THE MUSIC OF PULSE IN THE WRITINGS OF ITALIAN ACADEMIC PHYSICIANS (FOURTEENTH AND FIFTEENTH CENTURIES)

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It is well known that the belief that music is inherent in the beating of the pulse was widely held throughout the Middle Ages. Numerous brief but explicit statements of this belief, and of the associated ideas that music is present in other bodily rhythms and or in the virtues and humors can be culled from the writings on music of music theorists and encyclopedists.[1] For such writers, the idea of the musicality of pulse was, of course, one specific expression of the more general notion that musical harmonies inhere in the body and soul of man. The supposed links between music and human physiology and psychology were, however, not only of interest to writers on music: as might be expected, physicians too concerned themselves with the subject.[2] Moreover, certain medical writers who flourished in the north Italian *studia* during the fourteenth and fifteenth centuries seem to have been much readier than either musical theorists or natural philosophers to provide their readers with detailed discussion of the nature of the music of pulse. The works of these physicians span nearly two hundred years of the teaching of the Italian schools and represent a fairly continuous tradition. Their views not only throw light on the concept of pulse music itself, and hence on one aspect of late medieval handling of the ancient theme of the harmonies of the universe; they also illustrate, in one small area, something

[1] The following are some of the works in which the inherence of music in bodily parts and functions (usually the virtues and humors and/or pulse) is asserted: Remigius Autissiodorensis. *Commentum in Martianum Capellam* 9.491.13, 9.516.7, ed. Cora E. Lutz (Leiden, 1962), 2:324, 352; Honorius Augustodunensis, *De imagine mundi* 1.82, PL 172:140; Aurelianus Reomensis, *Musica disciplina,* ed. M. Gerbert, SEMS 1:30; Hugh of St. Victor, *Didascalicon de studio legendi,* ed. C. H. Buttimer (Washington, D.C., 1939), pp. 32–33; Richard of St. Victor, *Liber exceptionum* 1.10 ed. J. Chatillon (Paris, 1958), p. 108; Ieronimus de Moravia, *Tractatus de musica,* ed. Coussemaker, SMMA 1:11–12; Jacobus Leodiensis, *Speculum musicae* 1.14, ed. R. Bragard, Corpus Scriptorum de Musica 3 (Rome, 1955–), 1:53; pseudo-Aristotle, *Tractatus de musica,* ed. Coussemaker, SMMA 1:253; "Der Musiktraktat in dem Werke des Bartholomaeus Anglicus *De proprietatibus rerum,*" ed. H. Müller, *Riemann-Festschrift: Gesammelte Studien* (Leipzig, 1909), p. 246. No doubt the list could be greatly extended. A particularly striking statement is that of the Franciscan Juan Gil de Zamora (d. ca. 1318): "musica, quae ita naturaliter est nobus coniuncta, ut si ea carere velimus, non possimus. Siquidem animae ad corpus, et econverso, suis mediantibus spiritibus, videlicet naturali, cuius sedes est in hepate, et vitali, cuius sedes est in corde, et animali, cuius sedes est in capite, magna musicae proportio est. Similiter humorum ad se invicem et ad corpus, et similiter ossium et nervorum, et arteriarum et cartilaginum, et carnium, et cutis ad se invicem, et ad corpus; unde et Plato dicit Deum animae musicae harmoniam" (*Ars musica,* ed. M. Gerbert, SEMS 2:377).

[2] Associations between music and medicine in general are, of course, very ancient and found in many cultures. For some examples, see D. M. Schullian and M. Schoen, *Music and Medicine* (New York, 1948).

of the nature of the actual application in medical training of the venerable tradition linking medicine with the liberal arts and with philosophy, a tradition institutionalized in the very existence of the faculties "of arts and medicine" of the Italian universities.[3] For academic writers on medicine, indeed, the value of a knowledge of music for the understanding of pulse became one of a set of axiomatic illustrations of the importance of an education in liberal arts for physicians.[4] To what extent this particular prescription was seriously intended or taken the following discussion of the opinions and sources of some of the academic medical writers on the music of pulse may help to show.

Among the writers who gave the subject of pulse music fairly extensive consideration, and whose views will be examined here, were Peter of Abano (d. ca. 1316),[5] Gentile da Foligno (d. 1348),[6] Jacopo da Forlì (d. 1414),[7] Ugo Benzi

[3] On the institutional connection between arts and medicine at Bologna, see Albano Sorbelli, *Storia della Università di Bologna,* 1 (Bologna, 1944), 105–115; for Perugia, Giuseppe Ermini, *Storia della Università di Perugia* (Bologna, 1947), p. 28; for institutional and intellectual association of disciplines at Padua, my own *Arts and Sciences at Padua* (Toronto, 1973). On the links between natural philosophy and medicine in antiquity, Oswei Temkin, *Galenism* (Ithaca, 1973), pp. 64–66, and bibliography there cited. As regards the liberal arts, Isidore of Seville was, of course, drawing on an already established tradition when he proclaimed that all the arts were necessary to medicine (*Etym.* 4.13.1–5). It should be noted that not all the arts were held equally necessary for the physician; by the period of university formation dialectic and astrology certainly held pride of place.

[4] See, for example, Haly Abbas, *Liber totius medicine* . . . (Lyon, 1523, at the New York Academy of Medicine) fol. 8r; Roger Bacon, *Opus tertium,* Ch. 59 in J. S. Brewer, ed., *Fr. Rogeri Bacon Opera quaedam hactenus inedita,* Chronicles and Memorials of Great Britain and Ireland during the Middle Ages 15 (London, 1859), 1:232, and note 93 below; Peter of Abano, *Conciliator* (Venice, 1496, Klebs 773.5), fol. 3r.

[5] Peter of Abano (Pietro d'Abano, Petrus Aponensis; the English form of the name is adopted in the text because of its familiarity) taught at both Paris and Padua, where he was professor of medicine, philosophy and astrology. His best-known work is the *Conciliator differentiarum et praecipue medicorum,* a work intended to reconcile the differences of philosophers and physicians. He also produced a commentary on the *Problemata* attributed to Aristotle (Mantua, 1475, Klebs 776.1, and two other early editions), various astrological writings and some translations of Galenic works from the Greek. The fullest account of his life and works is still Lynn Thorndike, *A History of Magic and Experimental Science* (New York, 1923), 2:874–947, supplemented by the same author's "Manuscripts of the Writings of Peter of Abano," *Bulletin of the History of Medicine* 15 (1944), 201–219. Peter's musical knowledge and interests are discussed and some attention given to his treatment of the concept of pulse music in G. Vecchi, "Medicina e musica, voci e strumenti nel 'Conciliator' (1303) di Pietro d'Abano," *Quadrivium* 8 (1967), 5–22.

[6] Gentile da Foligno was a professor of medicine at Perugia and probably also at Padua, where he was physician to the reigning prince, Ubertino da Carrara. Although chiefly remembered for his numerous *consilia,* the best known of which concerns bubonic plague, he was also a voluminous commentator on medical authorities and a writer on medical theory. See G. Girolami, *Sopra Gentile da Fuligno [sic], medico illustre del secolo XIV* (Naples, 1844); George Sarton, *Introduction to the History of Science* (Baltimore, 1948), 3, 1:848–852; and Thorndike, *History of Magic,* 3:233–252, and F. Bonora and G. Kern, "Does Anyone Really Know the Life of Gentile da Foligno," *Medicina nei secoli* 9 (1972), 29–53. For references to the numerous surviving manuscripts and to early printed editions of his works, see index entries in Lynn Thorndike

of Siena (d. 1439),[8] and Pietro Vermiglioli (fl. 1480).[9] Each of the authors named devoted between one and five folio pages to the discussion of the music of pulse, and all of them formally endorsed the concept, although with varying degrees of qualification. Their opinions ranged from the apparent enthusiasm for the harmonies of the universe and the music of pulse displayed in the lengthy and learned exposition of musical theory provided by Peter of Abano to the disinterest and probable skepticism evident in the much briefer account by Gentile da Foligno. The most extended and perhaps the most influential treatment of the subject was that included by Peter of Abano in his *Conciliator*,[10] in which considerable prominence is given to the subject of the music of pulse. Not only did Peter make the customary claim that the physician should know music because of its relevance to pulse, but he also devoted one of the four *quaestiones* on pulse and the arteries contained in the work to a vigorous defense of the proposition that music is found in pulse. Moreover, his readers were provided with definitions of music according to Boethius and Isidore, definitions of consonance and dissonance and an account of the mathematical proportions used in music. He also discussed semitones and the scale, the monochord and musical instruments, and supplied a short account of the Greek diatonic, chromatic and enharmonic tetrachords and a list of Greek musical terms. The principal source of Peter's musical theory seems to have been the *De institutione musica* of Boethius;[11] however, he also cited St. Augustine and Guido of Arezzo and, as has been demonstrated, showed some familiarity with the musical practice of his own day.[12] The expositions of the music of

and Pearl Kibre, *A Catalogue of Incipits of Mediaeval Scientific Writings in Latin*, rev. ed. (Cambridge, Mediaeval 1963), hereafter cited as TK, with column number.

[7] Jacopo della Torre da Forlì taught at Bologna and Padua and was the author of commentaries on the *Aphorisms* of Hippocrates, the *Ars parva* of Galen and the *Canon* of Avicenna. According to Michele Savonarola, a younger contemporary, the works of Jacopo da Forlì were widely used as university textbooks: "Marsilii Sophilici [i.e., Marsiglio di Santa Sofia, for whom see note 24 below] et Foroliviensis opera medicorum nostri temporis legentium gymnasia repleant" (*Libellus de magnificis ornamentis regie civitatis Padue*, ed. A. Segarizzi, Rerum Italicarum Scriptores, new edition, XXIV, 15 [Città di Castello, 1902], 37). See also A. Gloria, ed., *Monumenti della Università di Padova (1318–1405)* (Padua, 1888), 1:437–439.

[8] In the course of Ugo Benzi's long professorial career he taught at Pavia, Piacenza, Bologna, Parma, Florence, Siena and Padua. He was especially renowned for his skill in disputation and, like Jacopo da Forlì, produced commentaries on the *Aphorisms*, the *Ars Parva* and the *Canon*. See D. P. Lockwood, *Ugo Benzi, Medieval Philosopher and Physician* (Chicago, 1951).

[9] Pietro was a professor of arts and medicine at Perugia; see G. B. Vermiglioli, *Biografia degli scrittori Perugini* (Perugia, 1828), 320–323. For other medical writers on the music of pulse, see note 24 below.

[10] *Conciliator* (Venice, 1496), diff. 83, fols. 120r–122r, "An in pulsu musicalis reperiatur consonantia" (title from table of contents at the end of the work). In the discussion of the value of the liberal arts for physicians at the beginning of the *Conciliator* (fol. 3r) the need for music is substantiated solely by a cross reference to *differentia* 83.

[11] In particular, his discussion of proportion seems to be closely patterned on Boethius, *De institutione musica* 1.4–6. For detailed discussion of the musical content of Peter's presentation, see Vecchi, "Medicina e musica," pp. 11–15.

[12] Vecchi, "Medicina e musica," pp. 10, 13–15.

pulse contained in the commentaries on the *Canon* of Avicenna by Jacopo da Forlì[13] and Ugo of Siena[14] and in the *De pulsibus* of Pietro Vermiglioli[15] probably depend in part upon the work of Peter of Abano, whom indeed they occasionally cite by name. These writers, too, transmitted some purely musical information[16] and by so doing emphasized the value of music for the study of pulse. Each of them, although somewhat more briefly than Peter, defined music according to Boethius and Isidore, explained musical proportion, defined consonance and dissonance, and explained musical terms of Greek origin. In rather striking contrast stands the exposition of Avicenna on pulse by Gentile da Foligno.[17] Although Gentile is said to have professed great admiration for Peter of Abano,[18] he appears to have been unaffected by the latter's interest in the music of pulse. The topic was treated by Gentile with what looks like disdainful brevity: he incorporated no definition or classification of music and made no reference to any musical experience of his own. A short explanation of the proportions said to be found in pulse is unaccompanied by any account of the nature of musical or mathematical proportion in general. Gentile's attitude perhaps reflects a more specialized medical interest in pulse than that of some of his fellow physicians, since he was the author of a widely read commentary on the *Carmen de pulsibus* of Gilles of Corbeil.[19] This commentary, too, is notable for the absence of references to music, proportion, and number. In it, indeed, opportunities for introducing musical discussion are resolutely ignored; for example, the terms "discors vel consonus" used by Gilles are said by Gentile to signify merely "equale vel inequale."[20]

Despite differences of approach and certain disagreements in matters of

[13] Jacopo da Forlì, *Expositio et quaestiones in primum Canonem Avicennae* (Venice, 1547; at the New York Academy of Medicine), Fen 2.3.1, fols. 132r–133r.

[14] Ugo da Siena, . . . *in prima fen primi Canonis Avicenne. Expositio* (Ferrara, 1491, Klebs 998.1; despite its title this work includes Fen 2 of Book I) Fen 2.3.1., sig. G3^{v}–[G5^{r}].

[15] Pietro Vermiglioli, . . . *Tractatus de pulsibus* (Perugia, 1480, Klebs 1026.1), sig. bi^{v}–bii^{v}. This work, too, is a commentary on Avicenna, *Canon* 1.2.3.1.

[16] Fairly close parallels can be drawn between the subject matter of the accounts of music by the medical authors discussed here and that of the musical sections of encylopedic works examined in L. Ellinwood, "*Ars musica,*" SPECULUM 20 (1945), 290–299, although the physicians treated of music much more briefly and omitted the discussions of its history and effects and of musical instruments provided by the encyclopedists.

[17] Gentile da Foligno, *Primus Avic. Canon. cum argutissima Gentilis expositione* . . . (Pavia, 1510; at the New York Academy of Medicine), fol. 122r.

[18] He is said to have fallen on his knees in the room where Peter had taught or, in some versions of the story, before Peter himself, crying "Hail, Holy Temple" (Girolami, *Gentile da Fuligno,* p. 6).

[19] Gentile's commentary is included in Aegidius, *De urinis et pulsibus* (Venice, 1414 [i.e., 1514]; at the New York Academy of Medicine) and various other early editions of the work of Gilles of Corbeil, who studied at Salerno and subsequently became physician to Philip Augustus of France. Gilles's metrical treatise on pulse, with a companion poem on urines, was widely circulated and survives in several manuscripts and early editions (see TK 161, 744, 1181; Klebs 465.1, 466.1–4); the most recent edition is Aegidius Corboliensis, *Carmina medica,* ed. L. Choulant (Leipzig, 1826).

[20] Aegidius, *De urinis et pulsibus* [1514], fol. 24v. Gilles's use of "pede dactylico" to describe the movement of a pulse is explained as a simile on the same page.

detail, a common body of information regarding the music of pulse can be drawn from the accounts of Peter of Abano, Gentile, Jacopo, Ugo and Pietro Vermiglioli. Its main outlines are as follows.

The claim that pulse was musical was based by the writers named upon the belief that both musical consonance and musical numerical proportion were in some way to be found therein. According to Gentile da Foligno, for example:

> a double proportion is attended to in musical sounds. One is that of the sounds themselves, because, that is, some are high and others are low. The other is the proportion of times. . . . And in the same way it should be understood that two kinds of proportion are found in pulse. One, that is, which corresponds to the proportion of sounds properly so called, that is, according to high and low. The proportion in pulse that corresponds to this is that between strength and weakness. . . . Similarly, in the second place, the proportion in pulse which is read according to speed and slowness corresponds to the proportion of sounds which has to do with the measuring of times of motion and rest.[21]

The notion that the duration and or intensity of pulsebeats corresponded to particular, identifiable musical proportions was expressed by all the authors. These proportions were generally held to be "the proportion of the whole and five" (5:2), which, however, according to Peter of Abano, Ugo of Siena and Pietro Vermiglioli should really be understood as "the proportion of triple"; the proportion of double (2:1), sexquialtera or sexquitertia altera (3:2), sexquitertia (4:3) and sexquiquarta (5:4).[22]

Despite unanimous agreement that the proportions named did in some sense or other occur in the duration of pulsebeats, the authors were dubious as to the precise relationships involved. Was diastole to be compared to diastole or systole to systole or diastole to systole? Should the stroke be compared to the rest immediately following it? Or was diastole plus rest to be compared to systole plus rest? These vexed questions were in particular discussed at some length by Peter of Abano, who professed the opinion that the senses could more readily discern the contrast between motion and rest than the relative duration of two motions.[23] Ugo of Siena added a critical

[21] ". . . attenditur duplex proportio in sonis. Una est ratione sonorum quia, scilicet, aliquis est acutus aliquis est gravis. Alia est proportio ratione temporum et quia ibi concurrit duplex tempus, scilicet, mensurans motum percussionis cordarum instrumenti et tempus mensurans quietes que sunt inter percussiones: ideo ab ipso tempore sumitur alia proportio sonorum. Et eodem modo est intelligendum duas proportiones reperiri in pulsu. Unam, scilicet, que correspondet proprie proportioni sonorum que est secundum acutum et grave (sic) cui correspondet in pulsu proportio que est secundum fortitudinem et debilitatem . . . similiter secunde proportioni sonorum que accipitur penes tempus mensurans motum et quietem correspondet in pulsu proportio que sumitur secundum velocitatem et tarditatem" (*Primus Avic. Canon. cum . . . expositione* [Pavia, 1510], fol. 122r).

[22] *Conciliator* (Venice, 1496), fols. 121v–122r; Jacopo da Forli, *Expositio . . . in primum Canonis*, fols. 132v–133r; Ugo da Siena, . . . *in prima fen primi Canonis*, sig. [G_4^{r-v}]; Vermiglioli, *De pulsibus*, sig. bii^r. The list is based upon interpretation of a passage in Avicenna, *Canon* 1.2.3.1 (see further below).

[23] ". . . motus namque magis percipitur quiete: quam motus motu" (*Conciliator* [Venice, 1496], fol. 121v). Galen had also discussed this question; see note 44 below.

review of current opinion on the subject, in which he discussed the views held by Peter of Abano, Dino del Garbo, Marsiglio di Santa Sofia,[24] and Jacopo da Forlì.

The other type of proportion was more easily explained. Just as tones could be high or low, so pulses were defined as "great" or "small," "dense" or "rare." Jacopo da Forlì further added that "speed and denseness in pulse are in some way like highness in tone. For the high tone moves the hearing quickly, but the low tone slowly. So the rapid pulse quickly impresses itself upon the touch . . . ."[25] Moreover, the variations of a pulse, like the different voices of a group of singers, might be either harmonious or dissonant. The two types of proportion were both involved in the notion that pulse, like music, proceeds according to fixed and recurring patterns, that is, "through circles of chances and times." In elaborating the last statement, which derives from Avicenna,[26] Jacopo da Forlì at any rate appears to have had in mind an analogy with the polyphonic practice of his own day. He equated "circulos casuum temporum" with "times of mensurated (*mensuratarum*) voices," explaining that "singers proceed in a circular manner, now raising, now lowering the voice, now cutting short, now drawing out, its time." "Concerning this," he added, "you may inquire more fully from musicians if you don't believe me."[27] Yet another set of harmonies was to be found in the relationship of the pulse to its owner. A pulse, even if well proportioned in itself, might be inharmonious if unsuited to his or her age or constitution, just as funereal music would be inappropriate at a wedding.[28] Peter of Abano

[24] Dino was a professor of medicine at Bologna and Padua and a copious and frequently quoted medical author. According to his son Tommaso, he discussed pulse "in quibusdam glosis quas composuit super libro Galieni de utilitate pulsus; quas non complevit" (Tommaso del Garbo, . . . *summa medicinalis* [Venice, 1506; at the New York Academy of Medicine], fol. 46r). Marsiglio di Santa Sofia was the best known member of a family which contributed a number of physicians to the Paduan medical faculty in the fourteenth and fifteenth centuries; he produced the usual range of commentaries and *consilia*, being especially noted for his work on fevers. See Gloria, *Monumenti* (1318–1405), 1:390–395, and G. Tanfani "Una illustre famiglia di medici padovani nel medio evo," *Rivista di storia delle scienze mediche e naturali* 24 (1933), 97–112.

[25] "Velocitas et spissitudo in pulsu acuitati vocis aliqualiter assimilatur. Vox nam acuta velociter movet auditum, gravis vero tarde. Ita pulsus velox cito imprimit in tactum . . ." (*Expositio . . . in primum Canonis* [Venice, 1547], fol. 132v).

[26] "per circulos casuum et temporum" (Avicenna, *Canon* 1.2.3.1 [Pavia, 1510], fol. 122r.

[27] "ars musicae completur in finem eius convenienter et complete attingit, dum servatur debita proportio sonorum inter se in gravitate et acuitate, longitudine et brevitate, etc. Et hoc circulariter variatur secundum circulos casuum temporum, id est, vocum tempore mensuratarum, vel etiam mensurae vocum. Circulariter nam procedunt cantatores nunc elevando: nunc deprimendo vocem, nunc abbreviando, nunc elongando tempus eius, et consequenter ipsam isto tempore mensuratam quo a musicis plenam inquiras informationem si mihi non credis" (*Expositio . . . in primum Canonis* [Venice, 1547], fol. 132v).

[28] For example: "duobus modis potest contingere quod proportio temporum et sonorum non sit conveniens uno modo quia est talis ut nullam faciat consonantiam, scilicet, non proportionatam fini quem intendit musicus vel non proportionatam auditui illius propter cuius delectationem musicus pulsat. ut ubi gratia alia consonantia utenda est in tristitia et funere et alia in nuptiis et bello. Similiter etiam duobus modis contingit illas dispositiones in pulsu esse disconvenientes. uno modo quod non sit conveniens alicui naturali complexioni hominis. alio modo

seems to have been alone among the group, however, in claiming that the pulse beat in different meters at different ages — trochee for infants, spondee for mature adults, and "iambotrocheo" for the aged.[29]

In presenting the material just summarized, the authors were drawing upon traditions stretching back to classical antiquity in both music and medicine. But it is, as far as I am aware, only in ancient and medieval medical literature that the attempt is made to isolate specific musical proportions as present in pulse. It therefore seems desirable to glance briefly at the music of pulse in the medical tradition available to the authors before reviewing their handling of themes drawn from writings on the theory and philosophy of music. It will become apparent, however, that some similar underlying assumptions are to be found in both sets of sources.

The theory of the music of pulse constituted one small part of the extremely elaborate and recondite science or pseudo-science of pulse developed by Hellenistic physicians and their Arabic and western medieval successors. Knowledge of pulse, of course, played a much more significant part in ancient and medieval than in modern medicine; this was no doubt mainly because, given the lack of other diagnostic tools, pulse shared with urine the virtues of being readily discernible and patently responsive to states of disease and health. But in the absence of full understanding of the circulation of the blood, pulse must also have seemed a phenomenon of profoundly mysterious significance, comparable to the ebb and flow of the tides[30] or the circling of the heavenly bodies. The main sources of the more arcane ramifications of the pulse theory of the later Middle Ages were probably the voluminous writings of Galen,[31] who devoted four major and several minor treatises to the topic,[32] together with the lengthy sections on

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quod sit alicui conveniens, sed illi in quo conveniuntur patet modo consideratio illorum. et proportionum partium pulsus secundum quod referuntur ad naturam vel equalitatem corporis in consonantiis que omnia consideranda sunt a medico." (Vermiglioli, *De pulsibus*, sig. bii^{r}).

[29] "Reperitur etiam musica metrica in pulsu. Nam ibidem pulsus infantium irrationalis proportionatur dictano augmentatorum trocheo; perfectorum spondeo; senum autem iambotrocheo" (*Conciliator* [Venice, 1496] fol. 120r).

[30] For Galen himself on the parallel between pulsation and astronomical motion, see note 41 below. Galen did not, however, subscribe to any tidal theory of pulse.

[31] Prior to the eleventh century few of Galen's writings appear to have been available in their entirety in the Latin west (see A. Beccaria, *I codici di medicina del periodo presalernitano* [Rome, 1956], p. 28, and W. Puhlmann, "Die lateinische medizinische Literatur des frühen Mittelalters," *Kyklos* 3 [1930], 395–416). The only authentically Galenic work on pulse included in Beccaria's catalogue is the relatively brief *De pulsibus ad Tirones*. Instead, some Galenic teaching on pulse was conveyed by way of simplified summaries which concentrated upon pulse as a practical diagnostic tool. Such, for example, was the treatise of the seventh-century Byzantine author Theophilus, or Philaretus, which was early translated into Latin and continued to be read in the later Middle Ages as part of the popular collection of medical tracts known as the *Articella*. See, e.g., *Articella* (Venice, 1487, Klebs 116.3), fols. 4v–5r.

[32] Galen's works on pulse are most conveniently consulted in his *Opera omnia*, ed. C. G. Kühn, 20 vols. in 22 (Leipzig, 1821–33), as follows: *De pulsuum usu*, 5:149–80; *De pulsibus libellus ad Tirones*, 8:453–492; *De pulsuum differentiis*, 8:493–765; *De dignoscendis pulsibus*, 8:766–961; *De causis pulsuum*, 9:1–204; *De praesagitione ex pulsibus*, 9:205–430; *Synopsis librorum suorum de*

pulse, all largely Galenic in inspiration, in the principal Arabic medical encyclopedias,[33] especially the *al-Maleki* or *Liber regalis* of Haly Abbas[34] and the *Canon* of Avicenna.[35] Also widely read was the versified pulse tract of Gilles of Corbeil, which, according to its author, was written to supply the mean between the confused prolixity of Galen and the *Pantegni* of Constantinus Africanus (which, in turn, was for the most part a rendition of the *al-Maleki*) on the one hand, and the excessive brevity of Philaretus on the other.[36]

These works presented pulse as a demanding and complex science. In Galenic physiology the heart as well as the lungs was believed to be an organ of respiration. The function of the heartbeat and the pulsation of the arteries was to disperse blood enriched with vital spirit *(spiritus vitalis)*, obtained from inspired air, throughout the body.[37] Galen himself distin-

pulsibus, 9:431–549; *De pulsibus ad Antonium*, 19:629–642. The statement, made by Galen himself (*De libris propriis*, 19:32) and frequently repeated, that he was the author of sixteen books on pulse refers to the fact that each of the four major treatises is divided into four books. Some at least of these works appear to have been studied at Monte Cassino and Salerno in the eleventh century, since, according to Constantinus Africanus (d. ca. 1085) the works of Galen used in his day included "Pulsuum particule minores" and "Magapulsuum" (*L'arte universale della medicina (Pantegni)*, ed. M. T. Malato and Umberto de Martini [Rome, 1961], pp. 39–40. The *Pantegni* is in large part a free translation of the *al-Maleki* (*Liber totius medicinae, Liber regalis*) of Haly Abbas (d. 994), but the remark cited does not occur in the corresponding passage of the stricter translation of Haly Abbas made by Stephen of Antioch in the twelfth century (see Haly Abbas, *Liber totius medicine* [Lyon, 1523], fols. 5v–6r). Burgundio of Pisa made translations from the Greek of *De causis pulsuum, De pulsuum differentiis, Compendium* (or *Synopsis*) *de pulsibus*, and *De pulsibus ad Tirones* (see TK 358, 480, 494, 631, 1014, 1151, 1186); Marcus of Toledo translated *De utilitate pulsus* (i.e., *De pulsuum usu*) from the Arabic (TK 1012). On these twelfth-century translators see C. H. Haskins, *Studies in the History of Mediaeval Science* (Cambridge, 1924) pp. 206–209 and n. 15.

[33] Most of Galen's pulse treatises were available in Arabic translation before the end of the ninth century (Sarton, *Introduction to the History of Science*, 2, 1:76); his views on pulse are frequently cited by Haly Abbas, Avicenna and Averroes in their writings on the subject.

[34] The *al-Maleki* was twice translated into Latin (see note 32 above). It consists of a fairly well organized account of medical theory in ten books, followed by another ten books on practice. Ten chapters in the theoretical section are devoted to pulse (*Liber totius medicine* 7.2–11 [Lyon, 1523], fols. 81r–88v).

[35] The *Canon*, one of the most widely used and influential of all medieval medical works, was translated into Latin by Gerard of Cremona. Book I of this massive survey of medical knowledge contains nineteen chapters on pulse (*Canon* [Pavia, 1510], 1.2.3.1., fols. 119v–132v). Pulse is also treated, much more briefly, in six chapters of Book IV of the *Colliget* of Averroes (*Colliget Averrois* [Venice, 1549; at the New York Academy of Medicine], fols. 69v–71r). The *Colliget*, last of the great Arabic *summae* of medicine to become available to western physicians, was translated into Latin in 1255; M. Steinschneider, *Die hebräischen Übersetzungen des Mittelalters und die Juden als Dolmetscher* (Berlin, 1893, repr. 1956), p. 672.

[36] *Carmina medica*, ed. Choulant, p. 25. On Gilles and his work see note 19 above; on Philaretus, note 31. Mention should perhaps also be made of the brief practical treatise on pulse attributed to Alfanus I of Salerno (d. 1085), edited in P. Capparoni, *Il "Tractatus de pulsibus" di Alfano I° Arcivescovo di Salerno (Sec. XI)* (Rome, 1936). See also E. Wickersheimer, "Note sur les oeuvres médicales d'Alphane, Archevêque de Salerne," *Janus* 34 (1930), 273–278.

[37] See Rudolph E. Siegel, *Galen's System of Physiology and Medicine* (Basel and New York, 1968), Chapters I and II passim. It may be noted at this point that Galen believed the cause of pulsation to be a "pulsative faculty" in the heart and arteries, and not any form of external

guished at least twenty-seven varieties of pulse.[38] Haly, Avicenna, Averroes and Gilles de Corbeil distinguished ten *genera* or ways of classifying pulse (for example, by strength/weakness, regularity/irregularity, etc.). In addition, the physician was in theory expected to be able to identify a large number of "special" pulses characterized by such traditional names as "formicans," "gazellans," and so on. The causes of variation in pulse were held to include age, *complexio,* climate, pregnancy, various types of disease, emotion and a number of other factors, all of which were discussed at length by Galen and other writers on the subject. No doubt considerable sensitivity to minute variations of pulse was in fact developed by physicians with few other means of diagnosis at their disposal.

The physician who turned to any of the standard authorities on pulse just named would find in the works of each of them some allusion to the musicality of pulse. Undoubtedly, however, the principal sources of information were Galen and Avicenna. Galen's somewhat obscurely expressed views, scattered through several of his pulse tracts, were paraphrased and developed by Avicenna in Book I, Fen 2 of the *Canon* as part of the discussion of the tenth *genus* of pulse, that is, in Avicenna's classification, of pulse determined by *pondus.*[39] Any reader of or commentator on the *Canon* of Avicenna was therefore confronted with the apparent endorsement of the music of pulse by two of the most highly respected of all medical authors. It is hardly surprising, therefore, that the treatment of the music of pulse by Peter of Abano in the *Conciliator* depends heavily upon the support of Galen and Avicenna.[40] The discussions of Gentile, Ugo, Jacopo and Pietro Vermiglioli are, as already noted, commentaries on the passage of the *Canon* in question.

Galen made a number of statements which might be read as endorsing the association of pulse with universal and human harmony. He maintained, for example, that the movements of the pulse were circular and could be

stimulation (such as, for example, ebullition of the arterial blood). About possible non-corporeal or ultimate causes of heartbeat and pulse he did not speculate. The vital spirit carried, together with blood, in the arteries was for Galen a highly refined material substance. He did, however, suggest that the *spiritus animalis* in the brain might be an essence or instrument of the soul (Siegel, p. 191).

[38] *De pulsuum differentiis,* ed. Kühn, 8:493. A concise account of the main points of pulse theory as it developed in late antiquity is to be found in W. D. Sharpe, "Isidore of Seville: The Medical Writings," *Transactions of the American Philosophical Society,* new series, 54, 2 (1964), 65.

[39] *Canon* 1.2.3.1 (Pavia, 1510), fol. 122r.

[40] For example, "Sed A. primo secunda ita. Debes scire quod in pulsu reperitur natura musice. Et quod Ga. videtur quod illud quod potest sentiri ex proportionibus ponderis est secundum unam proportionum musicarum etc." (*Conciliator* [Venice, 1496], fol. 120r). The role of Avicenna as a source of Peter of Abano's theories about the music of pulse is ignored in Vecchi, "Medicina e musica." The use of the abbreviation A. for Avicenna appears to have misled the last named author into attributing the words "Miror quomodo proportiones iste per sensum discerni possunt" to Aristotle (ibid., p. 19). In fact they are Avicenna's (see *Canon* 1.2.3.1 [Pavia, 1510], fol. 122r). The Aristotelian works cited by Peter in his discussion of the music of pulse are referred to by title, rather than by the name of the author. On the role of Aristotle in regard to the music of pulse, see further below.

compared with the movements of the heavenly bodies[41]; and he discussed the universal presence of rhythm in pulse[42] and indicated his belief that particular numerical proportions were to be found therein. The proportions listed by Galen (double, triple, quadruple, "and so on," and 5:2, 7:2, 9:2, 11:2) do not appear to be intended to constitute a *musical* series.[43] Nonetheless his language implied that musical knowledge could at any rate provide useful parallels and comparisons for the understanding of pulse. Yet Galen was strongly critical of the excesses of the followers of Herophilos, an Alexandrian physician of the third century B.C. who had apparently laid much stress upon the metricality or musicality of pulse; moreover he reminded his readers that the practical usefulness of music for the understanding of pulse was not really very great.[44] The caution and restraint

[41] ". . . quemadmodum in planetis, seu errantibus astris, invenitur tamen aliqua in circuitibus paritas, quemadmodum in illis ipsis planetis, propter hoc ordinatam quidem esse dicimus, sicuti planetarum motionem, ita etiam pulsuum, qui per circuitus pares sunt (*Synopsis librorum suorum de pulsibus,* ed. Kühn, 9:445).

[42] "Nunc vero reliquas differentias pulsuum percurro; primam quidem eam quae est rhythmi, musicorum speculatione quid communicantem" (ibid.). "At generis rhythmi non est perinde absolute explicare quae sint differentiae; caeterum prae omnibus pulsum omnem obtinere modulum quendam, est ostendendum: ne deceptus quis pulsuum, qui modulum non servantes appellantur, nomine adducatur ut omni esse orbatos rhythmo eos pulsus falso existimet. Nam ut sine collo homo atque citharoedus sine voce, ita etiam proportionem non servans pulsus vocatur; vitiam enim nativi rhythmi non absolutam abolitionem significat" (*De pulsuum differentiis,* ed. Kühn, 8:515).

[43] "Jam vero inter omnes rhythmos hi pari proportione, illi impari constant; pari, ubi distentionis tempus aequet tempus contractionis; impari, si alterutrum eorum excedat. Id quod modo certis, modo incertis fit excessibus; certis bifariam, aut multiplici proportione, aut ut numeri ad numerum qui et superpartialis appellatur; proportio quidem multiplex est dupla, vel tripla, vel quadrupla, vel aliqua insequentium; ut numeri ad numerum, quum quanta sunt duo distentionis tempora, tanta sint contractionis tempora, quinque vel septem, vel novem, vel undecim; incertis, in universum tripliciter; nam aut distentionis est tempus incertum, aut contractionis, aut utrumque. Sigillatim vero quisque horum interdum paululum amplificata habet incerta tempora, sive plura sint, sive unum primum; interdum plus; est quum plurimum. Atqui tempus primum planum est non natura ipsa esse, sed sensu accipiendum, sic etenim apud musicos etiam fit" (*De pulsuum differentiis,* ed. Kühn, 8:516–517).

[44] Galen sharply rebuked those who took Herophilos' references to music too literally, with the words "Ideoque de rhythmis etiam quae prima aetate debebant in musicis ludis addiscere, haec temere inserunt libris medicinae" (*De dignoscendis pulsibus,* ed. Kühn, 8:871). He also pointed out some of the practical difficulties involved: "Ipse Herophilus [*sic*] rhythmos frequenter ad praesagiendum adducit: verum quid interpretetur rhythmum, difficile est inventu, temporisne distentionis solius ad tempus contractionis solius proportionem, an ipsum etiam quietis tempus, quae comitatur utrumque motum, iis attribuat. Unde inter Herophilios, qui ab illo cognomen invenerunt, non convenit utrum de illis decenter sentiat, neutrum enim ejus oratio plane ostendit, neque confirmare rerum natura potest. Quod si jam alteram sententiam tuemur instituto musicorum, tempora quietum praecedentibus motibus adjiciemus: sin quod facit ad praesagiendum, cum motu motum comparantes, separatim quietum tempus aestimabimus. . . . Tamen quandoquidem alterum eligendum est, repudiato musicorum nomine, quod conducit ad praesagiendum potius ducam . . ." (ibid., pp. 911–912). A further tirade against confusions and absurdities contained in the writings of Herophilos on pulse rhythms is to be found in *De praesagitione ex pulsibus,* ed. Kühn, 9:279. On Herophilos, see J. F. Dobson,

evident in Galen's handling of the topic were a good deal less apparent in Avicenna, whose approach was perhaps influenced by his own interest in music.[45] Avicenna committed himself to the explicit statement that "the nature of music is found in pulse," adding that just as music consists of high and low notes arranged in proportion, so does pulse consist of strokes of greater or less speed and intensity; and both music and pulse involve a rhythmic pattern of time intervals. He further provided what may be the first list to become generally available in the Latin west of the five particular musical proportions said to be involved.[46] He also claimed that it was "easy" for anyone with a practised touch and a knowledge of music actually to feel those proportions.[47]

Less interest in the subject of music was evinced by the other authoritative medical writers on pulse. Haly Abbas prefaced his work with the traditional statement that the physician should be learned in all the liberal arts, the value of music lying in its usefulness for pulse. That Haly attached relatively slight significance to his own prescription is perhaps indicated by the immediately following statement that the physician's knowledge of the liberal arts need only be minimal and by the almost complete absence of musical allusions in the lengthy and detailed discussion of pulse in the seventh of his ten books on theory.[48] Gilles of Corbeil, as already noted, employed metrical

"Herophilos of Alexandria," *Proceedings of the Royal Society of Medicine* 18 (1925), Section of the History of Medicine, pp. 19–32, and Sarton, *Introduction to the History of Science*, 1:159. The works of Herophilos are lost and are known largely through Galen's references to them. He was, however, known to Latin literary writers as one who had associated pulse with music. According to Pliny, for example, "arteriarum pulsus in cacumine maxime membrorum evidens index fere morborum, in modulos certos legesque metricas per aetates — stabilis aut citatus aut tardus — discriptus ab Herophilo medicinae vate miranda arte, nimiam propter suptilitatem desertus" (*Natural History* 11.89, ed. H. Rackham, Loeb Classical Library, 3:570). Martianus Capella made Armonia deliver a comparable statement (*De nuptiis Philologiae et Mercurii*, ed. A. Dick [Leipzig, 1925], p. 493).

[45] See A. C. Crombie, "Avicenna's Influence on the Mediaeval Scientific Tradition," in G. M. Wickens, ed., *Avicenna: Scientist and Philosopher* (London, 1952), pp. 101–102. Avicenna's writings on music were not translated into Latin during the Middle Ages.

[46] Avicenna appears to have selected from, adapted, and added to the numerical proportions suggested by Galen with the intention of forming a musical series: "Galenus autem videtur quod id quod potest sentiri ex proportionalitatibus ponderis est secundum unam proportionem musicarum nominatarum aut non nominatarum. Nominatarum vero aut secundum proportionem totius et quinque et est proportio tripli cum est proportio dupli adiuncta cum proportione addentis medietatem et ipsa est que dicitur proportio per quinque. Et secundum proportionem que est per totum et est dupla. Et secundum proportionem que est per quinque et est addens medietatem. Et secundum proportionem que est per quattuor et est addens tertiam. Et secundum proportionem addentem quartam postea non sentitur" (*Canon* 1.2.3.1. [Pavia, 1510], fol. 122r). For the interpretation given to Avicenna's list of proportions by his Latin medical commentators see above and note 22.

[47] "Et ego quidem miror quomodo proportiones iste per tactum discerni possunt: dico tamen quod ei est facile qui in gradu tangendi consuevit et proportionatur sonos per artem postque erit ei potentia cognoscendi musicam acquisita et comparabit factum per notum: homo etiam iste cum suam intentionem ad pulsum reduxerit humori poterit discernere proportiones per sensum" (ibid.).

[48] "Eget etiam musicorum scientia ut suam exerceat in cordarum sensu diligentiam et to-

and musical terminology in describing certain variations in pulse. He claimed that "the course and harmony of life resound in pulse," referred to meter and to "discordant" and "consonant" movements of pulse, and stated that the ordering was "to be known by reason of number."[49] He does not, however, appear to have made any general statement about the nature of the music of pulse or to have provided any descriptive account of it. Something very like outright skepticism was displayed by Averroes, who, after giving a highly compressed summary of Galen's contentions regarding musical proportion in pulse, observed drily "if it is as he says, it is remarkable."[50] That even Averroes was not prepared to reject the musicality of pulse out of hand is, however, indicated by his qualifying remarks to the effect that the difficulty of detecting the music of pulse might be due to the extreme brevity of pulse strokes as compared with musical notes.

The authority of Galen and Avicenna was, of course, in itself sufficient to secure the discussion of the topic of the music of pulse, and respect for the claim that the five musical proportions were inherent therein, by Peter of Abano and the Italian commentators on the *Canon* of Avicenna. Moreover, the existence of rhythm in the pulse was a matter of everyday medical experience. If rhythm were identified as music, a concept supported by excellent authority,[51] then the presence of some form of music in pulse was

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norum quo facilis pulsuum fiat illi doctrina et sensus venarum. Scias tamen minime harum ex necessitate scientiarum [i.e., the seven liberal arts] utilitatem in medicina oportere esse dicere: cum possit artem medicine homo sine his discere instrumentum ut peritissimus fiat medicus sine artis logice et disciplinarum scientia" (*Liber totius medicine* 1.3 [Lyon, 1523], fol. 83). As noted, Haly like Avicenna and others distinguished ten *genera* of pulse. It was the last two of these, termed in Constantinus Africanus's version of Haly's work "secundum concordiam" and "secundum numerum percussionis pulsuum" and in the version of Stephen of Antioch "ex quantitatis proprietate" and "ex numero pulsuum vene" that usually provided opportunity for musical discussion. This opportunity Haly, unlike Avicenna, did not take up. His discussion of the second category of pulse, "ex tempore motus," does contain some comments on *pondus* in pulse, but the term is apparently used simply to refer to the appropriateness or otherwise of a particular pulse for the age or condition of a patient (ibid., fols. 82r, 83r–v). One may contrast this with the explanation of Avicenna's definition of *pondus* in pulse provided by Gentile da Foligno: "notat pondus quod reperitur in pulsu ad proportionem ponderis reperti in sonis musicalibus" (*Canon cum . . . Gentilis expositione* [Pavia, 1510], fol. 122r).

[49] (*Carmina medica*, ed. Choulant, p. 30):

In pulsu resonant: tenor et concordia vitae,
Synzygiae vitalis amor, modulamina cordis
Intima temperies, animi secreta voluntas,
. . . . . .
Spissum constituit mora, quae discriminat arses,
Qui pede dactylico pessum declinat ab alto
. . . . . .
In quibus est motus discors vel consonus, unus
Ordo vel adversus, numeri ratione notandus.

[50] "Galenus dicit quod iste compositiones naturales non inveniuntur nisi secundum unam compositionum [*sic*] notarum musicarum proportionatarum et ordinatarum. . . . Et si ita est ut dicit mirabile est" (*Colliget* [Venice, 1549], fol. 70r).

[51] The *De musica* of St. Augustine is largely concerned with prosody; Cassiodorus (*Institutiones*

an indisputable physical reality. Furthermore, a venerable tradition derived from non-medical sources provided confirmation for the association of rhythms in the body in general and in pulse in particular with numerical harmonies in the soul and in the universe,[52] and for the belief that pulse was in some special way connected with the operation of the soul. Plato himself in the *Timaeus* had explicitly related music in the human soul to the numerical harmonies believed by him to govern the universe with the remark that (audible) music "is given to mankind for the sake of harmony," which "is related . . . to the movements of our soul by its circuits."[53] Indeed, the whole notion of man the microcosm necessarily implies that the world harmony must be participated in by man.[54] Calcidius commented on the passage just quoted without suggesting that the body was anything but a hindrance to the harmony of the soul[55]; but several other influential writers of late antiquity and the early Middle Ages contributed to the development of the notion that physical harmonies might be related to those of the soul. For example, Macrobius declared "in this life every soul is captivated by musical sounds . . . because it bears in the body the memory of the music which it knew in heaven."[56] Similar statements were made by Martianus Capella, who also placed in the mouth of Armonia a reference to the rhythms of pulse.[57] St. Augustine in his *De musica* expressed the belief that

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2.5.4.) and Isidore (*Etymologiae* 3.18.1) both stated that the parts of music were *harmonica, rhythmica* and *metrica.* Of the late medieval Italian writers on the music of pulse discussed in the present article, Peter of Abano certainly subscribed to the view of meter as a branch of music, since he included discussion of prosody in his commentary on the musical portion of the so-called *Problemata Aristotelis* (*Expos. Prob. Aris.* 19.39).

[52] On medieval beliefs regarding world harmony, see further Manfred F. Bukofzer, "Speculative Thinking in Medieval Music," SPECULUM 17 (1942), 165–180; Edgar de Bruyne, *Études d'esthetique médiévale* (Bruges, 1946), 1, Chapter I; Leo Spitzer, *Classical and Christian Ideas of World Harmony* (Baltimore, 1963).

[53] "quantumque per vocem utilitatis capitur ex musica, totum hoc constat hominum generi propter harmoniam tributum. Harmonia vero, id est modulatio, utpote intentio modificata, cognatas ut velut consanguineas habens commotiones animae nostrae circuitionibus" (*Timaeus a Calcidio translatus commentarioque instructus,* ed. J. H. Waszink and P. J. Jensen, *Plato latinus,* 4 [London, 1962], 47D, pp. 44–45).

[54] On the history of the idea of man the microcosm, see Rudolf Allers, "Microcosmus: from Anaximandros to Paracelsus," *Traditio* 2 (1944), 319–407, and George P. Conger, *Theories of Macrocosms and Microcosms in the History of Philosophy* (New York, 1922), pp. 1–52. Neither of these authors, however, devotes attention to the working out of the concept by medical writers, which appears to be not without significance in terms of the harmonies of pulse. See, for example, Gilles of Corbeil, *Carmen de pulsibus,* on the heart as the sun of the body ("sol microcosmi") (*Carmina medica,* ed. Choulant, p. 28).

[55] ". . . quia iuxta rationem harmonicam animam in superioribus aedificaverat naturalemque eius actum rhythmis modisque constare dixerat, sed haec exolescere animae ob consortium corporis necessario obtinente oblivione, proptereaque immodulatas fore animas plurimorum" (Ch. 267, *Plato latinus,* 4:272).

[56] ". . . in hac vita omnis anima musicis sonis capitur . . . quia in corpus defert memoriam musicae cuius in caelo fuit conscia" (*In somnium Scipionis* 2.3.7, ed. J. Willis [Leipzig, 1963], p. 105.

[57] "Pythagorei etiam docuerunt ferociam animi tibiis aut fidibus mollientes cum corporibus

the rhythms of the pulse and of breathing are produced by the operation of the soul, in which number, or rhythm, is inherent. In trying to distinguish the rhythms in the act of reciting from rhythms in the memory, he remarked: "if the soul sets in motion those numbers which we find in the pulsing of the veins, then the question is solved; for it is obvious that these rhythms are in operation, and memory is of no assistance to them." And again: "Although, indeed, I do not doubt that the various pulses of the veins and intervals of respiration are produced on account of the organization of (different) bodies; yet who would dare to deny that they are produced by the operation of the soul?"[58] Cassiodorus declared: "The science of music, therefore, is diffused through all the acts of our life for this reason: if, in the first place, we do the will of the Creator. . . . Indeed, whatever we say or whatever is inwardly moved by the pulsing of the veins is proved to be associated through musical rhythms with the power of harmony."[59] The last statement, pithy and readily quotable, was to have a long history. Those who repeated or paraphrased it included, among others too numerous to mention, Hrabanus Maurus, Vincent of Beauvais, and Marchettus of Padua, the theorist of the fourteenth-century Italian *ars nova.*[60]

General familiarity with the tradition that has just been summarized on the part of the medical writers under discussion can, no doubt, be assumed. However, although Peter of Abano cited Plato and St. Augustine in connection with the music of pulse, the main source of his musical ideas, and of those of Ugo, Jacopo and Pietro Vermiglioli was, as already indicated, the *De institutione musica* of Boethius. From this work, which, of course, frequently served as a standard textbook of music theory in the medieval schools,[61] they were able to draw not only their technical knowledge of music, such as it was,[62] but also a version of the Platonic philosophy of music which

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adhaerere nexum foedus animarum. membris quoque latentes interserere numeros non contempsi . . ." (*De nuptiis,* ed. Dick, pp. 490–491). See also note 44 above.

[58] "si anima hos numeros agit, quos in venarum pulsu invenimus, soluta quaestio est; nam et in operatione hos esse manifestum est, et nihil ad eos adjuvamur memoria. . . . Quamvis enim pro temperatione corporum varios venarum pulsus, et respirationis intervalla fieri non ambigam; tamen operante anima fieri, negare quis audeat?" (*De musica* 6.3.4., in *Opera omnia,* Benedictine edition, 1 [Paris, 1841], 1165).

[59] "Musica ergo disciplina per omnes actus vitae nostrae hac ratione diffunditur; primum, si Creatoris mandata faciamus et puris mentibus statutis ab eo regulis serviamus. quicquid enim loquimur vel intrinsecus venarum pulsibus commovemur, per musicos rithmos armoniae virtutibus probatur esse sociatum" (*Institutiones* 2.5.2, ed. R. A. B. Mynors [Oxford, 1937, 1961], p. 143).

[60] Hrabanus Maurus, *De universo* 18.4, PL 111:495–496; Vincent of Beauvais, *Speculum doctrinale* 18.10 (Strasburg, 1473); Marchettus of Padua, *Musica, seu Lucidarium in arte musicae planae* 1.3., ed. Gerbert, SEMS 3:66.

[61] Regarding academic instruction in music, see L. Ellinwood, "Ars Musica," SPECULUM 20 (1945), 290–299, and Nan C. Carpenter, *Music in the Medieval and Renaissance Universities* (Norman, Oklahoma, 1958).

[62] See Vecchi, "Medicina e musica," p. 11, note, for a critical evaluation of Peter of Abano's musical knowledge as displayed in his exposition of the Aristotelian *Problemata.* As already indicated, Peter dealt with music theory at greater length and in more detail than the other medical writers discussed in the present paper.

confirmed and served as an intellectual framework for the medical tradition regarding the music of pulse. According to Boethius "the whole union of our body and soul is by means of music. For the disposition of the body itself contains it; even so is the heartbeat (*pulsus cordis*) set in motion. . . . The condition of our soul and of our body seems in a certain way to be composed according to identical proportions."[63] Of the three categories — *musica mundana, musica humana,* and *musica . . . constituta . . . instrumentis* — into which Boethius divided music, the last was probably intended to embrace all music audible to human ears, including that of the human voice.[64] Presumably involuntary bodily rhythms might fall into the category of *musica humana,* the function of which was, according to Boethius, to "mix the disembodied life of reason with the body," to join the rational and irrational parts of the soul, and to "mingle together the elements of the body."[65] Precisely how Boethius conceived of *musica humana* is not clear; but since his concept of music was essentially mathematical and since his other two categories both involve physical movement and mathematical proportion, it seems probable that he regarded *musica humana,* too, as sharing in these qualities in some way.[66] Certainly, if one were to seek an example of soundless physical rhythms in man, the beating of the pulse might spring readily to mind.

In view of the foregoing, the preference of Peter of Abano, Jacopo, Ugo and Pietro Vermiglioli for a version of the Boethian threefold classification of music (adopted by all of them with the substitution of the term *musica organica* to describe the third category) is readily understandable,[67] as is the fact that Peter and Jacopo gave space to praise of the harmonies of the

[63] ". . . tota nostrae animae corporisque compago musica coaptatione coniuncta sit. Nam ut sese corporis affectus habet, ita etiam pulsus cordis motibus incitantur. . . . nostrae animae et corporis status eisdem quodammodo proportionibus videatur esse compositus" (*De institutione musica* 1.1, ed. G. Friedlein [Leipzig, 1867, repr. 1966], p. 186).

[64] Ibid. 1.2. On the inclusion of voice in the third category see G. Pietzsch, *Der Klassifikation der Musik von Boetius bis Ugolino von Orvieto* (Halle, 1929), pp. 43–44.

[65] "Humanam vero musicam quisquis in sese ipsum descendit intelligit. Quid est enim quod illam incorpoream rationis vivacitatem corpori misceat, nisi quaedam coaptatio et veluti gravium leviumque vocum quasi unam consonantiam efficiens temperatio? Quid est aliud quod ipsius inter se partes animae coniungat, quae, ut Aristoteli placet, ex rationabili inrationabilique coniuncta est? Quid vero, quod corporis elementa permiscet, aut partes sibimet rata coaptatione contineat?" (*De institutione musica* 1.2, ed. Friedlein, pp. 188–189).

[66] It has, however, recently been argued convincingly that in the *Consolation of Philosophy* Boethius gave extensive consideration to *musica humana* as a moral category. See David S. Chamberlain, "Philosophy of Music in the *Consolatio* of Boethius," SPECULUM 45 (1970), 80–97. Much valuable information about the entire subject of *musica humana* is assembled in this article.

[67] The Boethian classification of music was by no means the only one available to late medieval scholars, and its use implies deliberate choice. On the use of Boethian concepts of music in encyclopedic and musical works up to the fifteenth century, see Pietzsch, *Der Klassifikation,* passim, and Chamberlain, "Philosophy of Music," p. 87. On the subsequent history of these concepts, see John Hollander, *The Untuning of the Sky: Ideas of Music in English Poetry, 1500–1700* (Princeton, 1961). Later medieval authors seem often to have substituted the term *musica organica* for *musica instrumentalis* (itself an adaptation of Boethius's actual terminology), presumably in order to avoid possible ambiguity regarding the role of voice. Peter of Abano and Jacopo da Forlì subdivided *organica* into *naturalia* and *artificialia.*

universe.[68] It is, however, perhaps somewhat unexpected to find that Jacopo, Ugo and Pietro Vermiglioli all specifically stated that the music of pulse should be discussed not as *musica humana* but as *musica organica.*[69] This insistence is the more striking inasmuch as Jacopo da Forlì gave first place to *musica humana* of the body in a threefold definition of *musica humana* along Boethian lines,[70] while for Ugo and Pietro *musica humana* consisted solely of "due proportion of the parts and virtues of the human body,"[71] with no mention of soul or of the relationship of soul and body. Presumably none of the authors would have denied that pulse was in some sense a manifestation of *musica humana* as well as of *musica organica,* but only Peter of Abano, perhaps the most broadly learned of the group, made such an assertion or showed interest in exploring, even briefly, this aspect of the subject. In his case belief in a system of heavenly and bodily harmonies may well have been reinforced by his notorious devotion to astrology and to astrological medicine.[72] Certainly his discussion of the three categories of music reveals a concern, apparently not shared by the other authors, with the nature of the connection between these categories. For example, he named as parts of *musica humana,* the union of soul and body by mathematical harmonies; breathing; and, of course, pulse itself. But even Peter tied the role of *musica humana* in pulse very closely to the claim that the type of music found in pulse can also be recognized as *musica organica.* According to Peter: "But music principally and for us is inherent, as human life shows; for the human soul is connected to the body by a link of this kind. . . . On account of which *musica organica* is present in us, for this depends on the other kind (i.e., *musica humana*). . . . *Musica organica* depends on organic pulsation."[73] Sub-

[68] For example: "Namque et ipse mundus quadam armonia sonorum fertur esse compositus: et coelum ipsum sub armoniae modulatione revolvi" (Jacopo da Forlì, *Expositio . . . in primum Canonis* [Venice, 1547], fol. 132v.

[69] For example: "Humana [musica] autem est debita proportio partium et virtutum corporis humani. Organica autem est illa quam descripsimus" (Ugo of Siena, . . . *in prima fen primi Canonis* [Ferrara, 1491], sig. G3^{v}.

[70] "Humana vero consistit indebita [*sic*] proportione partium componentium humanum corpus inter se, et organicorum ad organica, consimilium ad consimilia virtutum animae inter se et ad ipsum corpus. Organica autem proportionem vocum concernit et sonorum organis sonoris cantatorum, quorum quaedam sunt naturalia ut instrumenta vocalia, quaedam artificialia, ut cythara, psalterium, symphonia, tuba, etc. In proposito autem intelligit Avicenna de 3, quae est ista quae est superius descripta" (*Expositio . . . in primum Canonis* [Venice, 1547], fol. 132v).

[71] See note 69 above and Vermiglioli, *De pulsibus* (Perugia, 1480), sig. bi^{v}.

[72] On Peter's astrological interests, see, in addition to the works named in note 5 above, P. Duhem, *Le système du monde: Histoire des doctrines cosmologiques de Platon à Copernic* (Paris, 1913–1959), 4:229–263; Lynn Thorndike, "The Latin Translations of the Astrological Tracts of Abraham Avenezra," *Isis* 35 (1944), 293–302; and the same author's "The Three Latin Translations of the Pseudo-Hippocratic Tract on Astrological Medicine," *Janus* 49 (1960), 103–129.

[73] "sed musica principaliter et pro nobis est insita: ut ostendit vita humana: nam anima humana tali connectitur corpori copula. . . . Propter quod ex musica nobis inerit organica: etiam cum hec dependeat ab alia. Nam in aliis motibus corporis quantativis, sicut in voce: aut in organis ortis poterit reperiri suo modo. per viam namque cognitionis et effectus musica organica dependet ex organica pulsuali" (*Conciliator* [Venice, 1496], fol. 121v).

sequently he added that the *musica organica* of pulse is related to its *musica humana* as a part to the whole.[74]

It is not necessary to assume that the avoidance of extended discussion of *musica humana* was due to any hesitations about the validity of this category of music. Professors as learnedly Aristotelian as Peter of Abano, Jacopo da Forlì and the rest[75] were of course fully aware of the modifications of traditional concepts of world music and harmonies in the soul to be found in the *De caelo* and *De anima* of Aristotle.[76] Aristotle had in fact denied the sonority of the music of the spheres and the notion of the soul as a self-moving number; but to some extent his ideas could be and were harmonized with the Boethian or Platonic tradition.[77] For example, as Engelbert, abbot of Admont (d. 1331), pointed out in his *De musica,* Aristotle's rejection of the idea that the planets emitted sounds in no way affected the truth of their relationship according to proportion and measure, qualities which continued to be thought of as pre-eminent components of music.[78] Moreover, Aristotle had not totally negated harmony in the body and appeared in the *Politics* to allow some validity to harmony in the soul.[79] *Musica humana,* like world music itself, was not therefore destroyed by Aristotelian criticism. Evidence that *musica humana* could remain a valid category for an author thoroughly acquainted with Aristotle's views on the music of the spheres and on number in the soul is to be found in the musical treatise of Engelbert of Admont just alluded to. Not only did this writer use the Boethian triple classification of music; he also provided a list of books valuable for the study of *musica*

[74] "ostensum sit in pulsu musicam saltem humanam reperiri. Et musica univoce magis: aut saltem analogice: ut de tribus particularibus musicis: ut superius innotuit predicatur tamquam genus. Unde dictum est quod altere species et doctrine sub alteris collocantur: quoniam sonorum proportiones sub illis que pulsuum naturaliter continentur magis si in ipso musicam volumus observare humanam. et si in sonis organicam cum hoc tunc velut pars contineatur in toto" (ibid., fol. 122r).

[75] On the Aristotelianism of Peter of Abano, Jacopo da Forlì, and Ugo of Siena, see J. H. Randall, Jr., *The School of Padua and the Emergence of Modern Science* (Padua, 1961) pp. 25–39.

[76] *De caelo* 2.9; *De anima* 1.4. Both passages were cited by Peter of Abano (*Conciliator* [Venice, 1496], fols. 120r, 121v).

[77] Roger Bacon described somewhat skeptically the attempts of "the more subtle philosophers" to harmonize the statements of Aristotle and Boethius regarding the music of the spheres (*Opus tertium,* ed. Brewer, Ch. 59, p. 230).

[78] "quamvis Aristotelis secundo libro coeli et mundi, evidentibus rationibus destruxerit et negaverit sonos corporum superiorum, licet alias proportiones motuum et magnitudinum corporum ipsorum et distantiam ac spatiorum inter ea non negaverit" (*De musica,* ed. Gerbert, SEMS 2:288). On Engelbert's life and works, see George B. Fowler, *Intellectual Interests of Engelbert of Admont* (New York, 1947).

[79] In the course of denying that the soul is "a kind of harmony" Aristotle remarked in passing, "It would be more appropriate to call health a harmony, and in general the powers of the body, rather than of the soul" (*Aristotle's De Anima in the Version of William of Moerbeke and the Commentary of St. Thomas Aquinas,* trans. Kenelm Foster, O.P., and Silvester Humphries, O.P. [New Haven, 1951], 1.4.137, p. 115. In discussing the place of music in education in Book 8 of the *Politics,* he indicated his belief in the power of music to affect the soul and call forth a certain response from it (*Politics* 8.5.9, trans. H. Rackham, Loeb Classical Library, p. 661).

humana,[80] a list that is of particular interest in the present context because of the possibility that it may reflect its compiler's studies at a north Italian center of medical learning in the 1270s and 1280s.[81] The authorities named are as follows: Aristotle in Book I of *De anima* and in *De animalibus*[82]; Galen; Avicenna in his medical works; Algazel in his works on natural things (*in suis naturalibus*)[83]; and Constabulus (*sic*) in the book *De spiritu et anima.*[84]

Perhaps the most striking aspect of the list is its pronounced medical or physiological emphasis. For its author, *musica humana* of the body, at any rate, was plainly a reality of some importance.[85] It may be surmised from his inclusion of the treatise of Costa ben Luca that he would have associated with *musica humana* of the body not only the beating of the pulse and breathing, but the whole concept of the role of *spiritus* in human physiology. How closely *spiritus* or *spiritus vitalis* could be associated with pulse on the one hand and the soul on the other is well illustrated in Costa ben Luca's work.

[80] *De musica,* ed. Gerbert, SEMS 2:288.

[81] *De musica* was written toward the end of Engelbert's life, but in the preface the author stated that he was returning to the studies of his youth. Although the technical material making up the body of the treatise may well be the fruit of a monastic training in music (a suggestion I owe to Professor Nino Pirrotta), it is conceivable that the material on the philosophy of music at the beginning may recall Engelbert's early studies in logic and philosophy at Padua under William of Brescia, later himself a celebrated physician (Fowler, *Intellectual Interests,* pp. 21–22).

[82] Probably the reference is to *De motu animalium,* in which it is explained that the soul is the final cause of the body's movement and the heart, the organ of soul, the efficient cause. A set of questions on *De motu animalium* is contained in a thirteenth-century manuscript (367) of the library at Admont, for which Engelbert collected many books; J. Vennebusch, ed., *Ein anonymer Aristoteleskommentar des XIII. Jahrhunderts. Questiones in tres libros de anima* (Paderborn, 1963), p. 7.

[83] The reference is presumably to Algazel's *Physica* and or *Metaphysica* (that is, to portions of the *Kitāb tahāfut al-falasifa* of Al-Ghazzali, d. 1111), both of which were to be found in the library at Admont (Admont, Biblioteca Monasterii, MSS 318, 14c, and 487, 13–14c; see TK 1611 and *Aristoteles latinus,* 1:254). These portions of Al-Ghazzali's work have been printed as Ghazzali (Algazel), *Logica et philosophia* (Frankfurt, 1969), being a reprint of the edition of Venice, 1506, with the addition of an introduction by C. H. Lohr) and, in part, in J. T. Muckle, ed., *Algazel's Metaphysics, A Medieval Translation* (Toronto, 1933). Al-Ghazzali does not appear to have introduced explicitly musical concepts into his work, but he discussed at length the human soul, its relation to the body, and its role in producing such phenomena as dreams and miracles (see Muckle, *Algazel's Metaphysics,* pp. 172–197). The union of soul and body was of course a standard sub-division of *musica humana.*

[84] That is, the treatise *De differentia animae et spiritus* of Costa ben Luca, or Qusta ibn Luqa, a Greek Christian philosopher and physician who flourished at Baghdad and died ca. 912. Thorndike, *History of Magic,* 1:657, cites another instance of the corruption of his name into Constabulus. The work is edited in C. S. Barach, *Excerpta e libro Alfredi Anglici De motu cordis item Costa-Ben-Lucae De differentia animae et spiritu* (Innsbruck, 1878); it is not to be confused with the somewhat similarly titled *De spiritu et anima* printed with the works of St. Augustine by Migne (PL 40:779–844) and variously attributed. The work included in Admont MS 367 under the title *De differencia spiritus et anime* (Vennebusch, *Ein anonymer Aristoteleskommentar,* p. 7) is presumably that of Costa ben Luca.

[85] Engelbert's definition of *musica humana* stressed its physical aspects. He omitted *musica humana* of the soul entirely (conceivably in deference to *De anima* 1.4) and spoke only of "proportionibus contrariarum qualitatum et diversarum ac dissimilium partium humani corporis inter se, et rursus unionis animae ad ipsum" (*De musica,* ed. Gerbert, SEMS 2:288).

According to the latter author, *spiritus* is a subtle corporeal substance distributed through the body by the pulsation of the veins (*sic*) and itself directly responsible for life, breathing and pulse; but soul, life's incorporeal *causa longior,* can act upon the body only through the intermediary of *spiritus.*[86] But if the links between the soul, *spiritus* physiology, pulsation, breathing and *musica humana* might reasonably be explored in a study of the philosophy of music that made use of medical texts,[87] this did not necessarily mean that such connections would be thought of as suitable topics for detailed discussion in works on medicine. The reality of the connections in question was no doubt accepted by those medical writers on the music of pulse who made use of a definition of music including the category of *musica humana;* but, as Ugo of Siena reminded his readers, when professors of arts and medicine discussed pulse "as physicians" they were expected to confine their attention to sensible phenomena.[88]

The failure of Ugo, Jacopo da Forlì and Pietro Vermiglioli to explore pulse as *musica humana* and their concentration, along with Peter of Abano, on pulse as *musica organica* is probably therefore due simply to the belief that only perceptible pulse rhythms concerned them as physicians, and to the further assumption that the only possible way of analyzing the musicality of such rhythms was according to the laws of sensible music. Yet the notion that

[86] Costa ben Luca, ed. Barach, p. 121. In general, medical writers tended to stress the corporeal nature of *spiritus*, philosophers and theologians its links with divinity and the soul. See G. Verbeke, *L'Evolution de la doctrine du Pneuma, du stoicisme à S. Augustin* (Paris and Louvain, 1945) for the history of the concept. Costa ben Luca appears to combine both approaches; cf. note 37 above.

[87] According to Gretchen Finney, Marsilio Ficino, Pico della Mirandola and others later developed the idea, probably drawn by them from Hermetic sources, that *spiritus* in man is in some way specially responsive to or a channel of world harmonies, and that celestial *spiritus* can be transferred to man by music ("Music: The Breath of Life," *Centennial Review* 4 [1960], 179–205). I have found no trace of this idea in the medical discussions of the music of pulse reviewed in the present article. It may be added that at least one fourteenth-century Italian medical writer vigorously denied, apparently in the face of general opposition, the existence of any special connection (more than with other organs or functions of the body) between soul and pulse: "Dico ergo quod Galenus et omnis fere medicorum schola dicit [*sic*] quod causa dilatationis cordis et arteriarum qui dicitur pulsus est virtus cordis . . . . Dicunt etiam quod hec virtus non solum est causa pulsus sed generationis spiritus et dationis vite: et huius per transmissionem spiritus vivificantis ad membra et quod hec virtus est virtus anime: et quod pulsus est prima operatio que est in corpore ab anima . . . . Dicemus ergo in hoc quod fere oppositum est quod medici attestantur suis libris . . . . Nos autem dicimus quod calor est principaliter causa efficiens dilatationis, non anima vel anime virtus nisi sicut quidam adiecta perfectio subaccidit tamen et quod ipse sit causa finalis" (Turisanus [Pietro Torrigiano de' Torrigiani, d. ca. 1320], . . . *plusquam commentum in Microtegni Galieni* . . . [Venice, 1512; at the New York Academy of Medicine], fols. 47v–48r). This work became a required text in the *studium* of Padua. See *Statuta dominorum artistarum achademiae Patavinae* (Padua, n.d.; Hain 15015), statutes of 1465 with revisions of 1495, 2.16, fol. 24v. The substitution of innate heat for "virtue of the heart" as the immediate cause of pulse represents a rejection of Galenic in favor of Aristotelian physiology.

[88] "Cum igitur loquendo de pulsu ut medici: debeamus dicere de sensibilium [*sic*]" (*In prima fen primi Canonis* [Ferrara, 1491], sig. G4^{v}).

musica organica could be thought of as embracing any sensible rhythm, whether or not sound was involved, evidently generated some hesitation.

Only Peter of Abano seems to have been at ease in classifying the music of pulse as true *musica organica,* perhaps because, as already noted, he was committed to the concept of meter as a branch of music.[89] Gentile, Jacopo, Ugo and Pietro Vermiglioli all introduced significant qualifications. Gentile would claim only that in pulse there is "something similar to that which is considered in music."[90] Gentile appears to have been the most skeptical of the group, but the others, too, made similar admissions. According to Ugo of Siena, "It is to be understood that in pulse are found dispositions which should be considered by the physician similar to the dispositions found in the consonances and tones which should be considered by the *musicus,*" a statement that was repeated almost word for word by Pietro Vermiglioli.[91] Only Jacopo da Forlì explained in so many words why such a major qualification had to be introduced, but it seems likely that similar reasoning lay behind the opinions of the others. Jacopo was evidently unwilling to classify phenomena not involving sound audible to human ears as true *musica organica.* For him rhythm, proportion, and meter, were not enough. As he said, "It is to be noted that true consonance is not to be found there, because there is neither sound nor tone in it [i.e., pulse], but its likeness, or proportion in consonance, is to be found."[92] Whether consciously or not he was echoing Roger Bacon, who, shortly after defining pleasing sound as an essential component of music, had written:

> [The motions of the pulse] are produced according to due proportions, which music uses, but the proportions there existing cannot be referred to hearing but only to touch, and therefore they are not part of the science of music. Yet the science of those proportions is subjected and subalternated to music. For one can never be a good physician and perfect in consideration of pulse without being instructed in musical proportions, as medical authors teach, among them Haly in the book *De regimine regali,* and many others.[93]

[89] See notes 29 and 51 above.

[90] "hoc est quod vult dicere Avicenna cum dicit quod in pulsu reperitur natura musice, id est, aliquid simile ei quod consideratur in musica quemadmodum ars musice" (*Primus Avic. Canon. cum . . . Gentilis expositio* [Pavia, 1510], fol. 122r).

[91] "intelligitur quod in pulsu reperiuntur dispositiones a medico considerande similes dispositionibus repertis in consonantiis et tonis que considerande sunt a musico" (Ugo da Siena, . . . *in prima fen primi Canonis* [Ferrara, 1491], sig G3^{v}). See also Vermiglioli, *De pulsibus,* sig. bi^{v}.

[92] "Notum tamen est quod ibi non est consonantia proprie, quia non est sonus nec vox in eo, sed similitudo illius vel proportio in consonantia reperta, et hoc intelligit Avicenna in littera" (*Expositio . . . in primum Canonis* [Venice, 1547], fol. 132v).

[93] "Alii vero motus, qui non possunt conformari sono proportionibus convenientibus, ut fiat completa delectatio sensibilis, non sunt de scientia musicae. Aliqui tamen motus alii habent consimiles proportiones, sed non possunt sono et gestui conformari in unam delectationem, ut sunt motus pulsus. Fiunt enim secundum debitas proportiones, quibus musica utitur; sed ibi existentes non possunt referri ad auditum, sed respectu tactus tantum; et ideo non sunt de scientia musicae. Scientia tamen eorum est subjecta et subalternata musicae. Nam nunquam bonus erit medicus et perfectus in consideratione pulsuum, nisi sit instructus in proportionibus musicae, sicut docent auctores medicinae, ut Haly in libro De Regimine Regali, et multi alii." (*Opus tertium,* ed. Brewer, ch. 59, p. 232). The passage of Haly alluded to has already been cited.

The notion of pulse as *musica organica* was further undercut by the skepticism of some of the writers regarding Avicenna's claim that the physician could expect to be able to identify the musical proportions in pulse by touch. Even Peter of Abano, who energetically defended the music of pulse against doubters (remarking that they did not need others to denigrate them, since they denigrated themselves),[94] was obliged to admit that the practical difficulties in the way of discerning its measures were very great.[95] Gentile da Foligno observed that Avicenna did not claim to have recognized the musical proportions in pulse by personal experience and evidently knew of them only in theory, not practice.[96] Ugo of Siena said bluntly that the labor of understanding or discerning the musical proportions of pulse was more trouble than it was worth in terms of any possible medical utility.[97]

The reader of these accounts of the music of pulse is left facing an apparent paradox. The authors claimed that they supported, and by their detailed discussion all of them except Gentile da Foligno certainly drew attention to, the concept. Even the critical Gentile was unable either to ignore the topic entirely or dismiss it out of hand. Furthermore, all of them except Gentile plainly believed at least a modicum of musical knowledge to be desirable for a physician. Yet in one way or another all of them except perhaps Peter of Abano radically reduced the significance of the music of pulse as adumbrated in their sources, whether by ignoring it as *musica humana,* by stating that it had merely the likeness of *musica organica,* or by denying its perceptibility, or by some combination of the three. Ultimately, their criticisms were practical and derived from experience, being based on common-sense conclusions about music and about pulse. Yet they were unwilling to abandon an established branch of *theoria* solely on account of practical considerations. Thus, although modified, the musicality of pulse, a concept with decidedly neo-platonic overtones, continued to be asserted by physicians trained in Aristotelian natural philosophy.

No doubt the authority of Galen and Avicenna, and the need to provide an explanation of some kind for the rhythms of pulse was in large measure responsible for the continued vitality of its music. But, as noted at the beginning of the present article, the fourteenth and fifteenth-century medical discussions of the music of pulse were produced in an academic milieu in which the ancient tradition that the physician should be learned in the liberal arts was institutionalized in faculties "of arts and medicine." The connection was not merely an institutional one; at the *studium* of Padua in

[94] "non opus hos ab aliis vituperari cum se vituperent ipsos" (*Conciliator* [Venice, 1496], fol. 121r).

[95] "Pulsus scientia gravis est et difficilis et cognitio ipsius cum magna suscipitur difficultate" (ibid., fol. 122r). The phrase is a quotation from Haly Abbas.

[96] "notandum quod per hec que dicit Avicenna colligitur quod ipse de istis proportionibus pulsuum modicam habuit cognitionem per experientiam sed solum per intellectum" (*Canon cum . . . Gentilis expositione* [Pavia, 1510], fol. 122r).

[97] "Maior enim est labor in faciendo se doctum ad hec discernenda quam utilitas in hec cognoscendo" (*in prima fen primi canonis*, sig. G5r).

the fourteenth century, for example, natural philosophy, astrology, and in all likelihood the other quadrivial arts as well were taught by doctors of medicine.[98] Moreover, many of the students of arts at such university centers as Bologna, Padua and Perugia were, no doubt, ultimately bent upon a medical career. In such circumstances, it does not seem improbable that university instruction in music and the other arts of the quadrivium may have been to some extent geared to medical interests (as definitely appears to have been the case with astrology). One might expect, at any rate, a predisposition to demonstrate the relevance of the arts to medicine wherever feasible. At the same time, music itself played a major part in the cultural life of the north Italian university centers. It has been remarked that some of the cities most noted for their faculties of arts and medicine, again Bologna, Padua, Perugia, were also major centers of musical activity and innovation.[99] Although formal academic instruction was no doubt largely confined to music considered as one of the mathematical arts, evidence has been collected to suggest that some learned physicians at Bologna and Padua were themselves enthusiastic patrons of the *ars nova*.[100] Conceivably, therefore, some at least of the writers under discussion — perhaps Peter of Abano and Jacopo da Forlì are the most likely candidates — may have had personal connections with musical circles. In any case, the nature of their treatment of the subject of the music of pulse indicates that the quadrivial art of music was considered of real, if minor, significance in medical education in the universities of northern Italy in the fourteenth and fifteenth centuries.

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[98] Siraisi, *Arts and Sciences,* Chapters III and IV.

[99] See Nino Pirrotta, "Due sonetti musicali del secolo XVI," in *Miscelánea en homenaje a Mons. Higini Anglès,* Consejo Superior de Investigaciones Cientificas (Barcelona, 1958–61), 2:660.

[100] Learned physicians whose participation in and or patronage of musical activity has been demonstrated include Giovanni della Luna (fl. 1298–1303) of Bologna; Dino da Olena, probably a pupil of Dino del Garbo, of Bologna; Giorgio Anselmi (fl. 1343–1349) of Bologna, and Marsiglio di Santa Sofia of Padua (ibid., 2:657, 661).