Bruce R Smith. *The Acoustic World of Early Modern England.* Chicago: University of Chicago Press, 1999.

Within the Wooden O

In a culture that favored conspicuous display—in the façades that buildings turned to the street no less than in the garments in which people presented themselves for public viewing—London's South Bank theaters stood out by their difference. On the outside they presented bare walls. City views by Norden, Visscher, and Hollar may vary in certain details about the amphitheaters, but all of them show plain, flat exteriors relieved only by small windows. It was within the narrow depths of London's best houses, Fynes Moryson notes, that the city's real splendors were to be found (1617: KKK4). The South Bank theaters present a similar case: they were built not to display but to contain. Inside, not outside, provided their very reason for being. What they contained, most obviously, was spectacle: many-sided galleries, surrounding the thrust stage as a focal point, gave much better sight-lines than a square structure would for viewing not only the play but other members of the audience. Extrapolating from the Fortune contract, no one in the Fortune or the 1599 Globe was more than fifty feet from an actor standing downstage, at the focal center of the space. What the theaters contained, less obviously, was sound. That same actor, standing at the center of the visual space, stood also at the center of an aural space. "Sit in a full Theater," says the delineator of "An excellent Actor" in Sir Thomas Overbury's expanded collection of characters, "and you will thinke you see so many lines drawen from the circumference of so many eares, whiles the *Actor* is the *Center*" (1616: M2). The South Bank amphitheaters were, in fact, instruments for producing, shaping, and propagating sound.

Evidence that theaters were thought about as sound-devices is not hard to come by. For special occasions it was common for large households—schools, colleges, the inns of court, the court of the realm—to erect temporary theaters inside an existing hall. Alan Nelson has reconstructed the elaborate timbered structure that was erected within the hall of Queens' College, Cambridge, for putting on college plays each season beginning in 1546 and continuing into the 1640s. Not only a stage but galleries for spectators were part of the structure, made out of marked timbers that were dismantled and stored away at the end of each season (1994: 16–37). In effect, the

theater was not so much a building in itself as a large, free-standing object that could be erected inside a preexisting building. Its multiple planes and all-wood construction would have provided richer resonance than the masonry room itself. Orazio Busino's description of the pre-Jones banqueting house at Whitehall likewise suggests a box-within-a-box. The external brick walls contained an interior structure of wood and plaster—complete with colonnades and a coffered ceiling covered with *putti*—that offered not only visual interest but the resonators and baffles required for good sound distribution in a large space (1995: 137).

Theoretical justification for such structures, if any were needed, could be found in Vitruvius, who designed the ideal theaters in *De Architectura* first and foremost around sound. Bronze vases were placed at regular intervals along the rising tiers not just for ornament but to catch sound waves of particular frequencies and amplify them. These vases worked like water glasses, filled to various depths, in a glass organ: when touched, each one produced a different pitch (5.3–5 in 1931, 1: 262–283). A Vitruvian theater could be played by the actors as if it were a musical instrument. According to Daniel Barbaro's influential commentary on Vitruvius (it was Barbaro who turned Vitruvius' *scaenae frons* into a proscenium arch with illusionistic scenery beyond), architecture presents a convergence of all the arts—including rhetoric. When it comes to theaters, an architect needs to be both a natural philosopher and a musician: "paying attention to motions of the voice, observations about numbers, and the practicalities of sound (which I take to be the principles of mathematics and the rules of music), he should shape theaters accordingly, so that the space resonates all the more." The shape of that space, Barbaro insists, should approximate the shape of sound itself: a sphere (Vitruvius 1567: 1–2, 172, my translation). Vitruvius's ancient precepts and the exigencies of early modern practice are reconciled in Sebastiano Serlio's *Architettura* (1545), which turns Vitruvius' designs for permanent stone-built structures into a wooden contraption that can be set up inside a great hall and taken down again (Smith 1988: 84–85).

Theaters as instruments for the production and reception of sound ask to be thought about in different ways than theaters as frames for the mounting and viewing of spectacle. What were the acoustic properties of the instruments themselves? What were they made of? What kinds of sounds could they produce? What constituted the repertory of sounds on which playwrights and actors could draw? What qualities of the human voice figured in this repertory? To answer such questions let us inspect the instrument itself before we attempt to inventory the range of sounds, first artificial, then human, that could be played on—and within—the largest, airiest, loud-

est, subtlest sound-making device fabricated by the culture of early modern England.

WOOD, PLASTER, THATCH, MORTAR, AIR

When the Lord Chamberlain's Men were forced to vacate The Theater in Shoreditch in April 1597, they took with them their playbooks, their props, and their costumes. Two years later, after playing in rented quarters at The Curtain, they went back and got their resonator. Laying legally dubious claim to the building their father had put up on leased land, Cuthbert and Richard Burbage dispatched a builder, Peter Streete, to dismantle The Theater's wooden frame, transport it across the river, and re-erect it on land they had just leased on the South Bank (Gurr 1996: 292–293). In that act the Burbages were not just moving a building: they were transporting part of the company's professional equipment, like viol-players bringing their instruments with them to a concert. The 1599 Globe was an instrument to be played upon, and the key element in that instrument was wood. The oak timbers that framed the structure were a foot square and up to thirty feet long. The 1599 Globe was not just an instrument but a *vintage* instrument: by the early seventeenth century fire regulations and the rising price of timber meant that most new theaters, in the City at least, were built of brick (Gurr 1992: 141).

As a device for propagating sound, the 1599 Globe was extraordinarily efficient. In its tubular shape it approximated the shape of the human vocal tract. In a theater, as in the human body, production of sound requires three things: (1) an energy source, (2) something that vibrates in response to that energy, and (3) something that propagates those vibrations into ambient space. In the case of the human body, the energy source is the lungs, the vibrator is the larynx, and the propagator is the throat, mouth, and sinuses (see fig. 1.1). If the structure of the Globe is imagined as the vocal tract, the energy source was either lungs (for vocal sounds and wind instruments) or arms and hands (for plucked and bowed instruments, drums, and sound effects). The vibrator was the stage. The propagator was the architectural surround. In the production of "theatrical" sound, the building itself functions as the larynx, mouth, and sinuses do in the production of purely vocal sound: they give the sound its harmonic profile and influence its volume. While one might assume that those qualities of timbre and volume were lost forever when the structure was pulled down sometime after 1642, evidence does exist for reconstructing the Globe as a distinctive acoustic space. Three factors deserve consideration: (1) the materials out of which the theater was built, (2) the size of the listening space, and (3) its shape.

The primary materials out of which the Globe was constructed—wooden beams, plaster over lath, and wooden boards over joists—all return to the ambient air a high percentage of the sound waves that strike them. Within the frequency range of adult male voices (with a mean of 120 cycles per second) plaster over lath absorbs only about 14 percent of these waves of energy, giving it an "absorption coefficient" of 0.14. That is to say, plaster over lath reflects back 86 percent of the soundwaves that strike it. Within the frequency range of adolescent male voices (with a mean of about 240 cycles per second) plaster over lath absorbs even less, about 10 percent, giving it a coefficient of 0.10 or a reflectivity of 90 percent (Egan 1988: 52; Fry 1977: 44; Curry 1940: 48–62). The 10 to 14 percent of sound that enters the plaster is due to the air space between and behind the laths: plaster over brick, by contrast, turns back fully 99 percent of the sound waves that strike it. In comparison with plaster, wood is more absorbent of sound, but with sufficient air space behind, beneath, or within, wood can act as a resonator, just as it does in a guitar body. Wood boards over joists in a structure like the stage of the Globe reflect about the same percentage of sound waves as plaster over lath: 85 percent within the frequency range of male voices, 90 percent in the range of adolescent voices (B. J. Smith 1971: 48).

The result of these reflections from wood and plaster within the wooden O is a plenitude of what acoustical science calls "standing waves"—stationary patterns of vibration formed by many reflected sound waves, coming from many different surfaces, all superimposed on one another (Handel 1989: 33). Auditors experience these steady waves of energy as full, present sound, uniform throughout the listening space. The effect is enhanced even by the energy the wood and plaster do happen to absorb. As a medium for transmitting sound waves, wood is highly "damped": in comparison to, say, metal, wood more rapidly loses the vibrations that strike it. At the same time, wood is more rapidly excited in the first place than metal is, and it has the distinctive characteristic of reaching a high amplitude across a wide range of frequencies. Metal reaches maximum amplitude at only a narrow range of frequencies and takes longer to get there (Handel 1989: 551; Fry 1979: 24–27). Vibrations in wood may be short in duration, but wood catches the harmonic complexities of ambient sound. In effect, the stage of the Globe acted as a gigantic sounding board: made of reverberative material, it translated vibrations in the air above into standing waves in the air underneath, producing a harmonically rich amplification of the voices of actors positioned on top. In this respect it worked like the wooden choir stalls in England's churches. Some of these structures positioned ceramic vessels under the floor boards—medieval versions of Vitruvius's

vases—and provided microphones of a sort in circular openings along the sides close to the stone floor.

Within the acoustic environment of the Globe there were only three highly sound-absorbant materials: the arras, the surface of the yard, and human bodies. In the lower-frequency range of male voices, heavy woven fabrics absorb about the same amount of sound as plaster over lath and boards over joists: just 14 percent. But for higher-frequency adolescent voices, they can absorb as much as 35 percent. In square footage, of course, the arras occupied only a small portion of the available space. Much more significant were the surface of the yard and the density of spectator-auditors. If the yard of the Globe resembled at all the yard of the excavated Rose—15 inches deep in hazlenut shells, ash, and clinker—it could have soaked up as much as 60 percent of the sound waves striking its surface. Clothed human bodies are also highly absorptive of sound, stopping up to 80 percent of the sound waves that strike them. As with the arras, so with clothed bodies: the higher the frequency, the greater the absorbency (Egan 1988: 52–53). Human bodies, then, presented the greatest obstacle to the efficient propagation of sound. Fortunately, the size and shape of the Globe mitigated that damping effect.

We tend to think of early modern theaters as having been small and crowded, but the 1599 Globe apparently offered a volumetric listening space per auditor that actually surpasses that of modern theaters. Assuming dimensions projected from partial excavacations of the site in 1989, the Globe was a twenty-sided polygon 99 feet in diameter (Orrell 1990: 95–118; 1997: 50–65; Blatherwick 1997: 66–80) (fig. 8.2). Assuming that this polygon was raised to the same height as the galleries in the Fortune contract, we have a structure 32 feet high that approximates the shape of a cylinder. To arrive at an estimate of the volume of that cylinder we can multiply the square of the radius (49.5 feet × 49) by the height (32 feet) by pi (3.14), to arrive at a volume of 243,714 cubic feet. Deducting the space occupied by the tiring house and the "cellarage" under the stage, we arrive at a listening space of about 231,028 cubic feet.* By modern standards, this

*Estimating the dimensions of the tiring house and the area beneath the stage is tricky, of course, since physical remains are lacking and documentary evidence is subject to different interpretations. Assuming, however, from The Fortune contract that the stage extended halfway into the yard and had a width of 43 feet and a depth of 27 feet 6 inches, and assuming further that it was 5 feet high, we can calculate the volumetric space beneath the stage as 5,913 cubic feet (43 × 27.5 × 5). If the tiring house, like the one at The Fortune, was built into the framework of the galleries at a depth of 11 feet 3 inches (allowing 3 inches for the thickness of the walls) and ended at a gallery or balcony 14 feet above the stage, then it took up another 6,773 cubic feet (43 × 11.25 × 14). Deducting these two figures from the overall volume (243,714 − 12,686), we arrive at a listening space of 231,028 cubic feet.

is a very large space indeed. The Olivier Theatre in London, for example, contains just 158,922 cubic feet, and the Barbican Theatre even less: just 48,854 cubic feet (Mulryne and Shewring 1995: 120–123).* What may be most remarkable about the 1599 Globe, however, is not the sheer volumetric size of the place but the volume of listening space per patron. Modern standards of acoustic engineering suggest an optimal space of about 98.9 cubic feet per person for speech, with 173 cubic feet as a maximum (Smith 1971: 44). If the capacity of the Globe was 3,000 people, then the listening space per person works out to 77.01 cubic feet—somewhat less than in most modern theaters. Compare the 137 cubic feet per person for the 1,160 listeners in the Olivier (Mulryne and Shewring 1995: 120). When, however, the Globe operated at less than full capacity—and Henslowe's diary suggests that most of the time it probably did—the listening space per auditor would have approximated or even exceeded modern spaces. Transferred to the Globe, the Olivier's 1,150 auditors would find themselves surrounded by 50 percent more listening space, 201 cubic feet per person to the Olivier's 137.

Among the factors that gave the 1599 Globe its distinctive sound, the most crucial was the structure's shape. The standing waves that create harmonically rich, in-filling sound are produced by reflections off many surfaces. In general, the more surfaces there are, the fuller the acoustic effect. As a twenty-sided polygon, the Globe provided plenty of reflective surfaces. The interplay of sound waves within the polygon can be appreciated by looking at the theater from two angles: from above (see fig. 8.2) and from the side (fig. 8.1). In each case an actor is imagined as standing at the rear of the stage, just in front of the tiring house. Figure 8.2 shows in gray the area where the actor's broadcast speech would be optimal, an area 70 degrees to his left and 70 degrees to his right. Although speech sounds at low frequencies (less than 500 cycles per second, the region of most vowels) are diminished very little to a speaker's sides or even to his rear, higher-frequency sounds (more than 4,000 cycles per second, the region of most consonants) tend to fade out in these areas (Egan 1988: 83). Dotted lines in Figure 8.2 show how concave surfaces like those of the Globe would have served to focus sound in the center of the yard, filling the space with standing waves. (With sound waves, as

*Comparing the volumetric listening spaces of these theaters with the Globe is, in more ways than one, not straightforward, since both the Olivier and the Barbican have an enormous fly-tower above the stage that is not reckoned in measures of the listening space. However, most of the sound waves that travel up into the fly-space are not reflected into the auditorium, and much of the speaking in these theaters takes place on the platform thrust out from under the fly-tower.

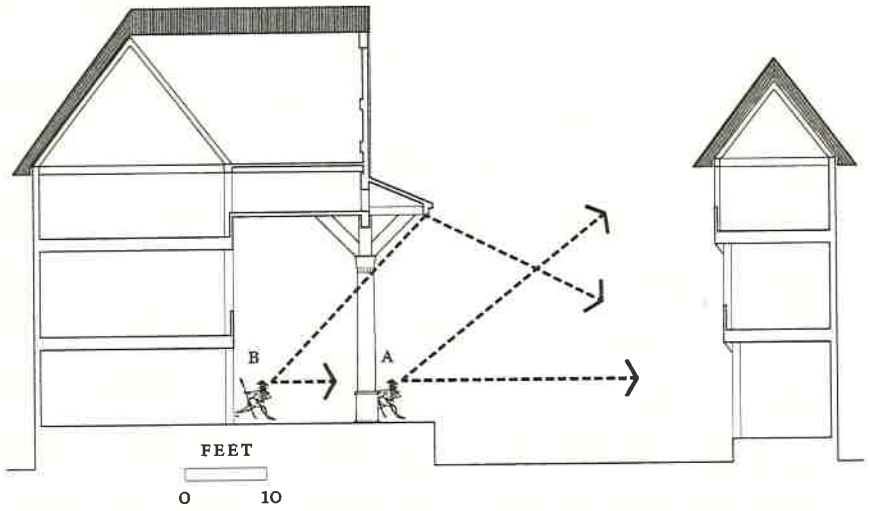

Figure 8.1. Side view of the Globe Theater (1599).

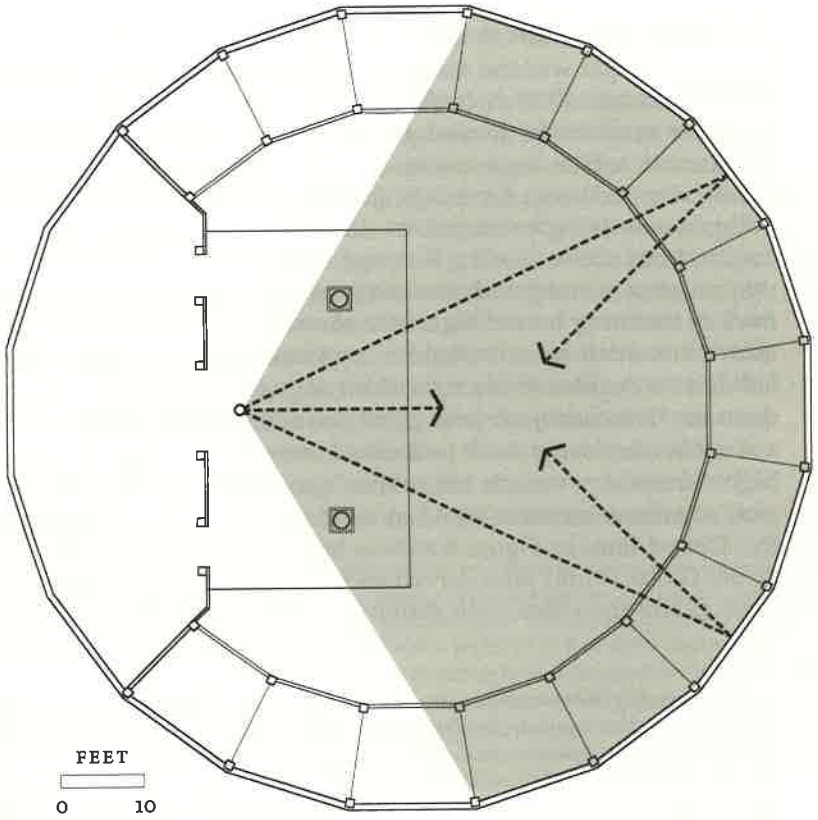

Figure 8.2. Top view of the Globe Theater (1599).

with light waves, the angle of incidence equals the angle of reflection.)

This pattern of sound concentration would have been complicated, however, by two structural factors: the absence of a roof over the yard and the canopy over the stage. In a cylindrical structure like the Globe, open at the top with nothing for soundwaves to strike against and closed at the bottom with highly absorbent material in the form of human bodies, sound waves would have been reflected mainly from side to side, not from top to bottom. The result would have been a "broad" as opposed to a "round" sound (Handel 1989: 41). Such a quality would be ideally suited to the epic sweep of history plays. Depth of the canopy over the stage proved to be one of the most controversial features in the 1990s reconstruction of the Globe on the South Bank, since the Fortune contract is silent on the subject, the visual evidence of contemporary views of London is contradictory, and most of the archeological evidence is still unexcavated. For the purposes of analysis, let us assume that the canopy covered the stage, if for nothing else than to protect expensive costumes from the rain. With the canopy, there would be two primary paths for sound waves, depending on where an actor happened to be standing (see fig. 8.1). If he were standing at the front of the stage, under the edge of the canopy (position A), the sound waves would have gone out directly to listeners standing in the yard and and sitting in the galleries. If, on the other hand, he were standing at the rear of the stage (position B), sound waves would have gone directly out into the yard, but they would also have been reflected off the underside of the canopy. Using as a reference point a patron seated at the furthest point from the speaker, in the rear of the bottom gallery, some 65 feet away, we can calculate that the difference between the direct path of sound and the indirect path would have been approximately 20 feet, producing a time delay between the two signals of less than 0.02 seconds. Modern acoustical engineering ranks such a delay as being just within the range of conditions "excellent for speech and music" (Egan 1988: 96).*

Contrast between the largely horizontal sound that an actor projects when standing downstage and the vertical as well as horizontal sound he projects further upstage calls into question some received ideas about early modern theaters that are based on visual analysis alone. Experience in the reconstructed Globe in London has demonstrated that the position of greatest dramatic power is not all the way downstage, where some theater historians imagine soliloquies to have been spoken, but several feet back, somewhere in between the

*I am grateful to Andrew Gurr for these calculations.

two pillars holding up the canopy. An actor may occupy the position of greatest *visual* presence at the geometric center of the playhouse, but he commands the greatest *acoustical* power near the geometric center of the space beneath the canopy. The canopy of the reconstructed Globe also demonstrates the excellent acoustics enjoyed by occupants of the Lords' Room in the upper recesses of the *scenae frons*. In terms of both vision and hearing, the Lords' Room offered an optimal situation: one could not only see and be seen but hear and be heard: the canopy would have projected the lords' voices as well as the actors'. Thanks to the absence of a roof over the yard, auditors in the yard and in the galleries would have found themselves in a perceptibly different relationship to the auditory events going on all around them. In a cylindrical space listeners can locate sounds horizontally far more accurately than they can in a space enclosed on six sides. Applause sounds on the left and the right, not all around; loud laughter comes from over *there*, a rude comment from over *there*. Performers in the reconstructed Globe in London have commented on the way audience response can start in one part of the theater and then spread laterally to the rest.* The experience of broad sound comes not only from the actors onstage but from one's fellow auditors.

In all three respects—building materials, size, and shape—indoor theaters like the Blackfriars presented an altogether different acoustic environment. Although many crucial details about the Blackfriars theater, which the King's Men occupied from 1609 to 1642, are not known, Burbage's 1596 deed of purchase and subsequent lawsuits provide a very good list of the materials out of which it was built: stone walls, paved flooring, galleries (presumably built of wood), a stage (also presumably built of wood), seats (likely wooden benches), window glass, "wooden windows" (probably shutters), and plenty of wainscotting that had formerly divided part of the space into seven separate rooms (H. Berry 1987: 46–73; Wickham 1972, 2.2: 123–138; Hosley 1969: 74–88; I. Smith 1964: 471–475, 302). Stone walls are even more highly reflective of sound than wood and plaster, returning 98 to 99 percent of the energy waves that strike them. Paved flooring is almost as reflective, returning 97 percent of sound waves. Even the small panes of glass in the theater's windows would have bounced back 80 to 90 percent of the ambient sound. Judged by its outer shell, the Blackfriars theater would have been a very "live" space. The theater's distinctive acoustic properties, however, were tempered by

*I come by these observations through interviews with actors at the Globe in October 1997 and through personal experience as an auditor at various places in the reconstructed theater.

wood. As the later legal documents make clear, galleries (*porticibus*) and seats (*sedilibus*) were expensive parts of the property and were deemed to convey with the title (H. Berry 1987: 68–71). As with the Globe, the primary damping medium was the audience.

Precise dimensions of the Blackfriars listening space are provided by the bill of sale and later legal documents: 66 feet north to south and 46 feet east to west. At 3,036 square feet, the floor area of the Blackfriars theater would have been slightly larger than the yard of the Fortune and slightly smaller than the still extant great halls at Hampton Court and the Middle Temple (I. Smith 1964: 102). Unresolved is the crucial question of how high the Blackfriars listening space may have been. That all depends on just where in the three-level property James Burbage fitted out his new theater in 1596 and how high the ceiling was. If, as E. K. Chambers and most other theater historians have concluded, Burbage's theater was located in the upper chamber where Parliament had once met, it could have included anywhere from 78,004 cubic feet of listening space to 96,565, depending on the ceiling height (fig. 8.3).* When people are added to the picture, the Blackfriars theater, like the Globe, shapes up as a space in which individual auditors enjoyed a listening space exceeding modern standards. If, as Irwin Smith proposes, the Blackfriars accommodated 512 people, we end up with per-person listening spaces of 152 cubic feet under a 32-foot-high flat ceiling, 188 cubic feet under a 38-foot flat ceiling, and 233 cubic feet under a 53-foot vaulted ceiling. (Compare the Globe's 77.8 cubic feet per person at full capacity or 155.7 at half capacity.) By the standards of modern acoustical engineering, the figures for the Blackfriars fall somewhere in between the optimal listening spaces recommended for speech

*Irwin Smith argues from the proportions of the halls at Hampton Court and the Middle Temple that the side walls must have been 38 to 40 feet high beneath a vaulted ceiling extending up another 15 feet (I. Smith 1964: 103). Hosley assumes the side walls to have been 32 feet high and to have ended at a dropped ceiling dating from the days when the hall had been partitioned into seven chambers (Hosley 1969: 79, 83, 87). At 66 × 46 × 32, Hosley's reconstructed space would have had a listening area of 97,152 cubic feet. Assuming that the tiring house took up part of this space, extending the full width of the hall (46 feet), at the same depth as The Fortune tiring house (11 feet 3 inches, allowing for the thickness of the walls), up to the height of the second gallery (25 feet), we can deduct 12,938 cubic feet, plus another 6,210 cubic feet for the size of Hosley's conjectural stage (46 feet wide × 30 feet deep × 4.5 feet high). The listening space would then have been 78,004 cubic feet. Other proposed heights would, of course, yield other estimates of the listening space. Smith's 38-foot walls with a 53-foot vault would (minus tiring house and stage) produce 96,565 cubic feet—about the same volumetric size as the great halls at Hampton Court and the Middle Temple. Adopting the 38-foot height of these extant structures but assuming that a dropped ceiling stayed in place, the volume would be 96,220 cubic feet.

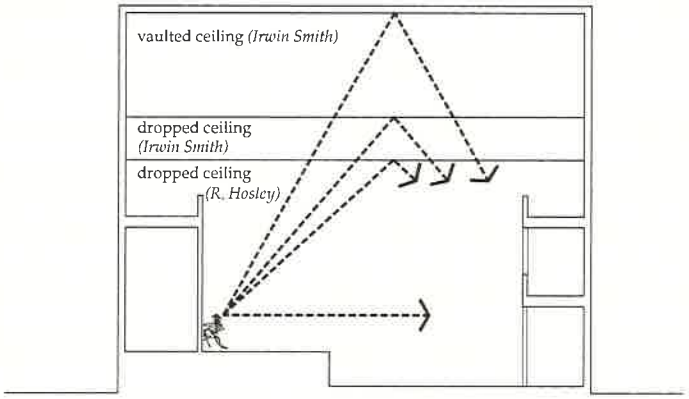

Figure 8.3. Side view of the Blackfriars Theater (1596).

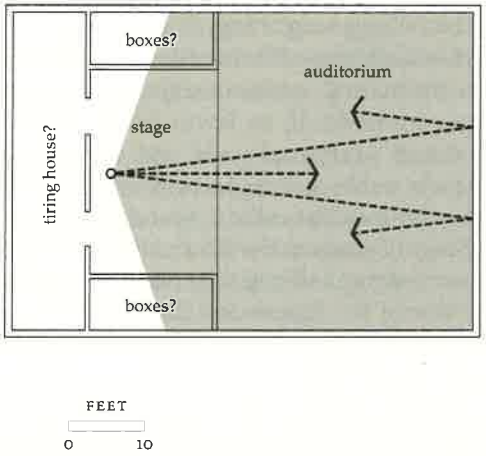

Figure 8.4. Top view of the Blackfriars Theater (1596).

(98.9 cubic feet per person) and for music (251 cubic feet per person) (I. Smith 1964: 42; Egan 1988: 96).

In its shape the Blackfriars theater fostered a very different kind of sound than the Globe. However stage, galleries, and open seating may have been configured, the Blackfriars was a rectilinear space. As such, it *dispersed* sound waves throughout the room rather than *focusing* them in the center (fig. 8.4). Standing at the rear of the stage, a speaker commanded a 140-degree broadcast area (shaded gray) that covered much more of the available listening space than it would have for an actor in the same position in the Globe. What is more, the

sound the speaker sent out into the hall would not immediately have been returned to the center, as it would have at the Globe, but would have struck the back wall, bounced to the sides, and only then returned to the center. This dispersal effect would have been enhanced by the multiple planes of the galleries. However deep they may have been, whether or not they ran the full perimeter of the room, the galleries provided a series of differently angled, resonant wood surfaces that contributed to the dispersal of sound in its full range of frequencies.

The reverberant quality of this sound can be calculated by positioning an actor at the rear of the stage and plotting the path of sound to a person seated at the opposite end of the room (see fig. 8.3). The direct path for sound waves would be approximately 50 feet. A dropped ceiling 32 feet above the floor would give reflected sound an angled path of about 70 feet; a dropped ceiling at 38 feet, an angled path of about 80 feet; a vaulted ceiling at 53 feet, an angled path of about 100 feet. For listeners, these differences would be significant. The lowest of the three ceiling heights, 32 feet, would produce a difference between direct and indirect sound of 20 feet—about 0.02 seconds—the same as in the Globe. A difference of 20 feet or less is rated by modern acoustical engineering as ideal for both speech and music. Higher ceilings would have yielded less propitious results. A ceiling height of 38 feet would have produced a difference of 30 feet, still rated as good for speech but only fair for music. A vaulted ceiling at 53 feet would have resulted in a difference of 50 feet between direct and indirect sound, rated as marginal to unsatisfactory (Egan 1988: 96). The scattering effect of hammer-beams, intercepting some of the sound waves before they reached the roof and sending them back towards the floor, might have mitigated the absolute disparity in distance. With or without a vaulted ceiling, the rectilinear surfaces of the Blackfriars theater would have produced a "round" sound quite different from the "broad" sound of the Globe—just the reverse of the effect suggested by the physical shapes of the two structures.

TRUMPETS, DRUMS, HAUTBOYS, CORNETS, RECORDERS, VIOLS

When noise-sensitive Morose vows to stay clear of the theater, he is quite specific about the sounds he does *not* want to hear: "fights at sea, drum, trumpet, and target." Playhouses rank high on Morose's list of the noisiest places in London (Jonson 1925–1963, 5: 169–170, 230). Morose's suspicions about what he might hear are confirmed by the petition raised by neighbors in the Blackfriars in 1596, when

James Burbage bought the Upper Frater and started fitting out a new acting space for the Chamberlain's Men. In addition to the traffic, the neighbors complain, "the same playhouse is so neere the Church that the noyse of the drummes and trumpetts will greatly disturbe and hinder both the ministers and parishioners" (Gurr 1996: 283). Their fears on this point, as it turned out, were misplaced: drums and trumpets do not figure prominently in the plays that were actually performed in the new indoor theater. The outdoor amphitheaters, established for twenty years, were something else again. To popular imagination, brass and percussion seem to have been what these playing places were all about. Customarily it was three trumpet blasts, filling all 231,028 cubic feet of the acoustic space, that signaled the start of performances at the Globe. Thomas Dekker seems wittily mindful of the difference between reading a play and hearing a play when he starts off the printed text of *Satiromastix*, acted at the Globe in 1601, with a kind of prologue "*Ad Lectorem*" ("To the Reader") in which he casts the ensuing list of printing mistakes as a "Comedy of Errors." What the reader sees on the page becomes an equivalent for what he or she would have heard in the theater: "In steed of the Trumpets sounding thrice, before the Play begin: it shall not be amisse (for him that will read) first to beholde this short Comedy of Errors, and where the greatest enter, to give them in stead of a hisse, a gentle correction" (Dekker 1953–1961, 1: 306). Dekker's Epilogue to the same script also invokes the power of trumpets to "set men together by the eares." The members of the audience who especially needed it, or so Dekker's Epilogue implies, were the standees whose proximity to the play is given a distinctly sexual turn: "Gentlemen, Gallants, and you my little Swaggerers that *fight lowe:* my tough hearts of Oake that *stand too't* so valliantly, and are *still within a yard* of your Capten: Now the Trumpets (that set men together by the eares) have left their Tantara-rag-boy, let's part friends." From the "Swaggerers" who are standing below him the speaker then transposes his speech upward to "the Gentle-folkes (that walke i'th Galleries)" (1953–1961, 1: 385, emphasis added). If Dekker can be trusted, plays in London's public theaters began with the auditory focusing of trumpet calls. The plays that ensued were full, not just of human voices, but of sound effects.

Instruments for providing some of those effects are detailed in Henslowe's inventory of the Admiral's Men's goods, drawn up in 1598. As the company's costumes and props make up a palette for *visual* design, so their musical instruments and other sound-producing devices make up a "palette" for *aural* design. Included on Henslowe's list are four groupings of musical instruments: (1) "a trebel viall, a basse viall, a bandore, a sytteren," (2) "j sack-bute," (3) "iij tymbrells,"

and (4) "iij trumpettes and a drum." Henslowe's diary for 1598–99 includes sizable payments (up to 40 shillings each, equal to the takings from 480 standees) for a sackbut, a bass viol, and "a drome when to go into the contry," as well as other unspecified "enstrumentes" (1907: 114–118; 1961: 101, 102, 122, 130). What some of the other instruments may have been are suggested by a speech in Dekker's *Old Fortunatus*, acted by the Admiral's Men the year after Henslowe had made his inventory. Shadow comes on while Andelocia is being charmed asleep by a lullaby. "*Musicke still,*" reads the stage direction: "*Enter Shaddow.*" In describing what he hears, Shadow in effect reiterates Henslowe's first entry and adds one other instrument: "Musicke? O delicate warble [recorder or flute] . . . O delicious strings [viols]: these heauenly wyre-drawers [cittern and bandore] " (Dekker 1953–1961, 1: 138–141; Chan 1980: 31). The cittern and the bandore were both guitar-like instruments, the bandore providing the bass to the cittern's treble (Munrow 1976: 80–83). With the addition of a recorder or flute, the instruments grouped in Henslowe's first entry make up an ensemble that sixteenth- and early seventeenth-century musicians knew as a "broken" consort. (It was "broken" because it was made up not of just one "family" of instruments, like a consort of recorders or viols, but of representatives from several different "families.") Morley's *First Booke of Consort Lessons*, published the same year *Old Fortunatus* was performed, calls for just this ensemble of flute, treble viol, bass viol, cittern, and bandore, with the addition of a treble lute. Philip Rosseter's *Lessons for Consort* (1609) is scored for the same set of instruments. In the case of the Admiral's Men, the standard broken consort might have been supplemented by two other instruments in Henslowe's inventory: the trombone-like sackbut and one or more of the tambourine-like timbrels (Long 1961–1971, 1: 28–29, 34). In such ensembles it was the bowed and blown instruments that carried the tune, the plucked and tapped instruments that provided rhythm. A lutenist, if one was handy, might have offered virtuouso variations on the melody (Chan 1980: 33).

To a different category of sound entirely belong the three trumpets on Henslowe's list, along with the drum. Lacking valves, early modern trumpets were restricted to the equivalent of bugle calls. In the theater their main use was for flourishes, fanfares, and military signals (Long 1961–1971, 1: 25). Other items in Henslowe's inventory are percussion instruments. An entry for "ij stepells, & j chyme of belles, & j beacon" has been interpreted by Michael Hattaway as sets of various kinds of bells: clock bells ("steeples"), hand bells ("a chime"), and a bell for ringing alarums ("a beacon") (1982: 32). David Munrow describes a chime as something more like a set of miniature cymbals: hung in a wood frame, the hemisphere-shaped chimes were

struck with hammers, not rung by hand (1976: 34–35). Certain items inventoried by Henslowe among the company's props should be thought about not only as visual icons but as sound-making devices: "j longe sorde," "viij lances," "j copper targate, & xvij foyles," "iiij wooden targates, j greve armer," "j buckler," "j shelde, with iij lyones," and "j gylte speare" would have contributed their distinctive crashes, clinks, and thuds to sounds within the wooden O.

Guns do not figure in Henslowe's inventory, but stage directions occasionally call for the firing of an unspecified form of "ordnance" or "piece" or, sometimes more precisely, of "chambers," small pieces of unmounted ordnance customarily used for firing salutes (OED, "chamber" 10). It was the stage direction *"Drum and Trumpet, Chambers dischargd"* in Act One, scene four, of *Henry VIII* that set the Globe on fire in 1613 (F1623: 1.4.50). Fireworks, like firearms, fail to make Henslowe's list, but exploding squibs were a standard aural event whenever devils arrived on the scene from hell (Leggatt 1992: 67–70). Another stupendous sound effect, usually the aural sign of supernatural happenings, was thunder. Ben Jonson, using the prologue to *Everyman in His Humor* (1616 text) to justify his disdain for such gimcrackery, divulges how thunder was made, by a bullet rolled about, presumably along a wooden timber (3: 303). From ethereal recorders to finely grained viols to blasting trumpets to booming artillery, the outdoor theaters of early modern London were full of sounds besides those made by human voices.

An unspecific stage direction for "*Musicke*" in scripts for the public playhouses is more likely to indicate an individual instrument or a pair of instruments than a full broken consort. The extent of the musical resources of the professional acting companies between 1590 and 1610 is not altogether clear. John Long and Mary Chan have each proposed that before 1590 actors themselves doubled as musicians but that after 1590 they depended more on professional musicians (Long 1961–1971, 1: 30–31; Chan 1980: 32–33). To judge from surviving scripts, ensemble music was required only occasionly in outdoor performances. When something more than trumpets, hautboys, and percussion was called for, it is possible that "waits" or "noises" were hired for the occasion. Professional musicians operated under separate licenses from the Revels Office (Hattaway 1982: 62–63). The establishment of boys' companies in indoor theaters after 1600 changed the aural scene considerably. For one thing, sounds were scaled back in volume. Differences between the two venues can be appreciated through the moment in *The Knight of the Burning Pestle* (acted at the Blackfriars in 1607) when the Grocer calls for shawms. The obliging boy actors tells him that, alas, the company has only recorders (Gurr 1992: 176). Stage directions in Marston's *Sophonisba*, written for the same venue, substitute domesticated cornets for the battlefield trumpets described in the script (Gurr 1992: 176). Even gunfire was toned down. *Love's Pilgrimage*, played at the Blackfriars in 1635, contains an order for a cannon to be shot off, accompanied by the book-holder's direction *"Joh. Bacon ready to shoot off a Pistol"* (Gurr 1992: 177).

The most significant difference between the indoor and the outdoor houses, however, involved music. The boy actors were trained as singers, and music was a major part of the entertainment they offered (Chan 1980: 14–15; Sternfeld 1963: 14–20). Certainly it was music as much as the play that charmed Frederic Gerschow, the Duke of Stettin-Pomerania's secretary, when he and his companions went to the Blackfriars Theater in September 1602 and took in a performance by the boys' company then in residence. "For a whole hour before," Gerschow reports, "a delightful performance of musicam instrumentalem is given on organs, lutes, pandores, mandolines, violins, and flutes" (1892: 29). Stage directions to the 1606 printing of Marston's *Sophonisba* "as it hath beene sundry times Acted at the *Black Friers*" confirms Gerschow's report that "organs" were part of the theater's equipment. The organ's capacity to cover the full range of pitches and volumes of all the other instruments, as well as to blend with the human singing voice, is suggested by the varied combinations specified in *Sophonisba:* "cornets, Organ, and voices" perform a wedding song in act one, "Cornets and Organs playing loud full Musicke" mark the act's end, "Organ mixt with Recorders" does the same for act two, "Cornets and Organs playing full musick" accompany a sacrifice scene in act three, "Organs Violls and Voices" perform between acts three and four, and "Orgaine and Recorders play to a single voice" as funeral music at the tragedy's end (2:1, 12, 18, 32, 36, 43, 63). When the King's Men took over the theater in 1609, the musical consort stayed on and continued to provide pre-play concerts and, on some occasions at least, music between the acts, as well.

In Andrew Gurr's view, the musical consort "brought the largest single alteration to the King's Men's practices when they took over the Blackfriars playhouse." The addition of music proved so popular that the company retrofitted the Globe to include a curtained music room in the balcony above the stage (Gurr 1996: 367–368). In acoustic terms, the effect of these musical preludes was to fill the aural field with sounds across a wide range of pitches. Michael Praetorius catches the effect in his description of broken consorts in *Syntagma Musicum* (1619):

> The English give the name Consort to what is very appropriate to a grouping of instruments (*consortio*), when several persons with various instruments, such as a Clavicymbal or a large Spinet, a large Lyra, a

> Double Harp, Lutes, Theorboes, Bandores, Penorcons, Citterns, Bass Viol, a little Treble Fiddle, a Transverse Flute or a Recorder, sometimes also a soft Trombone or a Racket, all together in a Company or Society play with very quiet, soft and sweet accord and harmonize with one another in pleasing symphony. (Galpin 1965: 202)

Contrast with the trumpet blasts that had heralded the start of performances in the outdoor amphitheaters could hardly be sharper. One effect of consort music was to situate the audience within a wider, more fully articulated field of sound than in the outdoor amphitheaters. By the time the play began, audiences had acclimated their hearing accordingly. Human voices emerged from a matrix of bass viol, bandore, treble viol, cittern, and recorder.

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Morose to the contrary, what is scored to be played upon in theatrical performances is not primarily drums or trumpets, hautboys or cornets, but human voices. The difficulty, for psychoacoustics, is that the sounds of drums, trumpets, hautboys, and cornets are much easier to specify than the sounds of human voices. Even if Edward Alleyn, Richard Burbage, Will Kemp, and Nathan Field were available to submit their voices to a spectrograph, we still would find it hard to explain their stage success. What we understand by "voice" is, after all, not a *thing* but an *effect*. The thing-ness of voice consists of (1) the body tissues of lungs, larynx, and mouth, (2) moving molecules of air, and (3) the cartilage, flesh, bones, and nerves of the ear. The effect of voice, for speakers and listeners alike, is something more than the sum of these material parts. Quintilian acknowledges as much in the treatise that codified Roman rhetoric for Renaissance schoolmasters: "just as the face, although it consists of a limited number of features, yet possesses infinite variety of expression, so it is with the voice: for though it possesses but few varieties to which we can give a name, yet every human being possesses a distinctive voice of his own, which is as easily distinguished by the ear as are facial characteristics by the eye" (11.3.14–15, with some modifications to the English translation). Quintilian goes on, however, to distinguish two features in the "physiognomy" of voice: *quantitas* and *qualitas*. "Quantity" is the easier of the two to describe, "since as a rule it is either strong or weak, although there are certain kinds of voice which fall between these extremes, and there are a number of gradations from the highest notes to the lowest and from the lowest to the highest." Quantity, that is to say, can be gauged in two ways: (1) by the volume of sound the speaker produces and (2) by the range of pitches he uses. Both things can be measured and specified. "Quality" is another matter altogether, "for the voice may be clear or husky, full or thin, smooth or harsh, narrow or diffuse, rigid or flexible, sharp or blunt, while lung-power may be greater or lesser" (11.3.14–15, in 1921–1922, 4: 251, with some modifications to the English translation).

In this particular passage Quintilian takes breath control to be a question of quality, but elsewhere in the *Institutio Oratoria* he includes it, along with volume and pitch, as a quantitative concern. Depth and frequency of breathing can, after all, be measured, and Quintilian is able to provide precise guidelines, complete with phrase-by-phrase examples (11.3.33–39, 43–57). Quintilian's concern in these passages is with *spatium*, with intervals, timing, rhythm. Managing *spatium* is as much a matter of discipline as volume and pitch are. Breath control is fundamental to all three. Thus, Aristotle specifies rhythm (*rhythmos*) as a third factor to be considered in rhetoric along with volume (*megethos*) and harmony (*harmonia*) (*Rhetoric* 3.1.4 in Aristotle 1941: 1435). Under the rubric of "*Action*, or *Pronunciation*" these three boundary markers of the vocal field are epitomized in *A Briefe of the Art of Rhetorique. Containing in substance all that ARISTOTLE hath written in his Three Bookes of that subject, Except onely what is not applicable to the English Tongue: "Tragaedians* were the first that invented such *Action*, and that but of late; and it consisteth in governing well the *Magnitude, Tone*, and *Measure* of the *Voice;* a thing lesse subject to *Art*, then is either *Proofe*, or *Elocution*" (Aristotle 1637: 152).

It is, perhaps, the noncerebral nature of volume, pitch, and rhythm—their brute physicality—that explains why early modern rhetorical treatises typically give much less attention to vocal delivery than to invention and argument (Ong 1968: 39–69). However briefly they may treat the practicalities of speaking what the orator has so meticulously been trained to invent, early modern rhetorical manuals all direct attention to the same three aspects of sound. "Magnitude," "tone," and "measure" are the delineators of voice that were carried over from Aristotle, Cicero, and Quintilian into early modern rhetorical manuals, thence into early modern schoolrooms, and quite possibly thence onto the stages of early modern theaters. At the very least, volume, pitch, and rhythm give us three quantitative reference points for plotting the repertory of voice sounds that scripts for the public stage imply. In treating an actor's voice as a sound-producing instrument possessed of a certain range of volume, a certain range of pitches, and a certain range of rhythms we are following the example of early modern rhetoricians. The *qualitas* of Burbage's voice may be beyond recovery; the *quantitas* is not. Let us consider these three factors one by one.

Magnitude of vocal sound is fundamentally a measure of *space*. In any sound, the air molecules that are being displaced will move in

waves of greater or lesser amplitude, depending on how much force has been exerted against the vibrating surface. Those waves strike listeners' ears with correspondingly greater or lesser force. Sounds perceived to be loud take up more space than sounds perceived to be soft. It should come as no surprise that plays designed for the Globe and other large outdoor amphitheaters betray an acute awareness of volume in capturing, holding, and guiding an audience's aural attention. Thomas Dekker, for one, presumes that the audience will be noisy, a roaring crowd that an expert actor can charm into silence. "Giue me *That Man*," says the Prologue to *If This be not a Good Play, The Diuell is in It*, who when a bad play starts emptying the house "Can call the *Banishd* Auditor home, And tye / His Eare (with golden chaines) to his Melody" (Pro.26–36 in Dekker 1953–1961, 3: 121–122). The Prologue to *The Whore of Babylon* goes so far as to pronounce a charm to establish calm within the quadrilateral spaces of the Fortune Theater: "The Charmes of silence through this Square be throwne, / That an vn-vsed Attention (like a Iewell) / May hang at euery eare" (Pro.1–3, 2: 499). To establish aural command, Dekker's usual strategy is to send out a Prologue and have *him* take possession of the acoustic field. If that tactic is successful, any volume of sound can come next. The Prologus to *The Roaring Girl*, for example, warns the audience that "our Scoene, / Cannot speak high," since the subject is mean, "A Roaring Girle (whose notes till now neuer were)." Having piqued the audience's interest ("I see attention sets wide ope her gates / Of hearing, and with couetous listning waites, / To know what Girle, this Roaring Girle should be"), the Prologus yields the stage to Mary Fitz-Allard her/himself, who starts off the play in anything but a roar, in a private scene with the servant Neatfoot (Pro.7–14, 3: 12).

With respect to volume, the Roman rhetoricians had recommended carefully plotted modulations in the course of a single speech. The *Rhetorica ad Herennium*, for example, counsels a "calm tone" [*sedata vox*] in the beginning and "a sustained flow" [*continens vox*], apparently at a relatively high volume, toward the end: "and does not this, too, most vigorously stir the hearer at the Conclusion of the entire discourse?" (3.12.22 in [Cicero] 1968: 195). Entire scripts seem to follow this advice. As plays tend to begin with high-intensity sound, so they tend to end. Most of Shakespeare's scripts, for example, end in public scenes presided over by an authority figure whose political power is presumably measured by his aural power as well as his physical presence. Out of the 39 surviving texts, only a handful do not end with a speech from such a figure, if not with a flourish, a drum roll, or a declamatory epilogue. Notable exceptions are *Henry VI Part One* (which ends with a confidential exchange between Gloucester and Suffolk), *Love's Labor's Lost* (the dialogue between Winter and Spring), *The Merchant of Venice* (quips among the four lovers, with silent Antonio standing by), *Twelfth Night* (Feste's song), and *The History of King Lear* (Albany's two couplets, followed by an "*Exeunt*" without the drum-rolls of the *Tragedy*'s "*dead march*").

The volume level in early modern performances was a function not only of narrative line but of subject matter, acoustical space, date of performance, and the age of the actors. In general, history plays and tragedies call for more noise than comedies do. As instruments for the actors to play upon, outdoor amphitheaters accommodated these large-volume sounds more comfortably than indoor theaters. One remembers the cornets substituted for trumpets in *Sophonisba* at the Blackfriars in 1606 or the pistol for a cannon in *Love's Pilgrimage* in the same space thirty years later. As designs in sound, Shakespeare's scripts reflect these general trends. At the same time, they exploit the human voice's full range in magnitude, from the whispering nobles in *Henry VIII* (3.2.S.D. before 204) at 30 decibels to Richard III's shout "A horse! A horse! My kingdom for a horse!" at 75 dB. Since decibels are logarithms—each 10 decibels measuring an increase in intensity by a factor of 10—the latter sound is more than 10,000 times greater than the first. Within those parameters range the volume of vocal sounds in Shakespeare's scripts.

The highly reverberant acoustics of the reconstructed Globe suggest that a speaker's output need not have been anything like 75 dB to fill the wooden O. The volume level of normal conversation is about 60 dB at three feet away from the speaker. Within a single bit of speech, variations of up to 26 decibels are possible between the most intense sounds and the least (Handel 1989: 7–72; Fry 1977: 40–60). To some degree, those variations in volume are cued by the phonemes that happen to make up the speech. Unvoiced consonants, for example, come out relatively low in volume—[th] is the weakest—while some vowels come out stronger than others (fig. 8.5). These relative intensities remain more or less constant across changes in the overall force of the speaker's breath, i.e. across changes in the overall volume of the speech. The strongest phoneme of all is [o:]. "*O* for a Muse of Fire": when the Prologue to *Henry V* attempts to silence the audience gathered within the wooden O, he begins with the most intense phoneme the human voice can make in English speech, followed by the tenth, sixth, and ninth most intense in [u:] and [ai]. Because listeners are bracketing the whole speech as a phenomenon, they will not necessarily perceive [o:] to be louder than other phonemes—listeners *need* [o:] to be louder than [u:] and [ai] in order to hear [o:] as [o:]—but the physical fact of the sound's relative intensity remains. By contrast, a concentration of consonants—particularly [m], [l], [n], and [ŋ]—positively require that the actor playing Ophelia

speak relatively softly when he says, "My Lord, I haue remembrances of yours / That I haue longed long to redeluver" (*H5* F1623: Pro.1; *Ham* Q1604: 3.1.99–100, emphasis added). In individual lines, as in opening scenes, volume control is written into scripts for the stage.

The projected volume of Ophelia's speech would also have been shaped by the vocal apparatus of the boy actor who pronounced the line. When Orsino tells Viola/"Cesario" "thy small pipe / Is as the maidens organ, shrill, and sound" (*TN* F1623: 1.4.32–33) he is measuring not only the physical size of the windpipe but the volume of sound it makes. With respect to smallness as well as shrillness, the interchangeability of boys' and women's voices is attested by the

oː	29	m	17
o	28	tʃ	16
aː	26	n	15
ʌ	26	dʒ	13
əː	25	ʒ	13
a	24	z	12
u	24	s	12
e	23	t	11
i	22	g	11
uː	22	k	11
iː	22	v	10
w	21	ð	10
r	20	b	8
j	20	d	8
l	20	p	7
ʃ	19	f	7
ŋ	18	θ	—

Figure 8.5. Comparative intensities (in decibels) of English phonemes. From Dennis Fry, *The Physics of Speech* (1979). Reproduced by permission of Cambridge University Press.

Wooer in *The Two Noble Kinsmen*, who tells of hearing the Jailer's Daughter (played by a boy) singing:

> I heard a voyce, a shrill one, and attentive
> I gave my eare, when I might well perceive
> T'was one that sung, and by the smallnesse of it
> A boy or woman.
>
> (Q1634: 4.1.56–59)

The change of voice that males undergo at the age of puberty was understood by early modern physiology to be the result of an increase in heat, which in turn produces a larger body—and a larger voice. *"Why are boyes apt to change their voice about fourteene yeeres of age?"* goes one of the questions in *The Problemes of Aristotle.*

> Bicause that then nature doth cause a great and sudden change of age. Experience prooueth this to be true: for at that time we may see that womens paps do grow great, to hold and gather milke, and also those places which are about the hips, in which the yoong fruit should remaine. Likewise mens breasts and shoulders which then beare great and heauie burthens. Also their stones in which the seed may increase and abide: and his priuie member, to let out the seede with ease. Further al the whole bodie is made bigger and dilated, as the alteration and change of euery part doth testifie.

The windpipe participates in this general enlargement of the body, producing a "larger" (i.e., louder) sound. The harshness and hoarseness so characteristic of adolescent speech is imagined to be the result of uneven expansion in the windpipe (Aristotle 1597: L8ᵛ–M1). That fourteen was the age of male puberty comes, not from the source for this anatomical information in Aristotle's *Generation of Animals* 4.8 (where the ages are unspecified), but presumably from the English translator's own observation and experience. Another of the question-and-answer exchanges in the English edition of *The Problemes* confirms fourteen to be the age of puberty for males and fixes twelve as the age for females, again in the absence of any such indications in the Greek text (Aristotle 1597: C1–C1ᵛ).

If volume is a measure of *space*, pitch is a measure of *time*. In physical terms, the perceived pitch of a sound is a function of its frequency, of how long it takes the displaced air molecules to return to the point of stasis from which the sound wave began. Modern acoustics measures the number of oscillations per second in Hertz (Hz), so that middle C on the piano sounds out at 261 cycles per second, or 261 Hz. As one of Quintilian's objective measures of voice, pitch is in part an aesthetic consideration. Cicero in his treatise *Orator*

distinguishes three "tones" or "registers" (*soni*) in the very nature of the voice: "shrill" (*actus*), "moderate" (*inflexus*), and "low" (*gravis*). Out of these three is produced "an accomplished and pleasing variety," which Cicero describes as a species of singing (17.57 in Cicero 1939: 346–349). Beneath artistic choices lay the fundamental facts of human anatomy—and the differences in anatomy between adult males and prepubescent boys. The fact that it was originally boy actors who pronounced now-famous lines like "I am Duchesse of *Malfy* still" gave the line special characteristics in pitch and timbre. The complicated cultural coordinates that allowed boy actors to be substituted for women have been set in place by Stephen Orgel and others (Orgel 1996: 31–82; Levine 1994: 1–25; Rackin 1987: 29–41). Physics and physiology contributed to the illusion. To start with, boys and women possess vocal cords of comparable length. Early modern physiology explained the similarities in sound as a function of the coldness and moistness boys' bodies shared with women's bodies—the same factors that produced, in each case, a "smaller" sound than adult male voices (Aristotle 1597: C1–C1^{v}, I8^{v}, L8^{v}–M1). Cicero observes that "in every voice there is a mean pitch": as it happens, the *mode* of pitch for fourteen-year-old boys and adult females has been demonstrated in modern experiments to be exactly the same. That is to say, the pitch most frequently sounded when fourteen-year-old boys are asked to read aloud from a text is the same as the most frequently sounded pitch by adult females: 261.6 Hz, approximately middle C on the piano. Only a small difference separates the *mean* pitch, the average pitch sounded, in each case: 241.5 Hz for boys (just below the B below middle C) and 220 Hz for women (the A below middle C). The *range* of pitches, as well, is roughly the same, although at the extremes women's voices reach somewhat higher frequencies and boys' voices somewhat lower. It is mainly a more extended lower range that distinguishes fourteen-year-old boys' voices from ten-year-old boys' voices. The modes and the means of pitch are in each case only slightly different (Fry 1977: 26; Zemlin 1964: 150; Curry 1940: 48–62).

In terms of what an audience would hear, the most significant difference between boys' and women's voices involves *harmonics*. What the vibrating piano string sets in motion at middle C is not simply a wave of 261 cycles per second, but a complex wave made up of 261 Hz plus integral multiples of 261 Hz at 522 Hz (261 × 2), 783 Hz (261 × 3), 1,044 Hz (261 × 4), 1,305 Hz (261 × 5), etc. These more rapid cycles, moving through the air all at the same time, constitute the "harmonics" of the sound; the lowest frequency, the one that sets the others in motion, provides the "fundamental" above which the harmonics vibrate. Waves set in motion by the vocal cords work in just the same way. If I sing the equivalent of middle C, I am propagating into the space around me a complex sound wave made up of 261 Hz, 522 Hz, 783 Hz, 1,044 Hz, 1,305 Hz, etc. Because I am using my voice, however, and not striking a piano string, some of these cycles are going to be more important than others. On the piano, the fundamental frequency is the strongest, with the harmonics gradually decreasing in strength up the scale. With voice, the size and shape of the vocal tract is such that the higher harmonics become relatively stronger than the fundamental. Because their vocal tracts are relatively narrower and shorter than women's are, boys when they speak give more prominence to the fundamental at the expense of the upper harmonics. The result is a less complicated sound wave, "purer" in timbre and sharper to the ear. Hamlet seems to be describing this quality when he greets his old friends the traveling players, comments on how much the boy actor has grown, and exclaims, "pray God your voyce like a peece of vncurrant gold, bee not crackt within the ring" (Q1604: 2.2.30–31). "Ring" offers a pun on the shape of the coin, the shape of the windpipe, the shape of the theater, and the "shape" of the boy's sound. "I am Duchesse of *Malfy* still": what audiences at the Blackfriars and the Globe heard in 1614 would have been sounds in the same pitch range as an adult female voice, but more carrying and penetrating.

The aural contrast between boys' voices and men's voices, both in pitch and in timbre, would have been striking. The most frequently sounded pitch for adult males (the mode) is 130.8 Hz, approximately the C one octave below middle C; the average pitch (the mean) is 120 Hz, one semitone lower; the range reaches down well into the next octave (Fry 1977: 26; Zemlin 1964: 150; Fairbanks 1960: 124) (fig. 8.6). The small overlap between the two voices in the region of G below middle C to C below middle C would be more than offset by differences in harmonics: for the pitch of each phoneme, adult male voices would resonate across the full range of harmonics above the fundamental, while boys' voices would ring out closer to the fundamental. These differences in harmonics would accentuate the natural tendency for lower-frequency sounds to be heard as filling the ambient space, in contrast to higher-frequency sounds, which tend to be heard as more localized in space (Handel 1989: 88). In effect, speech sounds gendered as male would pervade the wooden O, filling it from side to side; speech sounds gendered as female would be heard as isolated effects within this male matrix.

Like volume, pitch in the early modern theater varied according to four factors: playing place, genre, date, and the age of the performers playing the protagonists. To gauge the interplay among these four variables, let us compare scenes from three plays at three different

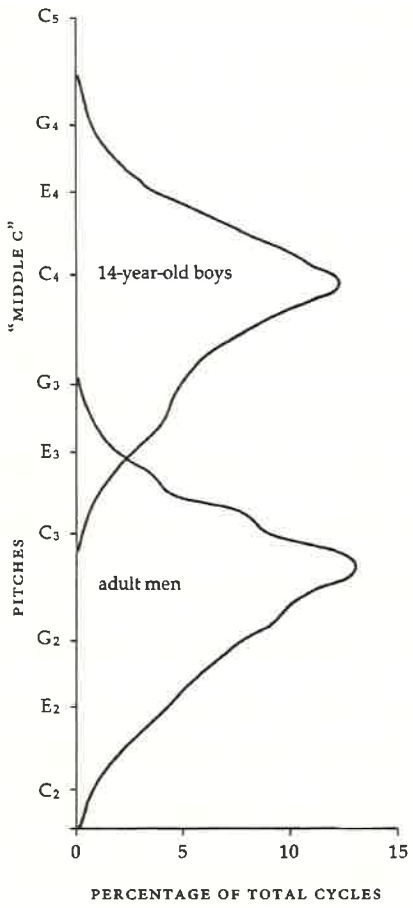

Figure 8.6. Comparative pitch modes: fourteen-year-old boys and adult males.

points in Shakespeare's career. At The Theatre and The Curtain, north of the City, Shakespeare's company mounted plays in which the dominant sounds were male voices and high-energy percussive sound effects. Loud percussive sounds were, indeed, the company's stock in trade in the 1590s, with history plays providing the most extreme examples. The voice parts in *Richard III* are scored overwhelmingly in the male register; the sound effects—flourishes, trumpets, sennets, drums, alarums—are all assaultive. Act Four, scene four, epitomizes this aural design (fig. 8.7). The scene can be analyzed in what modern actors know as "beats," or units of completed action, each signalled by important entrances and exits. Within each of the beats, rectangles enclose the pitch ranges of the several sorts of instruments, human and mechanical, called for in the script. On the upper, treble clef horizontal rectangles indicate the pitch range for boys' voices that speak

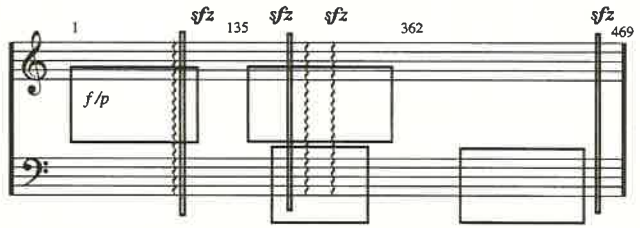

Figure 8.7. Pitches and volume levels, *Richard III*, 4.4.

the lines of the women characters who appear in this scene: Elizabeth, Margaret, and the Duchess of York. On the lower, bass clef horizontal rectangles indicate the pitch range for the adult male voices that speak all the other parts. Slender vertical rectangles extending across both clefs indicate the effective pitch range of trumpets. Finally, jagged vertical lines across both clefs indicate the random frequencies of drumming and other noises. In the first sequence (lines 1–135) Elizabeth, Margaret, and the Duchess of York form a chorus of wailing women. The three actors make their treble lamentations, presumably at a forceful volume (marked *forte*, or loud, in the score), in counterpoint to Margaret's asides, presumably at lesser volume (marked *piano*, or soft, in the score). Their litany is at last interrupted by "*K. Richard marching with Drummes and Trumpetts*" (Q1597: S. D. after 4.4.135), the volume of which is indicated in the score as *sforzando*, or suddenly loud. In the second sequence (ll. 136–362) Richard confronts the women. Although the women are scripted to speak more lines than Richard and his male compeers, Richard repeatedly tries to silence their demands for their murdered husbands and sons:

> A flourish Trumpets, strike Alarum Drummes:
> Let not the Heauens heare these Tell-tale women
> Raile on the Lords Annointed. Strike I say.
> *Flourish.* *Alarums.*
> Either be patient, and intreat me fayre,
> Or with the clamorous report of Warre,
> Thus will I drowne your exclamations.
> (F1623: 4.4.149–154)

When the Duchess of York persists, Richard threatens more alarums: "Strike vp the Drumme" (4.4.180). Extended speeches between bass-clef Richard and his treble-clef interlocutors give way to one-line exchanges (ll. 274–308), one-line exchanges to a virtual oration by Richard (ll. 328–348) as the king takes firm command of the aural field. The women exit, setting up the final sequence of the scene (ll. 364–469), in which Richard confers with his peers, receives news from

four messengers, and prepares to go off to battle. The scene ends with a scripted "*Florish*" of trumpets (S.D. after 4.4.469). The play as a whole ends with a great deal more noise and fanfare—but no more treble voices other than the brief words of Lady Anne's ghost (5.5.113–120).

Brash sound was an effect for which theaters north of the city—the Curtain, the Fortune, the Red Bull—remained famous, long after the indoor theaters of the City were plying subtler designs on listeners' ears. The actors at the Fortune were famous for their "sesquipedales" sound: a deep, resonating bass. However exuberantly Shakespeare's company may have exploited the capacity of amphitheaters for broad, booming sound, they could play the instrument to very different effect in comedy. *Twelfth Night* (1601), like most of Shakespeare's earlier comedies, offers a wider range of pitches than history plays and tragedies, with much more prominence given to higher-frequency sounds. From the beginning of the play to the end, treble-clef sounds move in counterpoint to bass-clef sounds in a manner that comes close to turning the play's musical metaphors into acoustic fact. "If Musicke be the food of Love," *Twelfth Night* provides a rich banquet (F1623: 1.1.1). The heightened range of pitches in the play is a function in part of the large roles assumed by female characters, Viola and Olivia in particular. The quality of spoken sound in the treble register is indicated by Orsino's comment on Viola/"Cesario"'s "small pipe." If Viola and Sebastian are visually twins, then they likely were so aurally as well. Certainly, Olivia hears no difference when she takes Sebastian for "Cesario" in 4.1, 4.3, and 5.1. Sebastian's part almost certainly, therefore, belongs to the treble clef.

Counterpoint to the play's ample treble sounds is provided by the subplot. Aside from Orsino and Antonio, the play's bass-clef sounds are grounded almost entirely in the antics of Sir Toby, Sir Andrew, Fabian, and Malvolio, as played out in 1.3, 1.5, 2.3, 2.5, 3.2, 3.4, and 4.2. Even the actor playing Maria may have contributed to the bass-ness of the subplot. Henslowe's notation of an expenditure "for bornes womones gowne"—William Borne (*alias* William Bird) being an adult member of Admiral's Men at the time of the notation—has persuaded some theater historians that men played some female roles, particularly wily maid-servants and other comic roles (Rutter 1984: 124). In this view, "high mimetic" drag for the heroines would have contrasted with "low mimetic" drag for comic characters, just as in *commedia dell'arte*. Some support for this argument may be found in the 1623 printing of *The Duchess of Malfi*, which states that Robert Pallant, who played the Duchess's maid Cariola, doubled as the Doctor. If so, the effect in scenes of dialogue between the Duchess and Cariola would have been an accentuation of the Duchess's acoustic isolation. If an adult male played Maria in *Twelfth Night*, the effect would likewise have been an accentuation of higher-frequency difference.

In between treble and bass come the musical elements in the play. Music with "a dying fall" opens the play, possibly in the form of a lute solo in the doleful style John Dowland had made popular. (Dowland's *First Booke of Songes or Ayres of Foure Partes with Tableture for the Lute* had appeared in 1597, *The Second Booke* just the year before the play.) Certainly a melancholy note is sounded in each of the songs scripted to be sung by the fool Feste: "O Mistris mine, . . . Youths a stuffe will not endure" in 2.3, "Come away, come away death" in 2.4, snatches of "Hey Robin, iolly Robin, . . . My Ladie is vnkind, *perdie*" in 4.2, and "When that I was and a little tiny boy," which closes the play. A certain droll edge seems to have suited the clown Robert Armin, who had probably joined the company in time to play Touchstone in *As You Like It* as well as Feste in 1601 (Wiles 1987: 144–158). Surviving transcriptions of "When that I was and a little tiny boy" indicate that this song, if not the other three, was performed in a pitch range approximate to a modern tenor.*

When the King's Men took over the Blackfriars in 1609, they moved into an acoustic environment that enhanced the range of pitches sounded in certain earlier plays like *Twelfth Night*. As the first play Shakespeare is likely to have written expressly for the Blackfrairs Theater, *The Tempest* exploits the acoustic potentialities of the new space to the full (Gurr 1996: 367). The script presents an acoustic design with a complexity and subtlety approaching consorted music. Prospero's voice may be the most prominent sound in the mix, but it is surrounded by sounds in a variety of registers, at a variety of volumes. Act Four, scene one, typifies the play's rich acoustic texture (fig. 8.8). The scene can be analyzed in four beats. In the first (ll. 1–33) Prospero exchanges congratulatory speeches with Ferdinand, who has performed the onerous tasks Prospero has set for him. Miranda stands silently by. As Ferdinand and Miranda sit apart, Ariel makes an entry, inaugurating the second beat (ll. 34–163), one of the most acoustically varied sequences in all of Shakespeare's work for the stage. Ariel's speeches, assuming they were spoken by a boy, belong to the treble clef. "*Soft musick*," provided by the Blackfriars consort,

*Determining the precise pitch-ranges both for singing voices and musical instruments is difficult, since there were no absolute standards of pitch in early modern performance. Pitch would be established according to the characteristics of the instruments being played, with the result that notated pitch might differ from actual pitch by as much as a fourth or a fifth. For this information I am indebted to Philip Pickett, music adviser to Shakespeare's Globe in London.

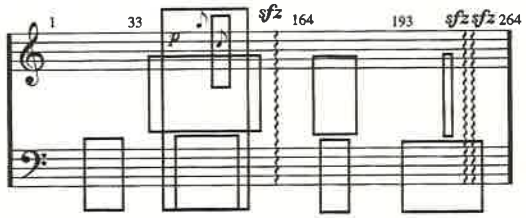

Figure 8.8. Pitches and volume levels, *The Tempest*, 4.1.

accompanies the entry of Iris and the beginning of the wedding masque Prospero conjures for Miranda and Ferdinand (F1623: S. D. before 59). As the score indicates, the full diapason of sounds in the consort's playing, from E_1 more than two octaves below middle C to E_7 more than two octaves above, surrounds and subsumes the pitch ranges of human voices, both as they speak and as they sing. In doing so, the musical consort repeats the effect it had accomplished before the play began: it fills the field of sound across a wide range of pitches, making bass-register male voices part of a much larger whole. Assuming that boys played Iris, Ceres, and Juno, the speaking parts in the masque are all treble, reaching their climax in the song "Honor, riches, marriage, blessing" that the three goddesses sing together. The only lower-frequency sounds in the second beat are the brief speeches Prospero and Ferdinand exchange in between the goddesses' song and the dance of the nymphs and reapers.

The ethereal harmony is interrupted, however, by Prospero's sudden interjection "I had forgot that foule conspiracy of the beast *Calliban*, and his confederates," followed by "*a strange hollow and confused noyse*" that disperses the dancers (F1623: 4.1.139–141 and S.D.). The noise, indicated by jagged lines, ends beat two and starts beat three (ll. 164–193), in which Prospero gives Ariel his instructions for trapping the conspirators with fine apparel. The final beat (ll. 194–264) returns the sound pattern solidly to earth in the speeches of Stephano, Trinculo, and Caliban. "*A noyse of Hunters*" injects cacophony into this lower-frequency matrix, followed by the high-pitched shouts of Prospero and Ariel as they urge on the avenging dog-spirits:

PRO[SPERO]
Hey *Mountaine*, hey.
AR[IEL]
Siluer: there it goes, *Siluer.*
PRO[SPERO]
Fury, Fury: there Tyrant, there: harke, harke.

In the scene's last moments the musical harmony of the masque devolves into what Ariel describes as violent noise: "Harke, they rore" (ll. 254–255, 259, with S.D.). It was just such an acoustic assault—"*A tempestuous noise of Thunder and Lightning*"—that framed the play's polyphony of voices and music in the beginning (S.D. before 1.1.1). For all the acoustic complexity of the play's inner scenes, *The Tempest* ends firmly in the bass register, with the voices of Prospero and other male characters accounting for 90 percent of the sound in Act Five.

The prominence of treble voices in *The Tempest* may be partly an effect of what audiences had come to expect in the Blackfriars in the years just before the King's Men took over the house. Performances by boys' companies at the Blackfriars, in the earlier Paul's playhouse, and elsewhere in the City would have presented an entirely different acoustical profile from performances by predominantly adult companies on the South Bank and north of the walls. As long as the boys' voices had not changed, the pitch range of the sounds they produced would have *all* been in the treble register. The effect would have been altogether delightful in plays like Lyly's *Sapho and Phao* and *Gallathea*, the "musty fopperies of antiquity" (i.e., out-of-date plays from the 1580s) that Paul's Boys and the Blackfriars Boys first put on when they returned to the stage in 1599–1600 after a ten-year absence (Shapiro 1977: 109–110; Gurr 1996: 337–365). But all-treble voices would have offered a curious effect, to say the least, in the "railing plays" for which the companies soon became famous—plays like *A Mad World, My Masters*, *Michaelmas Term*, *The Dutch Courtesan*, *Eastward Ho!*, *Northward Ho!*, *Westward Ho!*, *Epicene*, *The Isle of Gulls*, *Satiromastix*, and *The Knight of the Burning Pestle*. Later criticism knows these "railing" plays as "city comedies." While adult companies did perform such plays—Jonson's *The Alchemist*, for example, was written for the King's Men in 1610—it is striking how many "city comedies" were in fact originally performed by boys' companies. It may not be genre alone that accounts for the relatively greater presence of female characters in these plays. For male characters, however, audiences would have heard an aural discrepancy between speakers and speeches that was not unlike the visual discrepancy they saw between boys' supposedly innocent bodies and the often lewd adults they were impersonating. The "rounded" sound of the indoor playing places would have given these treble voices greater presence than in the "horizontal" soundscape of the amphitheaters, but the acoustic effect would still have lacked the "depth" provided by men's voices. All in all, one can imagine a piping, squawking, chattering effect. That, at least, is what Rosencrantz describes when he tells Hamlet about the new boys' troupes in the city, "an Ayrie of children, little

Yases, that crye out on the top of question; and are most tyrannically clap't for't" (F1623: 2.2.340–342). Eyases are young hawks, screechy in voice, aggressive in body. In performances by the boys' companies some aural relief from the higher-frequency mean may have been provided by members of the troupe who had passed puberty. As the companies gradually became professionalized in the course of the second decade of the century, some of the original cast members stayed on, transforming the boys' companies of 1600 into what might better be styled the "youths' companies" of 1615 and later (Gurr 1996: 359–361).

Venue, genre, and date: the three factors that shaped pitch definition in early modern theater interacted in complicated ways. In general, however, we can describe from 1590 to 1615 a move toward greater variety and subtlety in the range of pitches scripted to be heard. Partly that trend was the result of the companies' exploitation of interior spaces as opposed to outdoor spaces, partly the result of new prominence given to consorted music, partly the result of a shift in repertory from history plays toward tragicomedies. In acoustic design as well as in narrative line, *Henry VIII* (1613) stands at the pivot point of this acoustic shift. From history plays of the 1590s come the flourishes of trumpets in 1.4, 2.4, 4.1, 5.3, and 5.4, the cornets that announce the king's entrances in 1.2 and 2.4, the beating of drums in 1.4, and the *"Noyse and Tumult within"* in 5.3—not to mention the *"Chambers discharged"* in 1.4 that set the Globe's thatched roof on fire (F1623: 584, 565). To the indoor theaters of the new century belong the hautboys that accompany the banquet and masque in 1.4, as well as the large roles assigned to Queen Katherine, Anne Boleyn, and an Old Lady.

Through all the changes in acoustic design, however, the adult companies maintained the centeredness of sound in the bass clef. However rich and varied the treble effects may have been, the base line remained the bass line. The equivalent in consort music would be the use of the largest viol as a "ground bass" that supports all the sounds above and defines the shifts in harmony. Among the very few plays that might seem to challenge this pattern *Antony and Cleopatra* (1606) is the most conspicuous. Cleopatra's share of lines in the play is large: she speaks 622 lines to Antony's 766. In the last scene alone she and Charmian account between them for 60 percent of the lines, wresting the mode of pitch into the treble range for the first time in the play. An analysis of 5.2 by beats indicates, however, the way male voices return the play to the lower-frequency norm that has obtained all along (fig. 8.9). Beat one (ll. 1–108) finds Cleopatra, attended by Iris and Charmian, as she receives Proculeius and Dolabella. A flourish of trumpets announces the second beat (ll. 109–203), in which Caesar

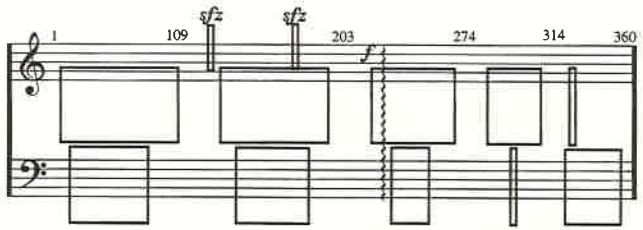

Figure 8.9. Pitches and volume levels, *Antony and Cleopatra*, 5.2.

enters and confronts the queen. In the third beat (ll. 204–274) Cleopatra receives the clown with his deadly basket of figs. In all of these exchanges with male speakers—even with Caesar—Cleopatra maintains her aural command of the field of sound. That authority continues in the fourth beat (ll. 274–314), in which Cleopatra and Charmian are left alone to kill themselves. Only the brief entry of two guards at the end interrupts the higher-frequency register of the play's climactic scene. The proportions are reversed, however, in the final beat (ll. 315–360), in which Caesar reenters to take control: of the stage, of the story, of the field of sound.

Volume and pitch shape the experience of stage plays in complicated ways, but among the three measures of quantity in voice, rhythm is the most basic: it subsumes the other two measures, since changes in volume and pitch occur in regular patterns. The rhythms of speech sound out in a range of phenomena: beats or meter, pace, stress, pauses and attacks, contours of intonation (Handel 1989: 383–459). In physical terms, an actor produces a continuous stream of sounds, through a process speech physiologists call "co-articulation," but he marks certain elements in that continuous stream of sound in certain periodic ways. Members of the audience listen in readiness for those regularities and use them to group the sounds into meaningful patterns. The rhythm of an actor's speech is the aggregate of all these patterns: from split-second iambs to five-second clauses to whole sentences lasting up to a minute. (Modern research indicates a normal speaking rate of 5 syllables per second, or 160 words per minute [Handel 1989: 48].) Many of these rhythmic patterns are acoustic: some phonemes, for example, last longer than others and so call attention to themselves. Other patterns are deliberate, the result of emphasis an actor wishes to give to particular words and phrases. Ultimately, as Stephen Handel argues, all patterns of rhythm derive from the capacities of lung, larynx, and mouth to produce speech sounds:

> Speech involves the complex coordination of many articulatory components, and each component has its own set of dynamic movement con-

> straints and possibilities. The lips, tongue, jaw, and glottis cannot open, close, or move instanteously, because of inertia, muscular slack, and limitations of the neuromuscular system. This implies constraints on the possible speech rhythms; some rhythms simply may not be possible to achieve. It is for this reason that ultimately our understanding of speech rhythms must refer to articulatory dynamics. It may be that language capitalizes on the articulatory restraints to generate distinctions between elements. (1989: 420)

The most fundamental restraint of all is breath. How rapidly or slowly an actor speaks, what stresses he gives to particular phonemes, where he pauses and for how long—all of these choices are a function of how often and how deeply a speaker breathes. *Virtus distinguendi,* "excellence in separating," is how Quintilian describes this particular skill, and he devotes detailed analysis to it in the *Institutio Oratoria.* The elements a speaker must learn to distinguish as he speaks are three: *commata, colon,* and *periodus* (11.3.35–39 in 4: 260–263). For Quintilian, these are, in effect, sound bytes of varying lengths, elements that compose the rhythm of speech. Only by a kind of synecdoche has print culture turned commas, colons, and periods into marks on the page. In the terms of Renaissance rhetoric, commas, colons, and periods are not just signs demarcating particular units of speech; they *are* those units of speech. The literal Greek meanings—*comma* is a cutting off, *colon* a member or a limb—situate speech just where it comes from: in the speaker's body, not on the page.

The coporeality of speech-making is the very foundation of John Hart's *An Orthographie, conteyning the due order and reason, howe to write or paint th*[']*image of mannes voice, most like to the life or nature* (1569). Latin rhetoricians, Hart explains, have translated *colon* as

> *artus membrorum* or *internodium,* which is the space, or the bone, fleshe and skinne betwixt two joyntes, and so (accompting a full sentence, as a complete bodie) these two prickes may well signifie a great part therof,: as of the body, may be taken from the ancle joint to the knée, and from the knée to the huckle or buttock joynt: and knowing thereby that there is more to come, whereas the other first rest of *comma,* doth but in maner devide the small parts (betwixt the joynts) of the hands and féete.

If commas are the bones of the hands and feet, if colons are thighbones, periods figure as the head, "the end of a full and perfite sentence" (1955, 1: 200). The human body provides Hart with one metaphor for speech-making; circularity provides another. The Latin equivalents that Cicero in *Orator* finds for the Greek term *periodos* all suggest roundedness: *ambitus, circuitus, comprehensio, continuatio, circumscriptio* (1939: 3.61.204). "Period," the term in early modern English for the same phenomenon, likewise captures the circular quality of speech-making. Circularity, no less than the joints of the human body, is a "natural" way of visualizing speech. The shape of the field of sound is in fact a circle. Circularity is to the physics of speech-making what the human body is to the physiology. Read on the page, a period is the end of something; heard within the circular field of sound, a period is something in itself, and the "shape" of that something is round. Comma, colon, and period occupy three conceptual categories at once: physiological, rhetorical, and orthographic. They are members of the body, members of speech, and members of a sign system, all at the same time. Spoken within the wooden O, they are also *acoustic* phenomena—dimensions of speech that can be heard.

Such a view of the matter has important consequences for early modern "pointing"—particularly the pointing of texts designed to be declaimed aloud. In fact, not just one system of punctuation obtained in early modern English but two: the older one based on the sound-producing capabilities of the human body existed side by side with—or perhaps beneath—a newer one based on the abstract logic of syntax. "Physiological" and "syntactical" are Walter Ong's terms for these alternative systems of punctuation (Ong 1944: 349–360). "Physiological" punctuation marks the places where a speaker would breathe and raise or lower the pitch of his voice; "syntactical" punctuation marks the separation of sentence elements according to the logic of Latin grammar. Poets, scribes, and grammarians of late antiquity and the Middle Ages had subscribed to the former system; "scientific" students of language in the sixteenth century were arguing for the latter system (Cruttenden 1992: 55–73; Parkes 1993: 50–61). What the rationalizers wanted to do, in effect, was to shift the site of speech from the thorax to the brain—and in that shift to insert one further clause in the Cartesian divorce of mind from body. That ontological step was one that most writers of Shakespeare's generation had yet to take. They wrote in a palimpsest of two different ideas about how writing is related to speech. Take, for example, Ben Jonson's pronouncement in *Timber:* "No glasse renders a mans forme, or likenesse, so true as his speech. Nay, it is likened to a man; and as we consider feature, and composition in a man; so words in Language: in the greatnesse, aptnesse, sound, structure, and harmony of it." The interpolations here of [,], [:], [;], and [.] serve to divide the statement up into logical units: "likenesse," for example, is marked off as an appositive of "man's forme." But the pointings also indicate relatively shorter or longer pauses for breath according to a scheme Jonson articulates in *The English Grammar.* Semicolons require "a meane breathing," commas "somewhat a longer breath," colons and and periods "a more full stay" (1925–1963, 8: 551–552). (Jonson's disagree-

ment with most authorities on the relative time values of colons and semicolons, or perhaps his confusion in *The English Grammar*, is understandable, since [;] had been introduced into printing by Aldus Manutius as recently as 1591 [1925–1963, 11: 209–210].) In this view, the phrase "or likenesse" is less an appositive than a "member"—a "comma"—that asks for a short pause before and after and so acquires a certain aural emphasis. By Jonson's own reckoning, what we have in the whole statement are ten commas, four colons, and two periods. Early modern "pointing" points, then, in two directions at once: toward a linear flow of logic, but even more insistently toward a circle of sound.

The effect of this double orientation is especially pronounced in scripts for the stage. If William Shakespeare's hand is indeed Hand D in *The Booke of Sir Thomas Moore*, it is clear that Shakespeare thought up speeches, wrote them down, and heard them out, all with physiological notation in mind. By modern standards, the 147 lines of Addition II-D to *The Booke of Sir Thomas Moore* is remarkably *under*punctuated. Where modern syntax would distinguish ninety or more separate sentences, the manuscript contains the scribal equivalents of only seven periods (all of them indicated by a [·] well above the base line), one colon, four semicolons (all rendered as [·,]), and 38 commas (Clayton 1969: 22). (By contrast, Stanley Wells and Gary Taylor mark 93 separate sentences in the Oxford text.) Such marks as the writer has chosen to make are all what Richard Mulcaster in his treatise on "the right writing of our English tung" calls "characters signifying . . . but not sounding" (Mulcaster 1582: 148). To "hear" these speeches, we must erase our modern expectations about punctuation, as well as any impulse we might feel to supply silently the punctuation marks that "ought" to be there by modern standards. The result is a set of speeches that *sound* very different from the way they *look* in modernized transcriptions like the one included in the Oxford Shakespeare. The verbal design of *Sir Thomas Moore*, Addition II-D, pits the London mob's one-, two-, and three-line outbursts against More's increasingly longer, ever more eloquent, and finally persuasive speeches. Against the mob's idea of driving away foreigners More argues:

graunt them remoued and graunt that this yo^{r} noyce
hath Chidd downe all the matie of Ingland
ymagin that yo^{u} see the wretched straingers
their babyes at their backs, w^{t} their poor lugage
plodding tooth ports and costs for transportacion
and that yo^{u} sytt as kings in your desyres
aucthoryty quyte sylenct by yo^{r} braule

and yo^{u} in ruff of yo^{r} opynions clothd
what had yo^{u} gott ·,· Ile tell yo^{u}, yo^{u} had taught
how insolenc and strong hand shoold prevayle
how orderd shoold be quelld, and by this patterne
not on of yo^{u} shoold lyve an aged man
for other ruffians as their fancies wrought
wth sealf same hand sealf reasons and sealf right
woold shark on yo^{u} and men lyke ravenous fishes
woold feed on on another.

(Wells and Taylor 1987: 463–467)

What this draft encodes for an actor playing More is not just the words he should speak but the pace and emphasis with which he should speak them—or at least the pace and emphasis with which Shakespeare in the act of writing "heard" such an actor speaking the words. As punctuated, the entire first nine lines are cast as a single aural unit that reaches an explosive climax in "What had yo^{u} gott" (l. 80). In the tension of slowly exhaled breath that mounts from line 72 to line 80, only a single brief pause is explicitly signalled (after "their babyes at their backs," l. 75), though other pauses may be implicit in the line-endings that terminate "hath Chidd downe all the matie of Ingland" (l. 73) and "plodding tooth ports and costs for transportacion" (l. 76). The idiosyncratic notation of three pricks (·,·) that follows "What had yo^{u} gott" signals a major pause—indeed, the one major pause in the entire speech, which happens as well to be its logical turning point. The second half of the speech is likewise notated as a single rhetorical turn, punctuated with minor pauses—a turn that reaches its climactic completion in "woold feed on on another" (l. 87). More's speech has its effect.

Doll before god thats as trewe as the gospell
lincoln nay this a sound fellowe I tell yo^{u} lets mark him

Logically, of course, Lincoln says *two* things in his single line—(1) "Nay, this' a sound fellow, I tell you" and (2) "Let's mark him"—and that is just how his line is punctuated in the modernized Oxford text (l. 98). Physiologically, however, his line is marked as sounds projected in the course of a single breath.

In the "physiological" scheme of punctuation favored by the writer of *Sir Thomas Moore*, Addition II-D, commas indicate not just pauses for breath but the rhetorical events that dictate those pauses—in particular, shifts in pitch and volume. Take for example More's peroration at the end of the scene. What if *you* were in the position of the strangers in England, More asks the London mob. What if *you* sought refuge in France or Flanders, in Germany, Spain, or Portugal?

Why yo^{u} must needs be straingers ·, woold yo^{u} be pleasd
to find a nation of such barbarous temper
that breaking out in hiddious violence
woold not afoord yo^{u}, an abode on earth
whett their detested knyves against yo^{r} throtes
spurne yo^{u} lyke doggs, and lyke as yf that god
owed not nor made not yo^{u}, nor that the elaments
wer not all appropriat to yo^{r} Comforts ·
but Charterd unto them, what woold yo^{u} thinck
to be thus usd, this is the straingers case
and this your montanish inhumanyty

The commas in lines 133, 136, and 138 may indicate brief pauses, but all of those pauses are occasioned by rises in pitch and volume on *you* (ll. 133 and 136) and *them* (l. 138). The implicit contrast between *you* and *them* in lines 130 to 136 is made explicit by the full stop that follows "Comforts" in line 137. Before that stop the talk is of *you;* after that stop the talk is of *them.* Syntactical punctuation has no way of indicating this emphasis, short of the italics to which I myself have resorted. For notating dramatic speech, syntactical punctuation is frustratingly rigid and astonishingly inefficient. The fact that none of the earliest printed texts of Shakespeare's scripts is as lightly punctuated as the draft of Addition II-D to *The Booke of Sir Thomas Moore* should make us wary of reading any of these texts as a precise index to stage practice. At the same time, we must realize that the earliest texts, because they were printed and read within an *episteme* that gave primacy to speech, situate character very differently from texts that have been edited according to the standards of syntactical punctuation.

Sound in early modern theater is important not so much for what it *is* as for what it *signifies.* What audiences actually heard in the theater and what they *imagined* they heard may not always have been the same thing. In the printed text of *Coriolanus,* premiered at the Globe in 1608, there appears a stage direction that calls for one set of sounds while the accompanying speech describes another set. Act Five, scene four, is one of the play's several crowd scenes that are amplified by drums and trumpets:

MES[SENGER]
Why harke you:
Trumpets, Hoboyes, Drums beate, altogether.
The Trumpets, Sack-buts, Psalteries, and Fifes,
Tabors, and Symboles, and the showting Romans
Make the Sunne dance. Hearke you. *A shout within.*
(F1623: 5.4.49–52)

What the audience in fact hears are trumpets, hautboys, and drums—loud enough in themselves. What the Messenger *tells* them they are hearing is a much wider range of instruments and a volume of sound that, figuratively at least, pushes beyond the theater's walls to the limits of the cosmos. Pierre Iselin has called attention to the way in which music in early modern scripts is *always* framed by language—and usually, Iselin argues, in an ironic way that keeps language firmly in control of musical sounds (1995: 96–113). The moment in *Antony and Cleopatra* illustrates Stephen Handel's point that sound is perceived at three distinct levels (1989: 181–182). In trumpets, hautboys, and drums the audience gathered in the Globe would have heard, first of all, certain *physical* phenomena: a range of distinct frequencies and intensities, particular patterns of attack and decay. At the same time, they would have heard certain *perceptual* phenomena that are not so easy to calibrate: "brightness" in the trumpet, "pointedness" in the hautboys, "dryness" in the drums. The Messenger's speech invites the audience, finally, to hear certain *imaginative* phenomena, to hear the sounds *as objects.* Most obviously those objects are the ones named in the Messenger's speech: trumpets, sackbuts, harps, fifes, drums, cymbals, a mob of people. Beyond that, there is the essence of these individual objects: "trumpet-ness," "drum-ness," "mob-ness." By a process of metonymy, the audience also hears the essence of all these objects taken together: danger, anarchy, chaos. What the sounds mean is the result of all three kinds of phenomena —physical, perceptual, imaginative—impinging on the audience's senses at the same time.

What the audience hears, in the last analysis, is not just physical properties of sound, nor even psychological effects, but the acoustic equivalent of a visual scene—an "aura," perhaps. Evidence from scripts written for the outdoor theaters from 1590 to 1610 invites us to distinguish several distinct "auras" or "aural scenes." Brass instruments define what might be called "the royal scene" or, more broadly, "the power scene." High in pitch, forceful in volume, quick in attack and decay, cornets and trumpets produced sounds that were sharp, hard, and bright—properties that were assumed by the royal personages who made their entrances to such sounds. A different sort of aura, "the hunt scene," was established by wind horns. "*Winde hornes. Enter a Lord from hunting, with his traine*" (F1623: Ind1 S. D. after 13): the broad, plangent bursts required in the Induction to *The Taming of the Shrew* are also scripted to be heard in *Titus Andronicus* 2. 2., *A Midsummer Night's Dream* 4.1, *The Tragedy of King Lear* 1.4, and *A Woman Killed With Kindness* (scene 3). "The combat scene" assaulted the audience's ears in bursts of brass, the rumbling of drums, and the bellowing of gunfire. The explosion of firearms, let us recall, ranks

among the very loudest sounds anyone was likely to hear in an age before internal combustion engines. Quick in attack and decay, running the gamut from the trumpet's keening to the drum's riot of multiple pitches to the ordnance's chaos of noise, the sounds of the combat scene served to evoke pitched battles. The same ensemble of sounds might also be used in connection with sword fights. In both the 1604 quarto and the 1623 folio of *Hamlet* gunshots accompany the fencing match between Hamlet and Laertes. "The game scene" takes on aural shape in the tabor's low tap and the pipe's high whistle, as in the morris dance performed in Munday's *John a Kent and John a Cumber,* probably acted by the Admiral's Men in 1589. If pipe and tabor accompanied jigs at the ends of plays, as Kemp's extratheatrical exploits suggest they did, then the game scene of folk festivity provided the sounds ringing in the audience's ears as they left the theater. Although each of these aural scenes has its visual counterpart—presence chamber, woods, battlefield, countryside—each is less a physical place than a kinaesthetic experience. The limits of vision in specifying that experience are indicated by the aura hautboys seem to have created. Technically, hautboys were members of the shawm family, double-reeded instruments whose loud, carrying sound made them a natural for town bands. A persistent distinction in early modern English between shawms in general and hautboys in particular may have turned on pitch or volume or both: "*haut-bois*" means "*high* wood." Taking the hint, most historians of musical instruments assume that hautboys were shawms in the alto (G_3 to D_5) and soprano (D_4 to A_5) ranges. Their shrill quality, sounding to some witnesses like skirling bagpipes, was proverbial (Munrow 1976: 40–41; Galpin 1965: 123; Long 1961–1971, 1: 20–21). The opening stage direction to *Henry VI, Part II* seems to capitalize on this assaultive quality: "*Flourish of Trumpets: Then Hoboyes*" heralds the entrance of King Henry and his court (F1623: S.D. before 1.1). Why both kinds of instruments? What hautboys could provide that early modern trumpets could not was melody. First the trumpets establish command over the sound field, then hautboys come into play as music for a stately passage over the stage. It must have been the example of shawms in town bands that cast hautboys as aural components of "the processional scene." The ceremonial movement of bodies in space helps to explain the conventional use of hautboys as accompaniments to dumb shows in entertainments at the universities, the inns of court, and the court of the realm, not to mention "The Murder of Gonzago" in the folio text of *Hamlet* (Naylor 1931: 169; F1623: 775). In *Antony and Cleopatra,* acted at the Globe in 1609, the direction "*Musicke of the Hoboyes is vnder the Stage*" underscores the pageant-like scene in which Hercules abandons Antony. Within that highly reverberant space the sound of

the instruments must have been very loud indeed—and its totalizing sweep complete. "Musicke i'th'Ayre," proclaims one of the listening soldiers. The other locates it "Vnder the earth" (F1623: 867). It is tempting to describe such a moment as "the cosmic scene," even if Jonson locates that effect in thunder. Power, hunting, combat, game, processional, supernatural: in each of these distinctive fields of sound human voices find a dominant place, but they share the aural scene with artificially produced sounds. When it comes to human voices within the aura of the wooden O, auditors likewise hear an amalgam of physical phenomena (volume and pitch), perceptual phenomena (qualities Quintilian describes as "clear or husky, full or thin, smooth or harsh, narrow or diffuse, rigid or flexible, sharp or blunt"), and imaginative phenomena (the voice of a king, the voice of a maiden disguised as a page, the voice of an air spirit, the voice of an earth spirit). The object the audience hears in a human voice is character.