, art arabe, science musulmane, civilisation musulman. En tuant la science, l'islam "s'est tué lui-même et s'est condamné dans le monde à une complète infériorité,"* (Paris, Calmann-Lévy, 1883).

10 Of this literature, see for example Nikki Keddie, *Sayyid Jamal Ad-Din "Al-Afghani:" A Political Biography,* (ACLS Humanities E-Book, 2008) and Cemil Aydın, "Beyond Culturalism? An Overview of the Historiography on Ottoman Science in Turkey," in eds. Ekmeleddin İhsanoğlu, Kostas Chatzis, Efthymios Nicolaidis, *Multicultural Science in the Ottoman Empire,* (Turnhout, Belgium: Brepols, 2003): 201-215.

11 Ellen Amster, "Westernization: The Middle East," in ed. Maryanne Cline Horowitz, *The New Dictionary of the History of Ideas,* (New York: Scribner, 2005): 2468-2469.

Ordering the Sciences: Dawud al-Antaki and his *Tadhkira*

The life and work of Dawud al-Antaki illustrate the cosmopolitanism of Ottoman medicine in the sixteenth century. Al-Antaki was born in al-Fu'a, a village near Antioch in about 1535 A.D., and though born blind, he came to the attention of a Persian visitor to the shrine of Habib an-Najjar who taught him logic, mathematics, physics and Greek. As a young man, Dawud traveled to the Syrian coast, Jabal 'Amil in Southern Lebanon, and Damascus, where he became a physician.[12] He was appointed head physician in Cairo, led a clinic at the Zahiriyya school, and authored fifteen works on *fiqh, kalam,* and medicine,[13] but jealous medical rivals accused him of heresy. They used Antaki's chapter in *al-Tadhkira* on talismans to accuse him of worshipping Satan and the planets.[14] Tired of academic politics, Antaki left Cairo for Mecca in 1598 and died there in 1599. Antaki's text seems to predate all Ottoman modernizations; he wrote his *Tadhkira* in Arabic, not Ottoman Turkish, and his text does not reflect what historians consider indices of "modern medicine:" anatomy drawn from observation (Siraisi), a systemic organization of knowledge (Blair), or the identification of disease entity (Rosenberg et al). Why then was Antaki's *Tadhkira* so popular in the "modern" era? First, Antaki presents a rich pharmacology in easily-applied, practical terms for the lay person. Second, he also offers an Islamic theory of the sciences, one that relates "popular" healing to the "high tradition" of the classical Arabic physicians in a single therapeutic system.

In Part 1 (physiology), Antaki is a classical Galenic physician, using humoralism, scholastic reasoning, and Aristotelian physics. The human body, like the physical world, is made of "the fire under the stars, air, water and earth." Human beings are composed of humors: blood (hot and wet like air), phlegm (cold and wet like water), yellow bile (hot and dry like fire) and black bile (cold and dry like earth). He likens the production

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12 Nicola A. Ziadeh, "Al-Antaqi and his Tadhkara," *ARAM,* (11-12: 1999-2000), 503-508, and Martin Plessner, "Dawud Al-Antaki's 16th Century Encyclopaedia on Medicine, Natural History and Occult Sciences," Proceedings of the International Congress on the History of the Sciences, 10th congress, 1962: 635-637, and Lucien Leclerc, *Histoire de la médecine arabe,* Volume II, 1876: 303-307.

13 Among them, *Istiqsa' al-'ilal* and *Risala fima yata'alliq bi al-safar,* from Ziadeh, [op cit.].

14 Plessner suggests the text was excerpted without change from the book of magic *Ghayat al-Hakim (Picatrix),* Plessner, [op cit].

of humors to cooking[15] and calls nutrition, growth, and generation Aristotelian "powers" that attract and repulse humors in the body.[16] His conception of the human mind also follows Aristotle: the "spirit" is a vapor in the blood that carries natural power to the heart, animal power to the brain, and psychological power to the sensory organs.[17] Antaki's chapter is a "review essay" of classical medical authorities that uses Ibn Sina, Abu Faraj, Galen, ("Jalinus"), Aristotle, Ibn Qaff, and "the Christians" to discuss specific points of physiology:

> Indeed, the natures of the humors, by what was decided previously among the scholars, and it is said in *Ash-Shifa'* [of Ibn Sina] that the community of doctors think cold is in the yellow bile, and their argument is that it causes trembling and shaking [in fever] and they see heat in black bile, because those with melancholic temperament can bear the cold with little difficulty. And these are simply wrong, because the first is clearly self-contradictory, and were it not so the person afflicted with choleric fever would not require water, and as for the second, the ability of the melancholic to tolerate cold is because of an excess of dryness...[18]

In anatomy and physiology, Antaki exemplifies the medieval/Renaissance physician. He draws from canonical texts rather than observation for knowledge of the body and his use of inductive reasoning demonstrates his

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15 "Indeed it is established that phlegm, as analogized to food, is not well-cooked, and blood is cooked to a perfect balance, and yellow bile is as exceeding the balance but not burned, and black bile is as the burned, and there is no doubt of the permissibility of the less-cooked to advance in degree to the higher degree of maturity...But is the opposite permissible, i.e. for black bile to become yellow bile? The people have said so...but the correct answer is that this is not possible," *Ibid.* 9.

16 *Ibid.* 13-14.

17 "The psychological power is divided into the perception of general concepts, and this is the rational self, like the intelligence, and perception of particular knowledge, either externally - and these comprise hearing and sight and smell and taste and touch - or internally, and these are likewise five in number, the first of which is the perception of the shared images from the five external senses, being *nitaasia*, also known as "the shared sense" with its location is in the front of the first interior section of the brain. Secondly, there is a storehouse for this power [sensory perception], which is the imagination with its location in the back of the brain. Or the faculty which perceives plain meanings and this is fantasy, with its location is at the back of the second interior section of the brain, and this is the most correct. Or the faculty which stores cognitions for times when they are needed, and this is memory, with its location is at the back of the third [interior of the brain]. Or there is the faculty which perceives the [sensory] images and the meanings with classification and composition and analysis, and this is the explanatory power..." Antaki, my translation, 17.

18 *Ibid.* p. 10.

reliance on natural philosophy *(physica).*[19]

Historian Ann Blair found Antaki's pharmacology equally medieval; Part 3 (1712 remedies) is organized alphabetically in accordance with the Arabic alphabet, rather than encyclopedically by theme.[20] But Antaki's pharmacy is stunning in its breadth; his catalogue includes plant, animal and mineral substances from Europe, the Levant, India, China, Egypt, Arabia, Sub-Saharan Africa, North Africa, and Asia Minor. As Efraim Lev has argued, the Ottoman *bilad al-sham* formed the hub of the world trade in spices and *materia medica*;[21] Antaki's pharmacological wealth was the result of this geopolitical reality. Secondly, though his anatomy is based in philosophy rather than dissection, Antaki's pharmacy uses very precise observations to describe each substance. Consider the botanical precision of his entry on *jar an-nahar:*

> "{letter J} [*jar an-nahar,* neighbor of the river], It is called thus because it only exists in the water or near it. It is like chard except it is fuzzy with prickly roots and seven leaves. Its taste is bitter and it has no flowers or fruit. As it grows, it spreads over the water like the *linofer.* It is cold and dry in the second degree and blocks diarrhea and blood and cuts thirst when drunk. It solves tumors when applied topically and mends wounds when it is moist or dry. It harms the nerves and sugar corrects this.[22]

Historians would also find Antaki "medieval" in his Galenic descriptions of disease, which he conceives as an imbalance of the four humors:

> {the letter y} [*yarqan*, jaundice]: Its cause is the weakness of the attraction of the spleen, so it pushes what belongs to it to the belly and it turns the skin yellow by means of that humor [yellow bile]. And black jaundice occurs when [black bile] is pushed to the mouth of the stomach. (It causes) hunger and a lot of excrement. (The remedy is to) clean the spleen from whatever was in it before and open the blockage by bloodletting...[23]

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19 See Nancy Siraisi, *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice,* (Chicago: University of Chicago Press, 1990).

20 Anthony Grafton and Ann Blair, *The Transmission of Culture in Early Modern Europe,* (Philadelphia: University of Pennsylvania Press, 1999).

21 Efraim Lev, "Trade of Medical Substances in the Medieval and Ottoman Levant (Bilad Al-Sham," in ed. Yaacov Lev, *Towns and Material Culture in the Medieval Middle East,* (Leiden: Brill, 2002): 159-183.

22 For example, Antaki *Tadhkira*, Section 3, 103.

23 Section 4 is aranged alphabetically by malady and by science. The maladies and their remedies are explained in humoral terms, Section 4, 5.

However, Antaki's approach to healing is eminently practical; consider his "Chapter on Remedies which promote Pregnancy" and "Medicine Which Completely Prevents Pregnancy."[24] Antaki ascribes sterility to physical causes and prescribes herbal remedies administered orally or in "*safuf*" (suppositories). Sterility is due to "a lack of straightness [of the vagina, fallopian tubes], or problems in reception [of sperm], or the flow of sperm, or an excess of humidity." For humidity, one must study "the intersections between [it] and excessive urination, corpulence, perspiration, and pulse." He prescribes drying and heating remedies (*masakhan)* to "prepare for the reception of sperm by resolving the cold and the heavy winds" in the womb:

> Crush a piece of garlic and cook it in clarified butter, then take a nut of *bua,* saffron, cinnamon, a hundred *sa'ila* of each, half of it is mixed, sifted and [she wears it in a *sufa* in the vagina] in the afternoon...[25]

Antaki's chapter is written for the layman: a simple medical explanation, an herbal remedy, and instructions for its preparation.

It was troubling to Antaki's biographer Muhammad al-Muhibbi that Section 4 of the *Tadhkira* includes magic and talismans.[26] Antaki has charts showing which of the seven kings of the *jinn* is dominant each day of the week and the "body, spirit, self, heart, and intelligence" of each Arabic letter,[27] tables of correspondences between the planets, astrological signs, numbers, parts of the body, elements, and Arabic letters.[28] For example:

The letters: a, h, Ta, m, f, sh, dh, b, w, y, n, S, t, Dh,

The part of the body: hair on the head

The astrological sign: Aries

The nature: like fire[29]

Using these charts, Antaki explains how to compose *jadwal* (magic squares). Some amulets have specific instructions, like this one for miscarriage:

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24 *Ibid.* Section 3, 145-146.

25 *Ibid.* Section 3, 145.

26 See Plessner, [op cit].

27 *Ibid.* Section 4, 89.

28 *Ibid.* Section 4, 90.

29 These correspondences resemble the "Zodiac man" manuscripts Siraisi describes in fifteenth-century Europe and medieval Persia, which mapped the influence of stars on parts of the body. For example, the chest (*sadr)* is governed by Scorpio (*'aqrab)* and is watery (*ma'y*). See Siraisi, [op cit].

> Another *khatim* (seal) to prevent hemorrhage and miscarriage, even for animals: write the writing you see here on a lead tablet [*louh,* the slate children use to learn the *Qur'an]* on Saturday of any month and hang it by a colored silk thread.[30]

There is a grid labeled "Jadwal regulating the extraction of angels and servants [*jinn* familiars] through the fundamentals:"

> (use): If you want to write love, compose a tertiary and gather the fiery letters and the name of the one you wish to fall in love with you and begin the composition in the fiery element of the trio, for his heart will burn with the violence of love, even if you wanted the attraction of a sultan, prince or other. Compose it on a page of gold at the hour of the sun when you are completely purified. Smoke it [i.e. burn it so it gives off smoke] on your right side with moistened wood (*'aud),* and a little safran and on your left with incense with musk in it...and if you want to do the opposite, then take the airy letters and the name of him you want and make a quadrilateral and you will succeed...and if you want to cause agitation, then take the airy letters and of the name of him you want and compose it in a quadrilateral and write in the blood of a magpie and smoke it with the gallbladder of a rooster.[31]

How is it that the "rational" Antaki can write about magic? European Orientalists Lucien Leclerc and Max Meyerhof argued that magic proved the scientific decline of the Arab world. However, if we study Antaki's marginalia, we find that Antaki places "magic" within a well-reasoned order of the sciences. *'Alm al-harf,* the science of letters, and other "magical" sciences fit conceptually into a scientific scheme with Antaki's "rational" medicine.

Antaki's order of the sciences reflects the structure of his universe: there is a divine realm of pure abstraction related to a material world of bodies. The best of the sciences are divine, because they describe God and are free of Matter. Mathematics is the second science because it is abstract, but it can be applied to matter and produce engineering and music. The other sciences follow in order of materiality; the natural sciences are third because they "need the Material." The most degraded are the mechanical sciences, "connected to the self of a person," and include kingship, the "politics of the

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30 Antaki, *Tadhkira,* Section 4, 199.

31 *Ibid.* Section 4, 92.

self" (psychology), and "organization of the ideal city." The divine sciences are six: 1. The Necessary (Existence of God) 2. The Principles of Existing Things 3. Proof of the Creator 4. Classification of the Concepts 5. States of the Self after Separation from the Body (*al-mufariqa)* 6. The Unseen World, "the Islamic peoples added a sixth, which is called the unseen, *'al-samayat,'* and it is the field of prophecy and the day of judgment..."[32] Medicine exists on the borderline between the divine and physical sciences, because it touches the question of *al-mufariqa,* but "medicine and autopsy are related to bodies."

Divine science (prophecy) and mathematics are the languages of communication between the visible/material world and the unseen/ ideal world. The Sultan is he who organizes the material world through mechanical sciences in accordance with reason:

> If he organizes only the visible things [in the world] using evidence as a means, this is the sultanate and he who practices [this science] is the sultan. And this includes his property in the regions of civilization...[33]

The Prophet is he who can change the physical world by introducing knowledge from the ideal world--the science of prophecy:

> As for the invisible (*bataniyya,* inner) science, evidence of its presence is indicated by great proofs [miracles] and it is the power of prophecy, and that person is the prophet [*mufad,* he who brings back knowledge from the next world], and he has the power of abstract matters which distinguishes him from ordinary men.[34]

Mathematics is also a language of translation from the ideal to the material world. Numerical symbolism was widely understood in this sense, for example in this excerpt from the Pure Brethren of Basra:

> The whole world is one as a city is one, or as an animal is one, or as a man is one. Its parts are held together like the organs of a living body, which derives its being and sustenance from the Divine Word. The language with which this interrelation is expounded is that of symbolism, particularly numerical symbolism. Everywhere within the Universe the

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32 Antaki *Marginalia,* my translation, 4-5. Logic (*al-muntiq)* is a tool for all sciences including the *Sharia'* (Islamic law), the "essential system" brought by Muhammad to protect self, reason, property, honor, and religious confession.

33 *Ibid.* 2, my translation.

34 Islamic scholars often use the verb *fada/yufidu* to describe the Prophet Muhammad receiving revelation of the *Qur'an* from the Angel Gabriel.

> key to the understanding of things is numbers, which like the morning sun, disperse the fog of the unintelligibility of things considered only in their terrestrial opaqueness.[35]

Because numbers link the material and divine worlds, all Qur'anic amulets reduce to numerical formulae. Thus, Antaki includes talismans as he includes geography, mathematics and veterinary medicine: a related science that impacts health and disease.

Medicine and Science at the Court of Sultan Mawlay Hasan

In contrast to the Ottoman Empire, which imported European science, medicine and technology in the *tanzimat* reforms,[36] nineteenth-century Morocco has been seen by historians as closed to European penetration. Edmund Burke argues that the tardy modernization efforts of Sultan 'Abd al-'Aziz in the 19th century failed because the *'ulama* opposed Europeans and their sciences.[37] However, the Moroccan sultans invited French and English physicians to court from the sixteenth century, when the Sa'adian sultan Mawlay 'Abd al Malik engaged the Frenchman Guillaume Bérard as his personal physician. "Maritime *jihad*," or piracy against European ships, provided the largest source of European doctors, engineers, and technicians. Doctors served the Moroccan court as slaves, were sent to minister to their enslaved countrymen, or converted to Islam as "renegados" and served as officers in the sultan's army. In 1810, a renegade Portuguese surgeon accompanied the Sultan on campaign to treat the wounded and compose drugs for the officers and rich soldiers. With the end of piracy came an end to this supply of European technical personnel. Still, in 1877, the French found a French *polytechnician* canalizing the River Fes, the Baron de Saint-Julien personal physician to the Grand Vizier, and a Spaniard directing a royal brass band that could play "God Save the Queen."

After Morocco suffered defeat by France and Spain in the 1844 Battle of Isly and the 1860 Tetouan War, Sultan Mawlay Hasan (1873-1894)

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35 Seyyed Hossein Nasr, *Islamic Cosmological Doctrines*, 44. On mathematics and Sufi discipline, see also William Chittick, *Faith and Practice*, 170-171.

36 Khaled Fahmy, *All the Pasha's Men: Mehmed Ali, His Army, and the Making of Modern Egypt*, (Cambridge, U.K.: Cambridge University Press, 1997).

37 Edmund Burke III, "The Political Role of the Moroccan Ulema, 1860-1912," in ed. N. Keddie, *Scholars, Saints and Sufis: Muslim Religious Institutions since 1500*, (Berkeley: University of California Press, 1972), 91-125.

recognized the need for state-directed military reform and the systematic acquisition of European technology. He sent *tolba* to study artillery in the arsenals of Belgium, England, France and Spain, a group of students to the Ecole de Génie in Montpellier for engineering training,[38] and accepted European military training missions in Morocco.[39] To acquire European medicine, he cooperated with the Spanish government to open training courses for Moroccan military surgeons at the Spanish hospital in Tangiers.[40] In 1861, the Moroccan state spent 62,747 francs on pharmaceutical drugs imported from France; a sum that exceeded the value of all Moroccan exports to France combined. After 1900, the French made science and technology Daniel Headrick's "tentacles of progress," ensnaring Morocco in debt and technological dependence. French deputy Eugène Etienne and his Comité du Maroc organized the Mission Scientifique du Maroc in 1905 to show metropolitan investors the value of Moroccan natural resources and persuade the Chamber of Deputies to invade and colonize.

The Sultan also sent the Moroccan physician 'Abd as-Salam al-'Alami to study European medicine at the modern Qasr al-Aini medical school in Egypt.

The Moroccan Sultans avoided interference from European governments by acquiring European science through isolated individuals--engineers, physicians and technicians captured as slaves in maritime *jihad* or through converts to Islam (*renegados*), rather than with an Ottoman-style *tanzimat*. This independence began to crumble in 1877, when Sultan Mawlay Hasan was forced to accept a French military mission, and fell increasingly in debt under Mawlay 'Abd al-'Aziz.

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38 AAE Nantes Tangier Carton 176, Dossier 2.

39 Ellen Amster, "The Many Deaths of Dr. Emile Mauchamp: Medicine, Technology and Popular Politics in Pre-Protectorate Morocco, 1877-1912," *International Journal of Middle East Studies*, 36 (2004): 409-428.

40 "The named Ahmed Tenisamani, doctor in Fez, declares he studied medicine at the school instituted in Tangier by Mouley el Hassan ...after receiving his diploma, he was designated by the *makhzen* military doctor attached to the expedition of Moulay Abdesselam el Mrani, of Bèn el Bagdadi and of Mahboub, where he fulfilled his role using European methods," AAE Nantes DACH Carton 84. See also Lucien Raynuad, *Etude sur l'Hygiène et la médecine au Maroc, suivie d'une notice sur la climatologie des principales villes de l'Empire*, (Alger: S. Léon, 1902), 60.