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UNIVERSITY OF CALIFORNIA

Los Angeles

Vocal Timbre and Technique in Caroline Shaw's *Partita for 8 Voices*

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy

In Music

by

Joshua Hesser Saulle

2019

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2019

ABSTRACT OF THE DISSERTATION

Vocal Timbre and Technique in Caroline Shaw's *Partita for 8 Voices*

by

Joshua Hesser Saulle

Doctor of Philosophy in Music

University of California, Los Angeles, 2019

Professor Ian Krouse, Co-Chair

Professor David Samuel Lefkowitz, Co-Chair

The vocal ensemble Roomful of Teeth has attracted a great deal of attention since its founding in 2009 for its exploration of vocal timbre, extended technique and singing style, and its attempt to forge an expanded vocal palette that transcends both the Western classical tradition as well as any one popular or world singing style. In doing so, it has encouraged the composers with whom it collaborates to elevate timbre to a place of primary compositional importance. One such composer, Caroline Shaw, has become the standard bearer for this new style of vocal ensemble writing with her Pulitzer-prize winning *Partita for 8 Voices*

This paper explores the stylistic and experimental lineages that led to the evolution of Roomful of Teeth, reviews the history and acoustics of vocal timbre itself, and uses spectrographic analysis as the basis for an examination and analysis of Caroline Shaw's compositional use of vocal timbre and special techniques in *Partita for 8 Voices*.

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INTRODUCTION

The arrival of the ensemble Roomful of Teeth, and its expansive, omnivorous brand of vocal eclecticism and athleticism has been a bracing and invigorating influence in a choral and vocal composition scene that for the previous few decades has largely luxuriated in the lush Neo-Romanticism and added-note colorism, or extreme diatonicism of Morten Lauridsen, Eric Whitacre, Arvo Pärt, and their imitators. These aesthetics, by and large, have consolidated a particular late-20th- and early-21st-century “standard” choral sound that partakes of and balances Western bel canto and British-college-choir-derived early-music performance styles. To ears acclimated to this style’s emphasis on a consistent, clear tone with moderate to little vibrato and well-blended ensemble, Roomful of Teeth’s panoply of extended vocal techniques and non-“classical” singing styles can seem like a wild riot of neon and technicolor by comparison.

Of course the techniques and styles Roomful of Teeth learns and teaches to its composer-collaborators are not new – many have been part of various folk traditions for centuries, and others have been common in avant-garde music since the early 20th century. Still others derive from various Western popular styles. Their stylistic eclecticism and often post-minimalist aesthetic are not new either – Meredith Monk and Toby Twining blazed those trails decades ago. What makes Roomful of Teeth different from either of those pioneers is that it is not an ensemble formed and constituted around the vision and aesthetic of one single composer, but which seeds the imaginations of many different composers with the possibilities of an expanded vocal palette and collaborates in cultivating and harvesting the diverse products of differing artistic personalities and approaches.

Among Roomful of Teeth’s diverse and growing repertoire, Caroline Shaw’s *Partita for 8 Voices* has emerged as its best-known and most widely-performed work, and probably the

work that has become most emblematic of RoT's aesthetic and artistic goals. Criticism and reviews of the work, and of much of RoT's repertoire has naturally focused on the trademark explorations of vocal timbre, technique, and singing style that are the group's *raison d'être*. In attempting to describe and discuss the group and its repertoire, and the *Partita* in particular, the well-known pitfalls of trying to use words to talk about timbre become a problem. From unfamiliarity with the techniques, as Anthony Tommasini seems to have shown in a review that mixes up belting and Tuvan throat singing¹, to critics simply defaulting to vague descriptors like "strange," "enigmatic," or "weird," on the one hand, or to eccentric and overwrought language like "supernuminous,"² and most memorably, in reference to the Courante movement, "a 9-minute evocation of angel sex."³

This tendency of language to fail when trying to meaningfully discuss musical timbre is the result of our ears and mind's tendency to perceive timbre holistically, as an object or thing apprehended *in toto*, without what Fales calls "informational consciousness," that is,

the information listeners are able to deduce from a sound is derived from a multitude of unremarkable acoustic details of which a great deal have been processed and interpreted preattentively – that is, without listeners' conscious awareness.⁴

Without having access to the processes by which our own ears analyze and perceive the constituent elements of timbre, we have limited language for discussing its characteristics,

¹ Tommasini (2013): "the nasal styles of throat singing that push the voice into a realm of controlled shouting."

² Tsioulidas (2013)

³ Lowder (2013)

⁴ Fales (2002) 59.

changes, or inter-relationships, having to rely, as Fales writes, on “metaphor, or analogy to other senses.”⁵

This dissertation, then, aims to examine in greater detail and precision the elements of vocal timbre in music, using the technology of spectrographic analysis to buttress, deepen, and the instincts and reactions of our ears, and to assemble a vocabulary for describing and discussing vocal timbre and its compositional use, taking Caroline Shaw’s *Partita for 8 Voices* as a case study.

Chapter 1 places the project of Roomful of Teeth and its composer-partners in context by exploring some of the relevant history of timbral exploration and experimentation in Western vocal and choral music. We examine immediate precursors like Monk and Twining and the various and often overlapping currents in the 20th-century modernist and post-modernist avant-garde, early music performance, and popular and world musics, that informed their work, as well as the development of “standard” Western classical vocal technique and practice.

Chapter 2 reviews basic principles of vocal production and acoustics, especially vowels and vocal formants, articulation, phonation and register, describing and classifying vocal sounds, and other elements that affect vocal timbre.

Chapter 3 reviews and discusses some tools, concepts and approaches for analyzing timbre, particularly the work of Robert Cogan, and some helpful information regarding reading and interpreting spectrograms.

Chapter 4 provides some specific background information on Caroline Shaw, Roomful of Teeth, and the circumstances surrounding the composition of *Partita for 8 Voices* during the Roomful of Teeth MassMoCA residencies, and the composition’s connection to the work of

⁵ Fales (2002) 57.

visual artist Sol LeWitt. This chapter also provides information about some of the specific vocal styles and techniques Shaw uses in *Partita*.

Chapter 5 delves into detailed, movement-by-movement analysis of Caroline Shaw's *Partita for 8 Voices*, seeking to elucidate how Shaw uses her palette of timbres and techniques to create musical shape, flow, expression, and form on both micro- and macro- scales.

Chapter 6 pulls back evaluate the bigger picture of how timbre and vocal techniques help shape and interconnect the work as a whole, and offers conclusions and questions for further thought and analysis.

1. TIMBRAL EXPLORATION IN WESTERN VOCAL MUSIC: ROOMFUL OF TEETH IN HISTORICAL CONTEXT

Before beginning the analytical component of this study, it will be useful to briefly review the development of vocal timbre and timbral manipulation in the context of Western concert and popular music. Such a brief overview is necessarily incomplete and simplistic, but it will help place the current study and its repertoire in a broader context.

1.1 The Renaissance: onomatopoeia and mimesis

From the earliest written records of Western singing practice, musicians have recognized the unique timbral flexibility of the voice. Renaissance theorists and pedagogues on singing commonly identified two main singing styles, *da chiesa* (sometimes *a cappella*) and *da camera*. The first, used in the performance of liturgical and other sacred music in churches, used a much louder, more resonant, and more consistent timbre, with some historians speculating that expressive or ornamental vibrato may have been used. *Da camera*, by contrast, was generally softer and lighter, but was more agile and flexible dynamically and timbrally, and was used for singing secular music, both in public and in private.¹

Notated timbral play in Western vocal and choral music can be seen at least as early as the 1500s, in madrigals, *frottola*, *chansons*, *battaglia*, and other secular works, Figure 1-1 shows the composer Janequin, in his *Chant des oyseaux*, using an imaginative array of syllables to depict birdsong, including (highlighted), syllables whose doubled r on held notes seems to

¹ Uberti (1981)

suggest a sustained tongue-or-uvular trill. In his *La Bataille*, he uses such nonsense syllables to suggest trumpet calls, drumbeats, horses galloping, and other sounds of warfare.

FIGURE 1-1: JANEQUIN, *CHANT DES OYSEAUX* (1527), *SUPERIUS*



Such onomatopoeic word painting and sonic mimicry were a common trope of 16th-century madrigals, particularly in the Italian genre known as madrigal comedies.² Indeed, composers like Vecchi and Banchieri explicitly seem to call for timbral manipulation in madrigals where they require the singers to imitate, by means of different syllables, the sounds of various musical instruments, and even animals, as shown in Figure 1-2. Here, “a cat, a cuckoo, a dog, and an owl, just for fun, improvise a counterpoint above a bass.”³ In the next example (Figure 1-3) “a maiden sings a classic rhyme very beautifully, accompanied by a mouth harp and a lyre.”⁴ Banchieri uses the voiced plosive [b] and changing vowels and diphthongs [io], [i], [ɛu],

² These were collections of madrigals, loosely unified by a common theme, conceit, or, in some cases, a dramatic plot (usually lifted from the *commedia dell'arte*). As with *commedia*, they often included stock characters of various nationalities, professions and social stations (who all had distinctive linguistic dialects or modes of expression and characteristic personal and physical traits). Musically, the madrigal comedies referenced or parodied every conceivable style, from church polyphony to various national folk styles, to the innovations of the *seconda prattica*.

³ “Un cane, un cucco, un gatto e un chiù per spasso/far contrappunto a mente sopra un basso”

⁴ “Canta un ottiva rima, molto bella,/col Biobò e la Lira una Zitella.”

and [ɑ] to mimic the twang of the mouth harp and the amplification of different upper partials produced by changing mouth shape. How literal Banchieri intended these onomatopoeias to sound can only be speculated. Although there is some debate over performance practice, evidence exists that at least some of these madrigal comedies were intended to be (and were) staged,⁵ and it is not difficult to imagine that performers took advantage of the many opportunities for vocal characterization and timbral play offered by the witty texts and diverse musical styles.

FIGURE 1-2: *CONTRAPPONTO BESTIALE ALLA MENTE* FROM *FESTINO NELLA SERA DEL GIOVEDÌ GRASSO* (1608) BY ADRIANO BANCHIERI

Un poco sostenuto

(Cucco)
Cu - cù - cu - cù - cu.cù

(Chiu o vero Zivetta)
Chiù - chiù - chiù

(Gatto)
Mi.au - mi.au - mi.au - mi.au - mi - au mi.a - u - mi -

(Cane)
Ba_bau - ba_bau - ba_bau - ba_bau

(Base al contraponto)
Nul - la - fi - des - gob - bis - si -

⁵ Farahat (1991)

FIGURE 1-3: *MASCHERATA DI VILLANELLE* FROM *FESTINO NELLA SERA DEL GIOVEDÌ GRASSO* BY BANCHIERI

Sostenuto

(Zitella Cantatrice)

a tempo

SOPRANI

CONTRALTI

TENORI I.

TENORI II.

BASSI

(Lira)

(Lira)

(Lira)

(Biobò Cio e Caca pensieri)

Bio bi.ri beu ba beubi bio bi bi o bi.ri bio ba beubi bi.o.

Li li.ron li.ron li.ron li li li.ron li li.ron li.ron li.

Li li.ron li.ron li.ron li li li.ron li.ron li.ron li.

rall.

1.2 Baroque and Classical

During the Baroque and Classical periods, dramatic singing and the improved capabilities of instruments preoccupied composers' imaginations, and the orchestra took over the role of tone-painting, leaving the voice free for textual expression and displays of technical agility and artistic sensitivity. The most important vocal developments in this period had to do with the rise of opera and the beginnings of *bel canto* technique, which aimed to smooth the *passaggio* and minimize the timbral differences between the previously discrete head and chest registers. Increased usable range and timbral consistency were both a response to and a catalyst for a growing appetite among audiences for virtuosic solo singing. Though in one sense individual

vocal timbre was becoming more consistent, the Baroque and early Classical periods saw perhaps the peak diversity of vocal types until the present day, due to the concurrent participation (especially in opera and oratorio) of standard male voices, boy trebles, adult male altos and trebles (both falsettists and *castrati*), and, for the first time, professional female voices. Solo singing within a choral context became a standard feature of the most important choral genres of the period (Masses, cantatas, oratorios, etc.), and, along with the growing use of instrumental ensembles, and (until the late Baroque) the use of polychoralism and antiphonal spatialization, was an important means of introducing timbral and textural variety into choral works.

While the solo voice became ever more trained and professional during this period, by the end of the Classical era, choral singing was undergoing democratizing changes in ensemble size and composition, thanks to the interlinked developments of congregational singing in Protestant churches in Germany and parts of Britain, and the inclusion of women in both secular and sacred ensembles (excepting Italian Catholic and Church of England choirs), and the rise of amateur choral societies and choral festivals, especially in England, based on the popularity of oratorio.

Handel's success with oratorios in 18th-century England had led to a surge in interest in choral singing there. Previously, large choral ensembles had been reserved for the most grand occasions, and rarely exceeded 30 to 40 voices. But in the 1780's, Handel and oratorio festivals in the English provinces attracted often hundreds of singers and instrumentalists. When they spread thereafter to the rest of Europe, they helped create a taste among audiences for new oratorios, and for a choral sound far more massive than had been common since the Renaissance. This in turn led composers of the day, notably Haydn, to compose with larger choruses in mind. Contemporaneous performances of *The Creation* and *The Seasons* featured choruses of 60-80 singers, according to accounts of the time. It also began to create a choral performance practice

that included significant numbers of amateur singers, as opposed to the largely professional ensembles of the Renaissance and Baroque.

As opera developed through the Classical period and into the early Romantic, *bel canto* technique continued to expand the range and power of the operatic voice, especially for sopranos and tenors. This, along with increasing orchestra size, growing realism in theater and opera, and changing moral and social views, led to the decline of the *castrato*, and by the 1830s, they had disappeared almost entirely.⁶

1.3 The Nineteenth Century: Freedom from text

The Romantic period saw both solo and choral singing travel in two different, almost opposing directions. One of these trajectories, inspired by the 19th-century interest in intense emotional states, the supernatural, history and mythology, tended toward larger, heavier, more powerful voices, and very large choruses. The other direction, the result of Romanticism's emphasis on individual expression, emotional interiority, and poetry, led to the flourishing of art song, and an explosion of amateur and semi-professional choral societies of various types and sizes (mens', womens', and childrens' groups, school and community groups, etc.). This latter trend contributed in turn to a resurgence of new writing for a capella or piano-accompanied choir, as well as rediscovery of older music, including Renaissance madrigals. Echoes of

⁶ *Castrati* continued to be employed in church choirs, especially in the Vatican, where the last one performed into the 1920s.

Janequin’s onomatopoetic chansons can be heard in Charles Gounoud’s partsong *La Cigale et la Fourmi*, where singers also sing a section *bouche fermée*. In his *La Chasse*, shown in Figure 1-4, the singers are given notes without words and instructed to imitate (“*Faites sonner*”) the sound of hunting horns (*Cors de chasse*) at different distances.⁷

FIGURE 1-4: GOUNOD, *LA CHASSE*

The musical score for "La Chasse" by Charles Gounod consists of four staves. The top two staves are for vocal parts (Soprano and Bass), and the bottom two are for piano accompaniment. The key signature is one sharp (F#) and the time signature is 3/4. The tempo markings are "Un peu large." and "Tempo.". The dynamics are "ff" (fortissimo) and "pp" (pianissimo). The lyrics "(Cor de Chasse) Faites sonner." and "LOINTAIN." are written below the vocal staves.

Although wordless vocal exercises have been part of vocal pedagogy for centuries, and extended singing on vowel sounds is at least as old as the melismas of plainchant, it was only in

⁷ In addition to the performance directions shown here, this edition includes a note recommending that two-thirds of the singers sing the loud, “near” horns, while the remaining third sing the soft, “distant” ones.

the 19th century that composers began writing completely wordless vocal pieces. Spohr wrote a Sonatina for voice and piano in 1848, but otherwise, most wordless vocal writing took the form of etudes with accompaniment. By the turn of the century, however, the vocalise had become an accepted subgenre of solo vocal composition, and major composers like Faure, Ravel, and Rachmaninoff contributed examples of high musical value. In separating the voice from its traditional role as carrier of text, composers began to treat the voice as an instrumental timbre, and soon composers included wordless singing (especially choral) among their palette of orchestral colors. Examples of this kind of usage are numerous, the most notable being several early Debussy works, culminating with *Sirénes* (1899), the Humming Song from Puccini's *Madama Butterfly* (1904), and 'Neptune' from Holst's *The Planets* (1914-1916), among others. The use of wordless chorus continued through the 20th century and has become a standard mode of choral singing, in both a cappella and accompanied settings. The sound has even become commonplace as a stock trope of Hollywood fantasy and action film scores, where wordless singing (or often, Latin or non-English syllables) signals any number of epic, magical, or ineffable associations.

1.4 Emancipation of Timbre: 1900-1970

For most composers of the previous centuries, unusual vocal timbres were chiefly used for mimetic, onomatopoeic or dramatic purposes in service of a text. The 20th century saw a rapid explosion of interest in emancipating vocal timbre from its subordination to pitch, harmony, and language. Composers began to experiment with a wide array of vocal sounds and techniques, extremes of vocal range, and the timbral possibilities in between speech and singing.

Perhaps the best-known early 20th-century extended vocal technique is *Sprechstimme*.

Though most commonly associated with Schönberg and the Second Viennese School, the earliest notated example was in 1897, in the original melodrama version of Humperdinck's *Königskinder*. Although mixing of spoken word with singing has roots as far back as ancient Greece, Renaissance monody, and operatic recitative, *sprechstimme* likely had its immediate roots in German *singspiel* and melodrama. Kravitt has argued that Humperdinck devised his notation as a way of reconciling the competing claims of declamation and music in the more fully integrated melodramas of the late 19th century, creating an "elevated speech such as Wagner theorized about."⁸ Or he may simply have been trying to exert compositional control over an already established practice of theatrical declamation:

In fact, we may conclude from the advice offered to the actor in Wilhelm Kienzl's book on declamation⁹ that elevated speech was an intrinsic ingredient of the late romantic style of reciting melodramas: "The reciter should guard against one special error - that of letting himself be bound too closely to speechlike pitches. Through the half-sung, half-spoken tones that many reciters employ, . . . speech becomes music."¹⁰

Whereas opera, lieder, and choral music had occasionally made use of spoken or *parlando* delivery or unpitched vocal sounds for dramatic effect, *Sprechstimme* was a mode of rhythmic vocal delivery whose standard timbre was completely freed from the necessity of stable pitch altogether. Although the use of this technique is normally associated with solo singing, as in *Pierrot Lunaire* or the operas of Berg, Schoenberg and others also used *sprechstimme* in

⁸ Kravitt (1976) 575.

⁹ Die Musikalische Deklamation, Leipzig (1885)

¹⁰ Kravitt (1976). 584.

choral singing, as in Schoenberg's *Die Glückliche Hand* and *Psalm 130*. Schoenberg's influence and the impact of *Sprechstimme* was such that it became a commonly-used technique in both solo and choral repertoire by composers as stylistically diverse as Boulez, Dallapiccola, Honegger, Roy Harris, Lutoslawski, Menotti, Milhaud, Orff, William Schuman, and Stockhausen.¹¹

Even as Schoenberg and others emancipated singing from the necessity of pitch, *Sprechstimme* and many of the other new techniques were still being used first and foremost to depict or express a text. Ravel, for example, in his *L'enfant et les sortilèges* (1925) employed a veritable menagerie of vocal sounds, including spoken voice and quasi-*sprechstimme*, pitched and indeterminate choral glissandi, coloratura, and all manner of onomatopoeic syllables for the task of depicting the animal inhabitants of an enchanted garden. But other artists, poets, and composers, notably Luigi Russolo and the Futurists, and their admirers, Antheil and Varèse, argued in favor of treating all sounds as objects in and of themselves, with the potential for compositional use apart from any extramusical meaning. Dadaism also contributed to this process with its emphasis on absurdity and nonsense, collage, and "sound poetry." Erwin Schulhoff's 1919 Dadaist work *Sonata Erotika*, for solo voice, uses the moans, sighs and grunts of sexual intercourse as its only material.

Russolo's Futurist manifesto *The Art of Noises* laid the philosophical foundations for Pierre Schaefer's later *musique concrète* as well as the aesthetics of Cage. In his tract, Russolo laid out six categories of noise, the fifth of which comprises "Voices of animals and people: Shouts, moans, screams, laughter, rattlings, sobs." Two other categories also contain vocal sounds: "whistles, snores, snorts.... whispers, mutterings, grumbles, grunts, gurgles." In his

¹¹ Sander (1970), 11.

Canzone Rumorista (1916) for soprano, violin, piano, and noise machines of his own invention, Russolo has the soprano utilize several of these sounds, along with tongue trills, and an extremely narrow, constricted singing voice at the beginning and end of the piece. In between, she sings and speaks a futurist sound poem by Depero, shown in Figure 1-5.

FIGURE 1-5: FORTUNATO DEPERO, *CANZONE RUMORISTA*



In treating phonemes and vocables like these for their sonic character rather than linguistic meaning, and explicitly resisting the idea of simple onomatopoeia, Russolo and his followers completed the separation, begun by the composers of vocalises and wordless choruses, of the voice from its linguistic function.

The experimental composers of the late 1950s through the 1970s took to heart Russolo's exhortation to use the full range of vocal sounds as raw material. Many of these composers were also concurrently exploring electronic and tape music, and that experience influenced their treatment of the acoustic voice, as did the dramatic and textual approaches of absurdist theater. John Cage's *Aria with Fontana Mix* and Luciano Berio's *Sequenza III* (both in collaboration with singer Cathy Berberian) mimicked the timbral shifts and jump-cut editing of many tape pieces:

Berberian had lived for three years in a world obsessed by epics of tape montage... In response, she had developed her own form of 'domestic clowning': a one-woman simulacrum of rapid tape editing that leapt from one type of voice to another, but maintained the expressive integrity of each.

Berio, working intimately with Berberian, developed a detailed notational system for *Sequenza III* that indicated types of sounds and techniques quite precisely while still building different degrees of interpretive freedom into the score. In Figure 1-6, we see notation for the performer speaking only (on one staff line), singing with only a contour that must be followed (three lines), and singing without set pitches, but observing the notated intervals (five lines):

FIGURE 1-6: BERIO, *SEQUENZA III*, CA. 4'



Berberian's 'clowning' was also the inspiration for Cage's *Aria*; however, he approached it in typically Cageian fashion:

With his showman's flair, Cage decided to turn this private joke into a public display. Berberian gave him texts in five different languages (Armenian, Russian, Italian, French and English). These he broke up into fragments to which he allocated ten different singing styles to be chosen by the performer. (In Berberian's case these were jazz, lyric contralto, *sprechstimme*, dramatic, Marlene Dietrich, coloratura, folk, oriental, baby, and nasal.) The alternating styles were

to be punctuated by different 'noises' (Berberian used mainly vocal ones).¹²

It is interesting that Cage effected timbral changes in this piece not by explicitly directing or notating them, as Berio did in *Sequenza III*, but by assigning the singer a number of singing *styles* in which to interpret the graphic score. This was in line with the chance and improvisational procedures he had begun to explore. It also anticipates the pastiche of postmodernism, and the mining of diverse singing styles that became a hallmark of Meredith Monk, Toby Twining, and eventually, Roomful of Teeth and their associated composers.

Although much of the vocal experimentation of this period centered (for practical as well as aesthetic reasons) on the solo voice, ensemble and choral music was not ignored. Varese, in his unfinished *Nocturnal* (1961), played with timbral correspondences between low orchestral instruments (especially percussion) and a chorus of basses whispering, rasping, and singing in its deepest register, highlighting some of the voices' noisy elements as well as the percussive transients of consonants. Ligeti, via micropolyphony in *Requiem* (1965), and Penderecki, through aleatory, created vocal sound-masses where timbre and texture were inseparable. Stockhausen, in addition to using similar timbral techniques as Berio and Berberian in *Momente* (1965), brought the technique of overtone singing into concert music with his 1968 work *Stimmung*, for six voices.¹³ Perhaps because its effect is rooted in, and often amplified by, harmony, overtone singing has been explored quite a bit in choral music, by composers such as David Hykes, Stephen Leek and Stuart Hinds.

¹² Osmond-Smith (2004), 5.

¹³ Stockhausen's wife Mary, in her memoir *Ich hänge im Triolengitter: Mein Leben mit Karlheinz Stockhausen*, recounts how he arrived at the technique after hearing his young son producing overtones while humming in his sleep. Whether Stockhausen was also familiar with the technique's long history in Tibetan and Mongolian folk and sacred music is not immediately clear.

1.5 Late Twentieth Century: Eclecticism and Collaboration

During the latter half of the 20th century, the range of influences on conceptions of vocal timbre in Western art music increased dramatically. As some composers and performers reacted to the hegemony of serialism and avant-garde modernism, they looked for inspiration to pre-tonal music, to jazz, rock, folk, and other popular genres, to music of many non-Western cultures, and to other performing arts like dance and theater. Three of the most influential trends for timbral expansion in vocal music in which these various sources converged were minimalism, the early music movement, and increasing receptiveness to non-Western and popular musics, as well as synthesis between music and other disciplines, giving rise to the genre known as performance art.

During the first half of the 20th century, scholars and performers seeking to create more historically accurate performances researched and reconstructed the instruments and performance practices of early music. The two main debates regarding choral music (sacred music in particular) were whether instruments were also used, and the timbral quality of the singing, specifically, the use of vibrato. By the late 1970s and early 80s, scholars and performers had decided on small (usually 8 singers or fewer) *a capella* ensembles, and favored the so-called “Oxbridge sound”: a “pure,” clear, light vocal timbre with little to no vibrato.¹⁴ This “anti-romantic” early music choral timbre also proved to be very attractive to composers of new choral music, who sought an alternative to modernist expressionism without returning to late-19th-century tonality. It also offered, in place of the large, unruly, volunteer or semiprofessional choir with limited rehearsal time and comfort with the unfamiliar, small ensembles of crack vocalists

¹⁴ In his *The Invention of Medieval Music*, Daniel Leech-Wilkinson has described how this historical hypothesis was related to (among other things) existing practices of English cathedral and university choirs during the 1960s-1980s.

with the skill and discipline to master fine details of microtonal intonation, or new and experimental vocal techniques. When Stockhausen composed *Stimmung*, it was for the early music sextet Collegium Vocale Köln, and when Arvo Pärt combined minimalism and medieval chant in his “tintinnabuli” style of the late 1970s, groups like the Hilliard Ensemble were a natural fit. The subsequent popularity of Pärt’s music in particular (and his curation by ECM records, along with other minimalist composers and experimental jazz artists) did much to solidify the stylistic overlap between early music singing and new music singing, and by the end of the 20th century, even neo-Romantic composers like Morten Lauridsen and Eric Whitacre composed with the “English sound” clearly in mind. Whitacre summed up the appeal of the practice to his style:

In my experience, the first thing is the sound production. There is a clear, straight tone that is a hallmark of British choirs, especially the women, that is paradise. When you create a cluster chord you can hear every note; it creates a true shimmer, you get a cloud of overtones.¹⁵

Elizabeth Randall Upton has proposed that there was also significant interaction between the early music movement of the 60s and 70s and the concurrent folk-pop revival. Indeed, popular music genres generally gained increasing influence over the course of the 20th century, with hugely consequential effects on vocal music of all types. Perhaps the single most significant development spurred by popular music was the electric amplification of the voice. Before the advent of microphones, jazz, blues, and Broadway singers developed the technique called “belting” (driving the chest voice up into the range of notes normally sung in mixed or head voice) to help project over the instrumental accompaniment. But with amplification, the voice

¹⁵ Armitage, Simon. “Paradise Lost: An Interview with Eric Whitacre” *The Oxford Culture Review*, 2015 <http://theoxfordculturereview.com/2015/06/22/paradise-lost-an-interview-with-eric-whitacre/>

was freed from the necessity to project, enabling singers such as Billie Holliday and Bing Crosby to use softer, more delicate, and more intimate colors and inflections. Later in the century, soul and rock singers like James Brown, Gene Simmons, and Stephen Tyler would go to the other extreme and use amplification to increase the visceral power and shocking effect of loud and harsh sounds like screams, growls, grunts, and groans. Under the microscope of amplification, every nuance and imperfection of a voice could be examined, and it is perhaps not surprising that “unusual” voices – Holliday, Louis Armstrong, Bob Dylan, Janis Joplin, Tom Waits – became just as popular for their uniqueness or strangeness as others were for their conventional beauty.

Composers of art music also realized the potential for using amplification to access a huge range of extremely subtle vocal sounds and techniques that would otherwise be covered by instruments or lost in all but the most intimate venues. These included breath sounds, ingressive (inhalative) phonation, lip and mouth smacking, and a host of clicks, pops, grunts, groans, hisses, Along with amplification, composers also took advantage of increasingly sophisticated electronics to process, manipulate, and layer acoustic sound to extend the range of vocal timbre beyond what the physical apparatus could normally produce. Used heavily by rock and electronic pop music artists from the Beatles to Madonna to Björk, electronic voice manipulation also played an important role in the work of Laurie Anderson, Diamanda Galàs, and other performance artists of the 1970-90s. Anderson is best known for the iconic use of vocoder in her song *O Superman*. In her apocalyptic magnum opus, *Masque of the Red Death* (1984), Galàs used electronic processing techniques to transform her own voice into a wide array of supernatural and Satanic voices with which to depict and protest the ravages of the AIDS epidemic.

Genre crossover and fusion was a hallmark of postmodernism in Western art. Minimalism had already incorporated elements of jazz, West African and Indonesian music, and

early music, and as its influence grew, it inspired a group of vocal and choral composers whose genre crossovers became ever more eclectic. They borrowed vocal techniques from many non-Western traditions in addition to Western popular and folk styles. In her “Notes on the Voice”, Meredith Monk catalogued a chronological list of “discoveries” including “Celtic, Mayan, Incan, Hebrew, Atlantean, Arabic, Slavic, Tibetan roots.”¹⁶ Monk’s vocal explorations transcended mere culture and geography, however. Having trained and worked simultaneously in music, dance, and theater, she approached the voice from a dancer’s or actor’s perspective, as another performative expression of her physicality and identity. Her improvisational, embodied vocal experimentation process sought to imagine the voices of different human or non-human identities, species, and states of being, for example:

“The voice of God... the voice of the 80-year-old human, the voice of the 800-year-old human, the voice of the 8-year-old human... the naked voice, the female voice... the morning voice, the voice softening as the sun rises... voices of animals, plants, insects...”¹⁷

Monk’s process was highly intuitive and relied on improvisation and direct work with the hand-picked members of her professional ensemble to develop sounds and techniques and the details of specific textures and timbres. Much of this work was done orally and aurally, and preserved in the memories of the performers, or in recordings, as opposed to written scores. Appropriately, Monk has described herself as a folk musician, rather than a minimalist composer:

I come from a folk music tradition. I was a folk singer with a guitar. The repetition in my music I think of as being like folk music: you have your chorus and verse... The minimalist thing is about reduction. Vocally, I have always thought about magnification, expansion. The repetitions are just a layer for the voice to take off from and go somewhere, and also to land on again.¹⁸

¹⁶ Monk (1976)

¹⁷ Ibid.

¹⁸ Interview with Meredith Monk quoted in Gann (1997) 209.

Whereas the timbral vocal techniques of avant-garde modernist works were often ephemeral and theatrical in their gestural, the repetitions of minimalism allowed Monk to isolate and capture familiar and unusual vocal sounds for deeper examination by both performers and listeners.

Another composer/performer who has followed a similar path to Monk is Toby Twining. Twining grew up in a musical family, playing gospel, rock, and Texas blues as a youth. But as he tells it he quickly became a voracious musical omnivore:

At age 16 I longed to expand my compositional palette and started listening to classical music. The European art music repertoire was almost entirely new to me. In addition to that, over the next 12 years or so, I learned some Jewish folk music, immersed myself in Early music, Ghanaian drumming, Ba Benzele vocal music, throat singing, improvisation at the piano for modern dance classes, the 20th century avant garde and studied composition with Ben Johnston ... While hanging around after graduation at the University of Illinois in Urbana, my friend Bill Brooks (now at York, UK) asked me to sing in a concert that featured *Stimmung*, Messiaen's *Cinq Rechants* and Cage's *Song Books*. Performing these works gave me a sense of terra incognita—the potential for extended vocal techniques with expansive structures—and I felt that all the mixed experience of my musical past coalesced finally in a vision for a new vocal sound. I'd like to think that the human voice can actually take a leading role in musical innovation again.¹⁹

In addition to these styles and techniques, Twining makes extensive use of yodeling, microtonal inflections, registral extremes, and an often dense, jazz-inflected, groove-driven harmonic and textural style. Both Monk's and Twining's vocalisms are often untexted, or treat texts as phonemic and timbral generators rather than (or as well as) expressive of linguistic meaning. Like Monk, Twining recruited and works closely with his own ensemble of highly skilled singers.

¹⁹ Interview with Toby Twining: <http://www.sequenza21.com/2011/11/2011-vital-vox-festival-interviews-with-toby-twining-and-iva-bittova>

1.6 Roomful of Teeth

From Monk and Twining a direct line leads to Roomful of Teeth: one of the current members of Twining's ensemble, Avery Griffin, is also a charter member of Roomful of Teeth, and Twining has written for the group. The liner notes for RoT's debut album list Twining, along with Monk and Berberian, as "Inspirations." While RoT has the same inclusive, expansionist aesthetic, and explores many of the same techniques as Monk and Twining, its approach is as much pedagogical as experimental. Whereas in Monk's or Twining's ensembles, singers would be both the recipients of a composer-director's study of or experimentation with non-western techniques, as well as the co-originators of vocal timbres and techniques through the collaborative rehearsal/composition process, RoT – singers, composers, and director – approach these techniques together as students:

Roomful of Teeth gathers annually at the Massachusetts Museum of Contemporary Art (MASS MoCA) in North Adams, Massachusetts, where they've studied with some of the world's top performers and teachers in Tuvan throat singing, yodeling, Broadway belting, Inuit throat singing, Korean P'ansori, Georgian singing, Sardinian *cantu a tenore*, Hindustani music, Persian classical singing and Death Metal singing.²⁰

RoT's founder and director, Brad Wells, came up through the rigorous classical training of Yale, has sung with high-level early music groups including Paul Hillier's Theatre of Voices, and conducted a wide range of choruses, from large university and symphonic groups to children's choirs to small, professional specialty groups. As a conductor, teacher, and researcher, Wells acknowledged the pedagogical impulse was as much a driving force in founding RoT as his own aesthetic, compositional interest – perhaps more so, in his own telling:

[I founded Roomful of Teeth] to scratch an itch, really. I wanted to open up possibilities. ... My ears had been searching, aching for new sound combinations that I wasn't hearing out in the world. I had always enjoyed composing but didn't feel confident to be the composer-in-chief

²⁰ <http://www.roomfulofteeth.org/roomful-of-teeth>

of a project, but I knew lots of composers I loved. I had met vocalists from different traditions whom I had confidence in as teachers. And then I thought, I'm just going to find some really talented young singers and see if they can be the kind of sponges I suspect they can be and let the composers make what they make and see what happens...

Wells also speaks of a sense that the success of RoT has been due in part to good timing, to an openness within the classical vocal community to exploring and incorporating other styles and traditions:

... I have some sense of why I waited as long as I did to start ... I wonder if one of the... pieces of the puzzle that needed to fall into place... was a sense that there was an approval in the current climate for this sort of thing among classical singers. I think perhaps fifteen years ago it would have been a tougher prospect to get as many talented young singers as I did interested and ready to go...²¹

While this may seem to ignore the accomplishments and professionalism of previous ensembles like Monk's or Twining's, there is some truth to the claim that young classically trained singers today are far more likely to be versed in popular and/or non-Western singing styles as well. Even academic vocal pedagogy has expanded its purview to include some of these other styles, to the extent that Broadway and pop-style belting, once universally deplored as vocal suicide by classical pedagogues, is now considered a sufficiently important style that singers should learn to do it properly to lower the risk of vocal damage.

This mainstreaming of cross-genre vocalism is due in no small part to the work of Monk and Twining and other similar artists, whose work represented a convergence of the 20th-century trends toward vocal experimentation, exploration and overlapping of popular music, world music, and pre-tonal Western music, and use of microphone amplification and electronic processing. RoT not only takes advantage of this cross-genre openness, it seeks to advance it,

²¹ Interview with Brad Wells by 21cm.org: <http://21cm.org/magazine/artist-features/2017/01/04/a-conversation-with-brad-wells/>

bringing the type of vocal exploration Monk and Twining did farther out of the experimental “classical” ghetto and to a broader audience, to the extent that Wells and RoT do not even cast themselves as a classical group, instead calling themselves a “vocal band.” A browse through the websites of many of the composers who have worked with RoT reveal a substantial number work within and across various genres and styles, including pop, indie, rock, hip-hop, jazz, and film and commercial music.

This type of all-inclusive stylistic mixing is not without its pitfalls, however, particularly where non-Western music traditions are concerned. In an interview with *IndyWeekly.com*, Wells replied at some length to a question on the danger of cultural appropriation:

Our feeling is that the experience of studying these techniques is very much about encountering the culture of singing that an expert will bring to us. In addition to learning some of the mechanics of Inuit throat singing, we spent a week getting to know these two singers from northern Quebec – what's behind their traditions, who taught them, why did these women do it. There's a kind of broader learning that's part of our exploration.

Then there's a kind of experience of echo. We don't hold ourselves as practitioners in any expert way of any of these techniques. It's more like the voices have been expanded in terms of what they've experienced and what's available to them.

I remember, a few months ago, talking to an anthropology professor who had studied textiles on some Southeast Asian island about how the textiles responded to Westerners coming through from the fifteen-hundreds on. The artists on those islands immediately started to take advantage of Western art aspects, sometimes subtly, sometimes less so.

The question of cultural appropriation assumes that the powerful culture is the only one that is involved in the exchange, but in fact these exchanges are happening constantly. There's an arrogance in our role, thinking of ourselves as the powerful culture and handpicking little things to use to our profit. These exchanges happen everywhere all the time, and you can't stop them. They can enrich everybody.²²

While Wells' final thought there about the power dynamics involved may seem a bit wishful and naïve, it displays at least a vision of RoT as participating in a larger cultural permeability, born of a post-postcolonial, technology-abetted globalism. Yet even as Wells and RoT acknowledge and approach with respect the cultural context of a vocal tradition, they also in some sense

²² Ruccia (2016): <https://indyweek.com/music/features/roomful-teeth-sings-sounds-world/>

abstract tradition from culture, repurposing it as pure technique, as raw material for use by composers in ways that may not refer or relate to its original cultural context. One could argue this is cultural appropriation in its purest form, or conversely, that the ambition, at least, is to de-privilege any one style while de-exoticizing others, placing all possibilities on equal footing in what Wells called a “borderless” vocal palette. The answer ultimately comes down to how each composer chooses to use techniques drawn from other singing cultures – are they used in ways that exoticize or fetishize the original culture? Are they being used in more purely timbral, non-referential ways? While these questions are not the primary focus of this dissertation, it is an important one to keep in mind as we think about the broader musical significance of RoT in the contemporary music scene, and about Shaw’s *Partita* in particular.

2. ELEMENTS OF VOCAL TIMBRE

The terms used to describe timbre are notoriously subjective and slippery, and this is especially true for that most individually variable and subjectively understood instrument, the voice. In order to make such terms as ‘bright,’ ‘dark,’ ‘rich,’ ‘thin,’ ‘warm,’ ‘cold,’ etc., slightly less slippery, a basic understanding of how the sounds and timbres of the voice are produced is appropriate. Readers who are already familiar with these basic concepts of vocal physiology and phonetics may wish to skip ahead.

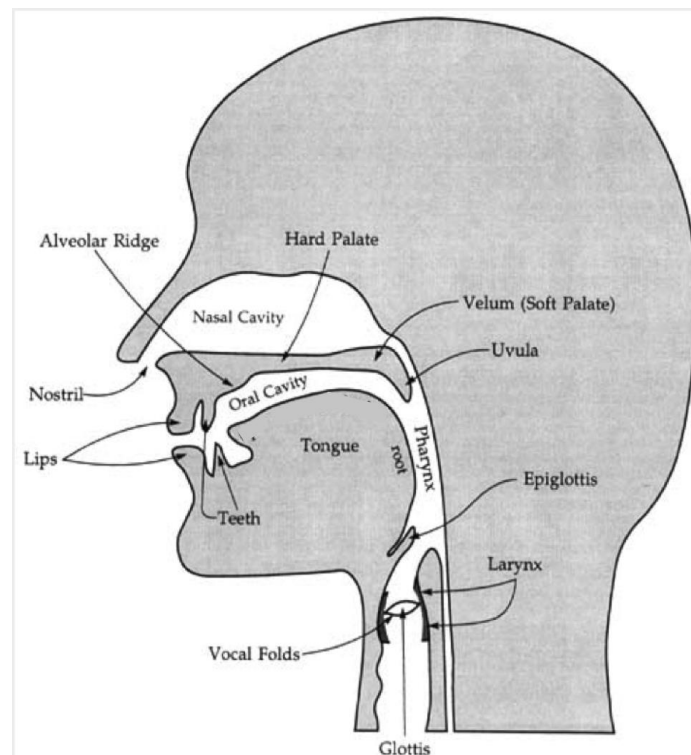
2.1 Vocal Production

The basic source/filter theory of vocal production should be familiar to most musicians: Pressure in the lungs forces air up the larynx and through the closed glottis, causing the tightened vocal folds to vibrate. These vibrations (a fundamental and its harmonic overtones), called the *source* signal, are then amplified by the resonant spaces of the vocal tract, which is (very roughly) analagous to the cylindrical body of a wind or brass instrument. In all instruments, the physical properties of the resonator (size, shape, and material composition) give it specific resonant frequencies, or *formants*, which not only amplify but also *filter* the source signal, boosting some of its partials and attenuating others. The resultant composite, or *spectral envelope*, of source spectrum plus resonance profile is one of the most important factors in creating the sound’s *timbre*. This is the reason a voice sounds different than a clarinet or a trumpet, and why two voices (or a violin and a viola, or a European and an American oboe, for that matter) can be distinguished from each other.

Where the voice differs significantly from most instruments is in its flexibility. In most

instruments, the size, shape, and material properties of the resonator/filter are fixed, or changeable only by relatively small degrees. This limits the resonance profiles that can apply to the source, and therefore, the ability to change and control timbres. The vocal tract, on the other hand, has an incredible degree of plasticity even within its anatomical limits. Consider how very different it feels to pronounce the vowels [i] as in “see” and [ɔ] as in “saw.” The vocal tract does not merely amplify and resonate the source signal; its resonances can be changed and shaped by using the articulators (throat muscles, tongue, palates, teeth and lips) to alter the size and shape of resonant spaces within the vocal tract (pharynx, mouth, nasal cavity). The main resonance chambers of the vocal tract are the larynx, pharynx, oral cavity, and nasal cavity, shown in Figure 2-1 along with other main anatomical features of the vocal apparatus.

FIGURE 2-1: HUMAN VOCAL APPARATUS (LUNGS NOT SHOWN)



2.2 The Letter of the Voice: Vowels and the vocal apparatus

Singing, in many traditions including the Western art tradition, takes place largely using vowel sounds, which are best able of all vocal sounds to project pitch and resonance. Indeed, the word ‘vowel’ itself is derived from the Latin *vocalis littera*, meaning “letter of the voice.” Thus it is necessary to address in detail the role vowels play in creating and changing vocal color. Vowels are classified by phoneticians as pulmonic sounds (caused by lung-pressured air) produced with an open or unobstructed vocal tract.¹

Early phoneticians classified vowels according to the anatomical mechanics of their production by the vocal articulators, chiefly the tongue and the lips. In this system, there are three main parameters determining vowel sounds: tongue (and to some extent jaw) *height*, tongue body *frontness* or *backness*), and lip *roundedness*.² If we examine MRI images of a speaker pronouncing the vowels [i], [ɛ], and [a] (Figure 2-2a-c), we see that between the first two, the tongue moves lower in the mouth (or, more accurately, the amount of space between the highest point of the tongue and the hard palate increases). As the tongue falls, it also begins to flatten and spread back toward the throat. Between [ɛ] and [a], both motions continue in even greater degree.

¹ Closure or constriction of the vocal tract or contact between the tongue and other articulators causes air pressure buildups or perturbations elsewhere than the glottis, producing the various types of consonants. An exception to this definition is the so-called *rhotic* vowel, [ɾ], which often involves the back of the tongue approaching or even touching the molars.

² Rounding the lips involves extending only the lips forward in a circular shape, as if saying [u] while maintaining the tongue and jaw position of the vowel unchanged.

FIGURE 2-2A-C: TONGUE POSITIONS OF [I], [E], AND [A]

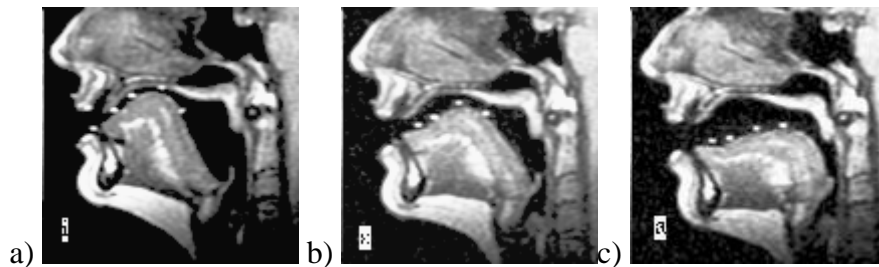
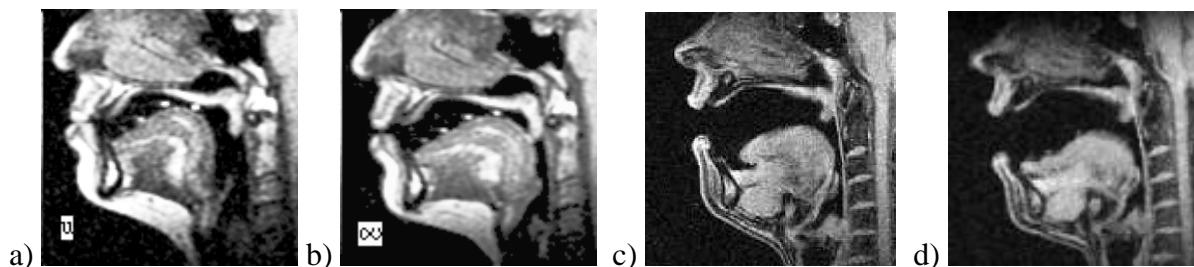


FIGURE 2-3A-D: TONGUE POSITIONS OF [U], [O], [ɔ] AND [ɑ]

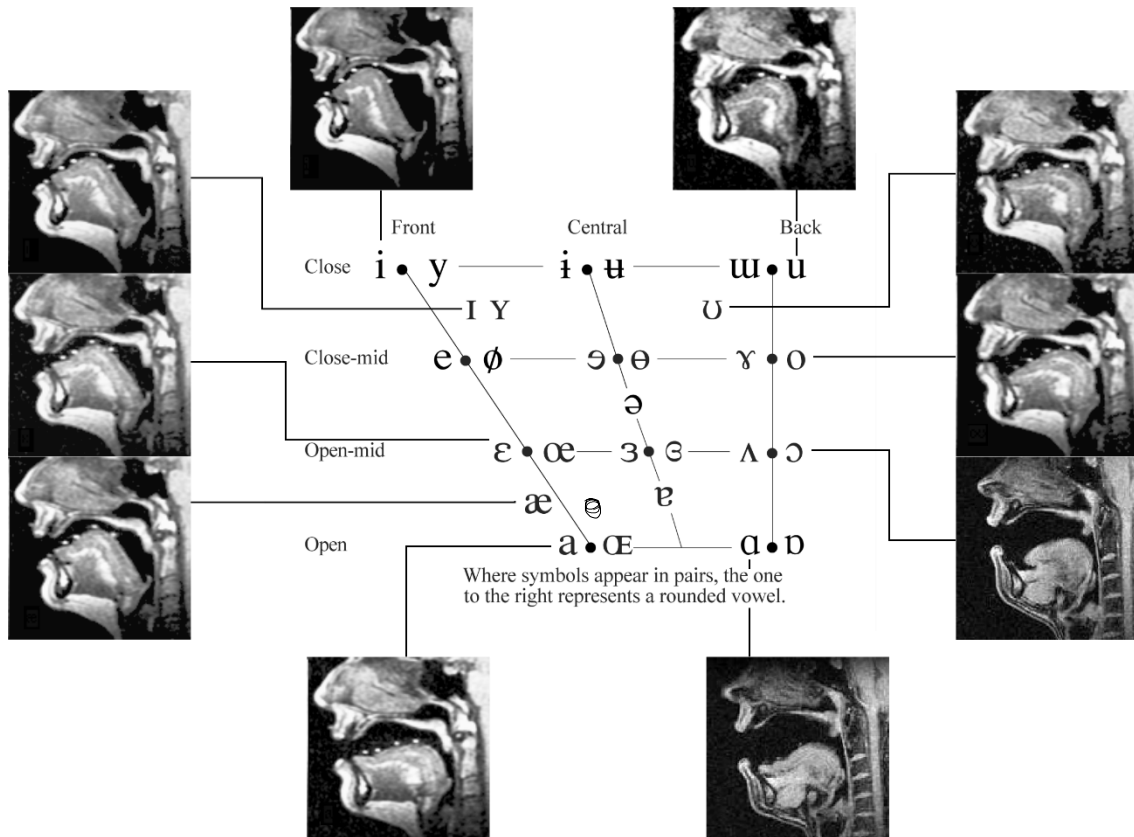


Conversely, if we compare MRIs of [u], [o], [ɔ], and [ɑ] (Figure 2-3) we can see a similar widening of the space between the tongue and the palate, but here the bulk of the tongue mass stays bunched farther back toward the throat. In addition, as can be seen in Figure 2-3a and 2-3b, the lips push forward to become significantly rounded. Notice that if we compare [a] and [ɑ] (2-2c and 2-3d), the tongue is indeed more bunched-up toward the throat in [ɑ], and the mouth is opened wider. Perhaps even more significantly, notice the difference between the two in the amount of space in the pharynx (the area right behind the root of the tongue). More on this later.

These anatomical classifications eventually became codified in the well-known vowel quadrilateral used by the International Phonetic Association, which is shown at the center of

Figure 2-4, along with accompanying MRI images of selected vowels. In this chart, the horizontal axis corresponds to the parameter of tongue frontness or backness, while the vertical axis corresponds to the parameter of tongue and jaw height, now usually referred to as openness or closedness. The third parameter, lip roundedness, is shown by pairing vowels (e.g. [ɑ•ɒ]), on the bottom right-hand corner of the chart), where the symbols on the left and right represent unrounded and rounded versions of the vowel, respectively.

FIGURE 2-4: IPA VOWEL QUADRILATERAL WITH ACCOMPANYING MRI IMAGES FOR SELECTED CARDINAL VOWELS



As closer scrutiny of the vowel chart and MRI images reveals, the actual position of the tongue is not always consistent with placement of vowels on the chart. For example, [ɛ] and [ɔ] should have the same degree of openness/tongue height, according to the chart, but [ɛ] clearly has a more closed position. Similarly, [ɔ] and [u] both look like they should have the same degree of backness, but this also is not borne out by the MRIs. In part this inconsistency of placement is due to the variability of vowel pronunciation between different individual speakers of different languages, accents and dialects, as well as the limitations of MRI technology.³ But in a more general sense, it is a result of early phoneticians, limited by the technology of the late 19th and early 20th centuries, describing the *production* of a sound, rather than the sound itself. Peter Ladefoged likens these phoneticians to ancient astronomers, who could only base their conclusions on naked-eye observations.

2.3 Acoustics of Vowels and Formants

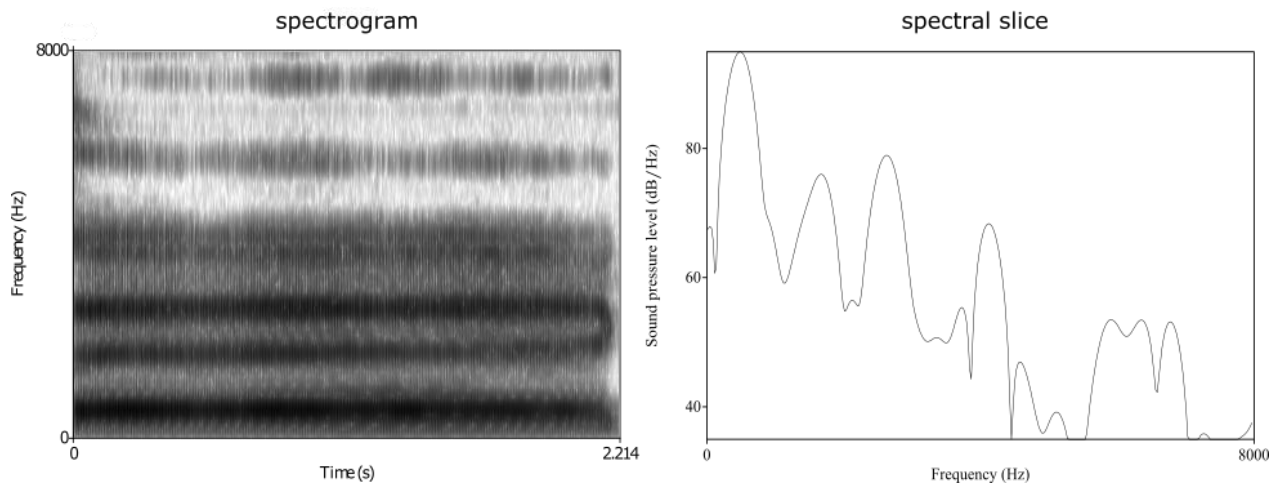
What these phoneticians were unaware of (or, later, were aware of but had no precise way of examining) was that while vowels are *pronounced* by changing the position and shape of the jaw, tongue, and lips, they are in fact *caused* by changing frequency resonances within the spectrum of the sound itself.⁴ As we have seen from our MRI images, changing the position and shape of the jaw, tongue and lips changes the size and shape of the entire vocal tract. The different resulting configurations create different natural resonances (much as differently sized and shaped rooms reverberate differently). These resonances amplify some frequency bands in

³ The long scan times for many MRI machines require a subject to sustain a vowel for the entire scan to obtain a clear image.

⁴ To clarify this distinction, consider that vowels can be electronically synthesized using only sine tones, without benefit of any human anatomy at all.

the spectrum of the vocal sound and dampen others. These amplified frequency bands, called *formants*, appear in spectrograms as dark horizontal bands, and in spectrum slice graphs as the highest peaks, as can be seen in Figure 2-5.

FIGURE 2-5: SPECTROGRAM AND SPECTRUM ANALYSIS GRAPH OF THE AUTHOR SINGING THE VOWEL [E] ON A2 (110Hz)⁵



Although all the frequencies present in a vocal sound obviously contribute to its timbre, phoneticians have determined that the differentiation of vowel sounds is almost entirely dependent on the first three formants (formants are always numbered in ascending order from lowest in frequency to highest).⁶

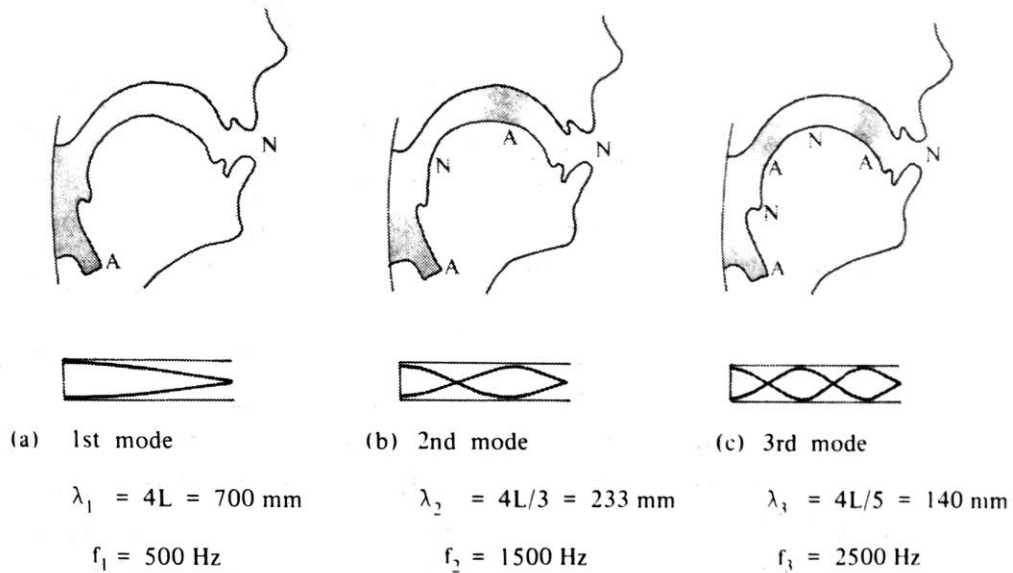
By comparing spectral/frequency analyses of vowel sounds with articulatory measurements and MRI images such as those in Example 7, phoneticians linked jaw *openness* to

⁵ Although overtones of the voice can reach almost to the upper limit of human hearing, for the purposes of making the most important formants clearly visible, these spectral images use an upper limit of 5000 Hz, which covers the range in which the majority of vocal frequencies are found.

⁶ In fact most English vowels can be electronically synthesized using only the first two. A demonstration of this can be found at <https://auditoryneuroscience.com/topics/two-formant-artificial-vowels>

Formant 1 (F1) and tongue *backness* to Formant 2 (F2). In fact, the interaction is quite a bit more complex, and has to do with the shape and size of the vocal tract in relation to the nodes and antinodes of the sound wave. If we think of the vocal tract as a cylindrical resonator closed at one end (the glottis) and open at the other (the lips), it will resonate the source signal according to the modes illustrated in Figure 2-6.

FIGURE 2-6: VOCAL TRACT CYLINDER MODEL WITH RESONANCES FOR 17.5CM ADULT MALE VOCAL TRACT⁷



This model results in a standing wave whose first three resonances are 500, 1500, and 2500 Hz, respectively. Not coincidentally, the ranges of the first three vocal formants for

⁷ (Campbell & Greated, 1987) 479. These calculations assume a constant “speed of sound in the warm air of the vocal tract” of 350 m/s⁻¹.

different vowels tend to be clustered around those three frequencies. If each mode corresponds to a formant, we can see where in the vocal tract those waves ought to have pressure nodes and antinodes (regions of lower and higher pressure fluctuation), as determined by the length of the individual vocal tract.⁸ By changing the size and shape of the tract at those spots, we can raise or lower the formant frequency. Reducing the tube diameter at a node will lower the frequency, and vice versa, while the opposite mechanics apply at an antinode. In our vocal tract model, the first mode's (Figure 2-6a) pressure node is at the tube opening (the oral opening) and its antinode is at the closed end (in the pharynx, above the glottis). If the diameter of the tube at this node is increased, usually by opening the jaw, the frequency of the first formant will be raised.

By the same logic, the second formant (Figure 2-6b) has a node located toward the rear of the oral cavity and an antinode toward the mid-front. So, by moving the tongue toward the node (up and back), we lower the second formant, and by either relaxing away from the node or moving toward the antinode (up and forward), we raise it. So, "front" vowels have a high F2 and "back" vowels have a low F2. The third formant, with three each of nodes and antinodes, is a more subtle formant, affected by several different vocal tract alterations, and often in conjunction with F2. More on that below.

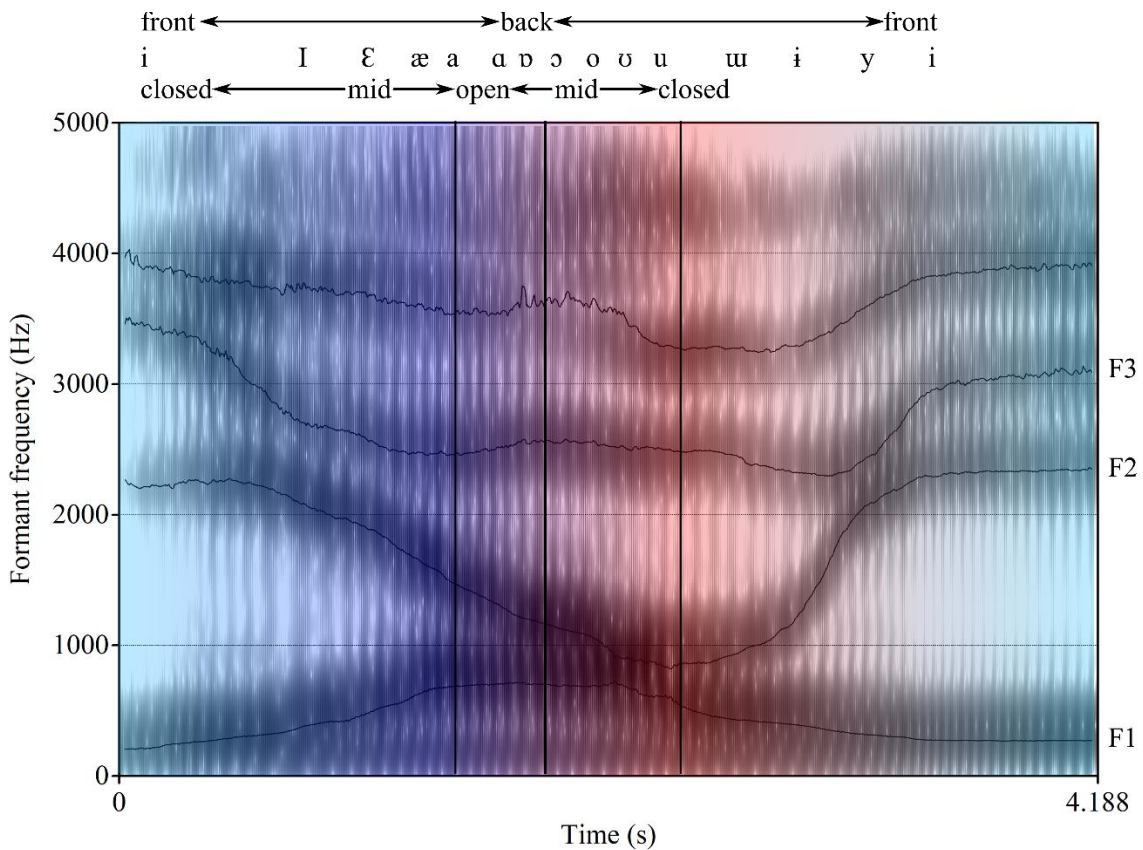
Because nodes and antinodes can both be used to change formants, there are sometimes many ways to produce a recognizable vowel. For instance, 'open' vowels like [a] can still be recognizably produced through gritted teeth, without opening the jaw at all. This is likely the result of the pharyngeal constriction and lip-spreading helping to compensate for the lack of jaw opening. The smaller oral cavity, however, greatly reduces the richness and resonance of the

⁸ This explains both the general shift in formant ranges between males, females, and children, and the variation in formant ranges between individuals of both genders. With an average vocal tract length of 14 cm, the resonance centers for adult females are roughly 570, 1700 and 2800 Hz. Those for children are still higher.

vowel's timbre.

Figure 2-7 illustrates this with a spectrogram of the author singing “yeowee” slowly and as smoothly as possible, showing the changing formants as the vowel moves counterclockwise around the IPA chart starting from [i]. As the jaw opens and the tongue moves up and back toward the throat, F1 rises and F2 falls. Because the tongue moves from an F3 node through an antinode and into another node, the F3 falls, tracking with F2, then levels off and even rises very slightly as it reaches the open-back corner of the vowel chart.

FIGURE 2-7: FORMANT CHANGE IN THE WORD “YEAOWEE” SUNG BY THE AUTHOR ON A2 (110 Hz)



Continuing counterclockwise around the perimeter of the quadrilateral from [a] to [ɑ] to [ɒ], the jaw remains quite open, keeping F1 fairly steady while the tongue continues bunching toward the back of the cavity, causing F2 to drop further, while F3 ticks up slightly, as described above. Moving up the back close-open axis, the jaw begins to close again while the tongue continues bunching back, dropping both F1 and F2. F3 remains steady though we might expect it to continue ticking upward. It is possible that the predominantly lip-rounded vowels on this axis help to keep F3 low. Finally, as we travel along the open back-front axis, we see a reverse image to the closed front-back axis: F1 drops slightly (even though the jaw does not move much, the move from lip rounding to spreading, and the opening of the pharynx as the tongue moves forward may account for it). F2 rises again, and F3 takes a slight dip, then joins F2 in rising as the tongue returns to a forward position.

2.4 The Vowel Space as a Representation of Formants 1 and 2

By analyzing the spectra of the individual cardinal vowels along the quadrilateral perimeter, and then plotting the obtained formant frequency values on an X-Y chart, in Figures 2-8a-c, we can see how F1/F2 relates to the IPA close/back axes, and also how much the IPA quadrilateral has been simplified and standardized for clarity and usefulness.

It should be kept in mind, of course, that the actual formant frequencies vary depending on the size and irregularities of individual speakers' vocal tracts.⁹ Vowel formant frequencies also are altered by variations of pronunciation due to dialect, the influence of surrounding

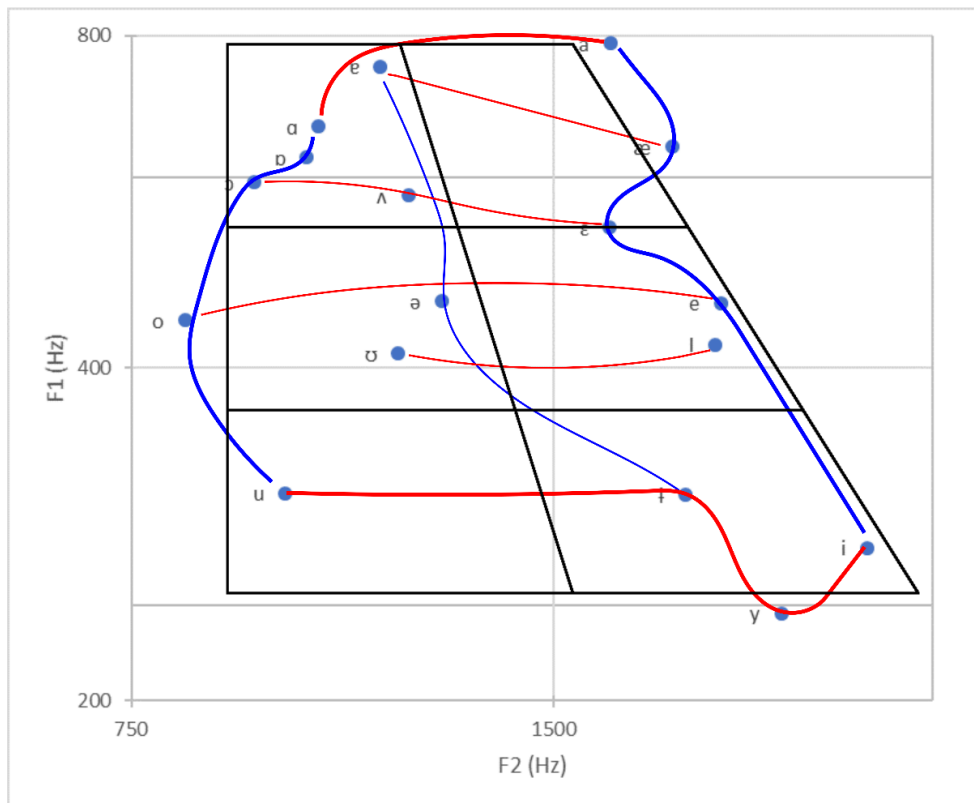
⁹ Length of vocal tract is a major determining factor of such timbral qualities as perceived gender and age of a speaker, with longer tracts helping create "male" voices, shorter tracts "female," and shorter still, "children's" voices.

FIGURE 2-8A-C: VOWEL PLOT, FORMANT GRAPH, AND DATA TABLE FOR CARDINAL VOWELS SUNG BY AUTHOR ON A2 (110 Hz)

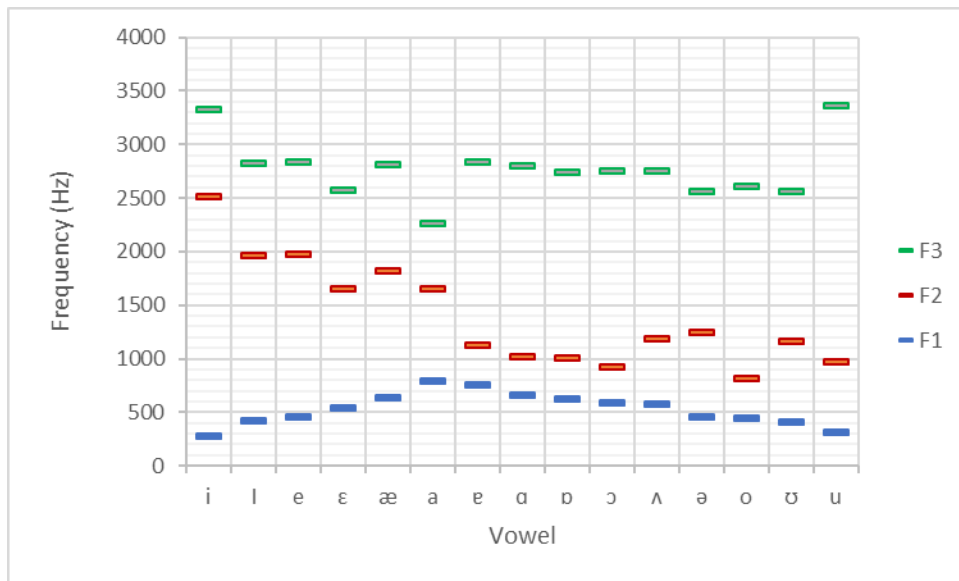
a)

Vowel	model	F1	F2	F3
i	seat	275	2514	3320
l	sit	420	1959	2823
e	say	458	1976	2839
ɛ	set	536	1647	2568
æ	sad	635	1825	2817
a	sat	787	1648	2264
e	Saab	750	1130	2833
ɑ	sot	662	1020	2802
ɒ	sought	621	1001	2739
ɔ	saw	589	918	2747
ʌ	sun	573	1183	2748
ə	the	460	1249	2556
o	soul	442	819	2605
ʊ	soot	412	1163	2566
u	soon	308	966	3359

b)



c)

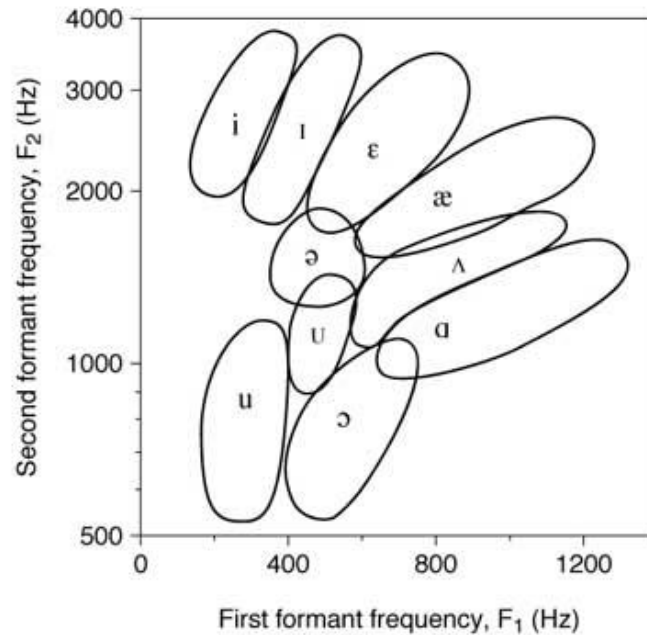


consonants, or simple natural variation within one speaker’s pronunciation. Thus, the positioning of vowels for even a single individual, and certainly across several speakers, more resembles Figure 2-9, with vowels occupying clustered ranges which often overlap each other, rather than single discrete points.

As mentioned previously, while the roles of the first two formants in vowel differentiation are fairly well-defined, formant 3 has a more nebulous function. As seen in Figure 2-7: Formant change in the word “yeaowee” sung by the author on A2 (110 Hz), F3 tracks with F2 to a large degree, with the exception of the back open-close axis, when it maintains a mostly stable position as F2 falls. F3 is most clearly involved in creating the American (and Mandarin) r consonant [ɹ], as well as so-called rhotic (r-colored) vowels, such as in the standard American

pronunciation of the words “bird,” “her,” or “ladder.”¹⁰ As shown in Figure 2-10, in rhotic

FIGURE 2-9: VOWEL FORMANT RANGES SCATTERPLOT¹¹

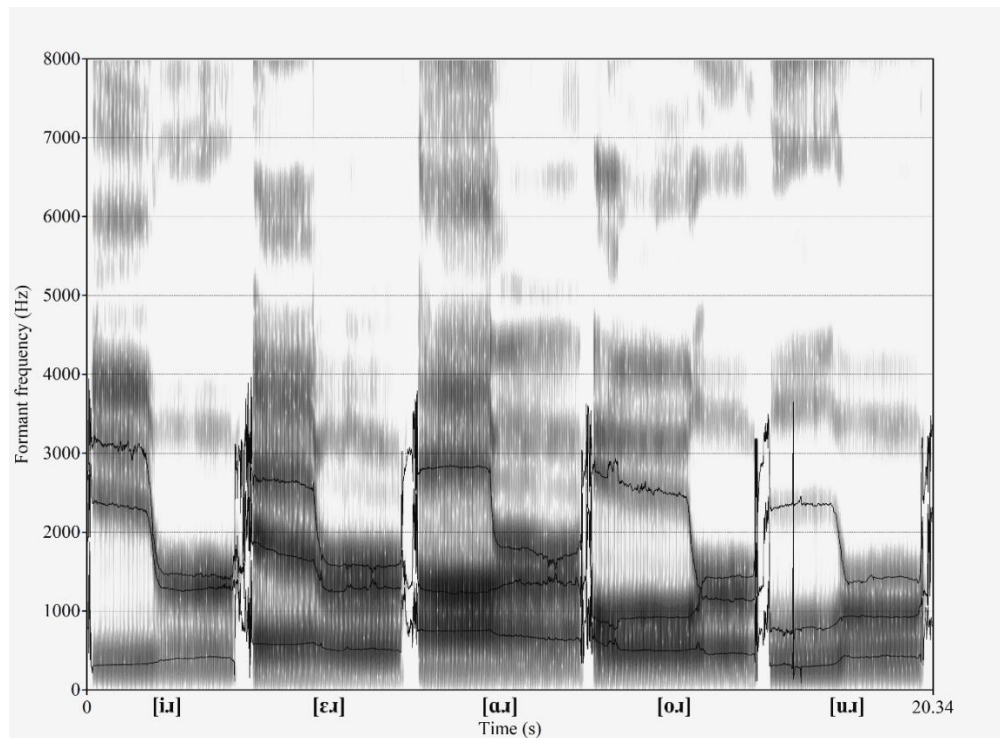


vowels, F3 drops significantly from its normal range above 2400 Hz, hovering just above F2 in the 1500-2000 Hz range. F2 is often also affected by the change in tongue position (rhoticity is achieved by by retracting and lifting the tongue toward the back molars and hard palate, where there is a F3 node.

¹⁰ Rhotic vowels have been represented using a number of different IPA symbols, such as adding [ɹ] to a base vowel (e.g. [aɹ]), as a superscript (e.g. [a^ɹ]) or with a retroflex diacritic added to the base vowel, e.g. [a̠].

¹¹ Peterson and Barney (1952)

FIGURE 2-10: CARDINAL VOWELS ADDING RHOTICITY



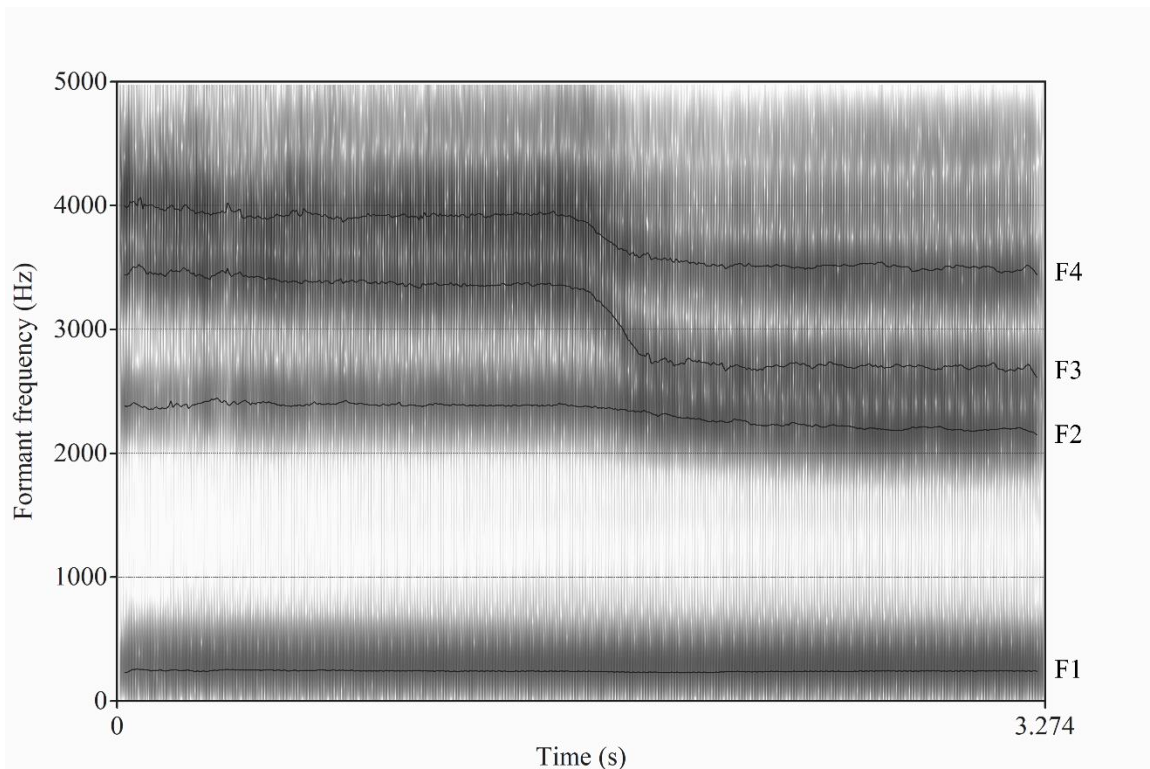
Rhoticity often also involves some degree of lip rounding, and indeed F3 is affected by lip rounding or spreading (as are all the formants, since the lips are a pressure node for all of them). Figure 2-11 shows the difference between the close-front vowel pair [i•y], where [y] is produced by maintaining the jaw and tongue position of [i] and rounding the lips only.¹² Accordingly, F1 and F2 remain fairly steady while F3 (and to a lesser degree, F4) drop significantly. The correlation of F3 to lip-rounding is not always so clear for English vowels, however, as English contains no vowel pairs that differ only in lip rounding.¹³ In many rounded

¹² [y] is not a common sound in English, but is familiar to speakers of French and German as in the words *tu* (Fr.) and *über* (Ger.)

¹³ Ladefoged (2005), 176

English vowels, F2 also is lowered by the rounding of the lips, as well as by slight changes in tongue position.

FIGURE 2-11: UNROUNDED-ROUNDED VOWEL PAIR [I•Y] SUNG BY AUTHOR ON A2 (110HZ)



Finally, some phoneticians have connected a rise in F3 to the lowering of the velum, which opens the nasal cavity. F3 is seen to rise in nasalized vowels, for instance, those of French, but the difference is much less significant (sometimes less than 100Hz) than for rhoticity, and Delattre cautioned that “the formant 3 rise is not one of the changes appreciably responsible for nasal quality; rather it has an effect on the *color* of the vowel, independently from its nasality, and comparable to the effect of formant 2.”¹⁴ Indeed, F2 often also rises slightly for nasalized

¹⁴ Delattre (1951) p. 874

vowels.

These various attributes tied to F3 and its relationship to F2 (rhoticity, lip rounding, and velar opening/nasalization) are often treated as secondary features in phonetic discussions of vocal production. For a musical discussion of vocal timbre and technique, however, they are of much greater importance, and will in fact be essential to understanding the mechanics of overtone singing, to be discussed later.

In turning back to the musical implications of these phonetic principles, let us consider one final acoustic property of vowels. Vowel formants remain fixed in whatever ranges they happen to be for an individual speaker, regardless of the fundamental frequency of the pitch being produced.¹⁵ So, if a speaker maintains a vowel while steadily increasing or decreasing the pitch of their voice, different partials of the sound will be amplified as they rise or fall through the formants. This is illustrated in Example 17, where, as the fundamental and its overtones fall in frequency, they receive a boost in amplitude (shown by darkening of the lines) as they move through the formants of the sustained vowel.

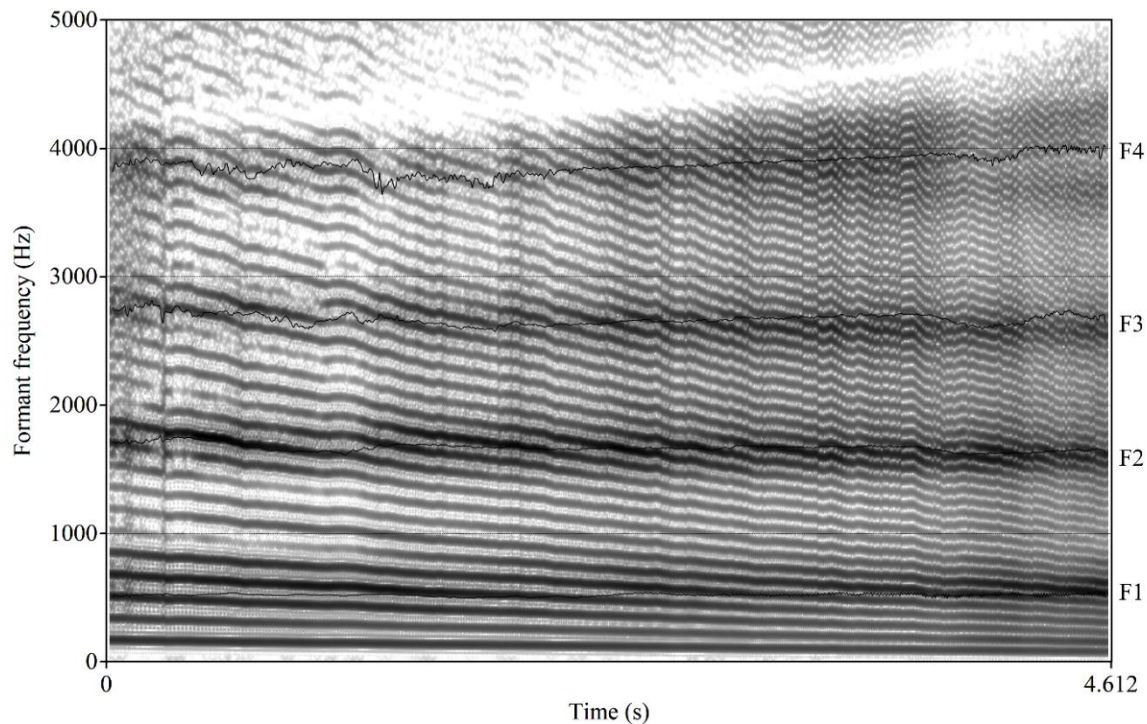
2.5 Vowel Formants and Resonance: Vowel Modification

The fixed nature of formants creates a unique problem for singers, however. In Figure 2-13, the approximate frequency ranges of the first three formants of selected English vowels are displayed as notated pitch intervals, with whole notes used for the approximate center of each range. If the fundamental of a pitch is higher in frequency than the first formant of whatever vowel is being sung, the vowel becomes very difficult or even impossible to produce and

¹⁵ Formant frequencies for female speakers tend to be

perceive accurately. Since most F1s are above 300 Hz, this problem does not much affect basses and tenors, except in the highest parts of their ranges. So, for example, a tenor will have more

FIGURE 2-12: NARROW-BAND SPECTROGRAM OF AUTHOR SINGING A DOWNWARD GLISSANDO ON VOWEL [ɛ]¹⁶

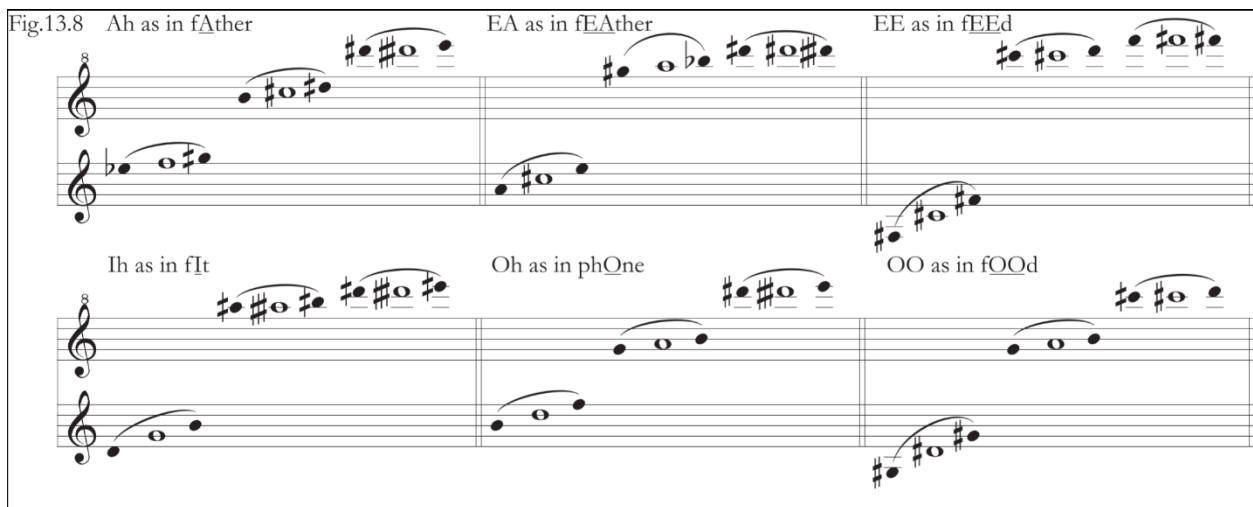


difficulty singing a pure [i] on a Bb4 than on an F#4. However, the rest of the vowels' first formants all fall at or above the top of the high tenor range. Altos and sopranos encounter this difficulty much more frequently. The vowels with the lowest F1s, [i] and [u], become less resonant above G4, and other vowels become difficult in order of rising F1 frequencies: [I], [o], [ɔ], and so on. This is often an issue in wordless choral singing, where the two most commonly used vowels are [o] and [ɑ]. [o]'s first two formants will resonate fundamentals and/or partials

¹⁶ For this example, we have switched from using broad-band spectrograms to a narrow-band spectrogram, which shows individual pitch frequencies more clearly.

for basses, tenors, and altos easily enough, but as sopranos move above the staff, the first formant stops resonating and only the second, weaker in amplitude and resonating much higher overtones, continues. This diminishes the identifiability of the vowel, results in a less resonant, shrill, or squeaky tone, and can also make breath support and control more difficult.

FIGURE 2-13: FORMANT RANGES OF SELECTED ENGLISH VOWELS¹⁷



Singers can counteract this problem by actually lowering their first formant. Since F1, we remember, is affected by the node at the mouth opening, the easiest way to achieve this is by opening the jaw to “color” the vowel toward a more open vowel whose F1 is at or below the frequency of the fundamental of the pitch being sung. So, for example, if our tenor needs to sing that [i] at A4, they would modify the vowel in the direction of [I], thus raising the first formant to include the fundamental. In our scenario of wordless choral singing on [o], while the rest of the chorus will be able to maintain its [o] into fairly high registers, the sopranos customarily color toward an [ɑ] as their pitch rises above the staff.

¹⁷ Based on Lefkowitz (Forthcoming), 273 (page number may change) [WHAT WAS LEFKO’S SOURCE?]

In addition to using vowel modification to mitigate the problem of supra-formant pitches, singers also use it to enhance the resonance of normal, sub-formant pitches. For instance, if a singer sings an [i] vowel whose fundamental is anywhere within the octave F#3-F#4, or in the octave below that, the fundamental and/or low harmonic partials of that pitch will be amplified by the first formant. If, on the other hand, the same singer then sang an [o] on G#4, the fundamental and first two partials would fall just outside of the range of the first formant, making that vowel at that pitch less resonant. Accordingly, our singer could modify the [o] in the direction of [I] or [u] to bring the first formant down to help amplify the fundamental. Thus, professional singers are constantly modifying their vowels as they change pitch and deliver text in order to achieve the best possible resonance and tone.

Vowel modification is an important practice of Western classical (specifically *bel canto*) vocal technique, where it is integral to the smoothing of registral differences and the balancing of bright and dark vocal timbres known as *chiaroscuro*. Vowel modification is also an important tool widely used by choral directors and singers to help achieve ensemble blend and improve intonation. Sundberg has shown that different vowels and vowel changes have specific pitch deviation tendencies, with, for example, [i – E] often going slightly flat or vice versa.¹⁸ Fagnan has shown that vowel modification techniques may reduce the deviations to near-imperceptible levels, thus improving intonation and blend.¹⁹ As we will see later, vowel color can also be used to heighten timbral contrasts, especially in conjunction with changes in vocal phonation and register.

¹⁸ Sundberg (1987), 143

¹⁹ Fagnan (2008)

2.6 Other Components of Vocal Timbre: Phonation, Register, Articulation

Timbre is a hugely complex phenomenon, and it goes without saying that vowels and their formants are not the only factors contributing to the total timbre of a singing (or speaking) voice. Indeed, many vocal sounds do not involve vowels at all (although resonance formants do affect unvoiced sounds). In examining these other factors, we also can begin to construct a list of terms and parameters for analyzing and discussing vocal timbre.

These terms and parameters reveal at least three approaches to describing vocal sounds: articulatory, acoustic, and perceptual. The articulatory approach describes sounds by *how* they are produced physiologically, the acoustic by sonic elements that can be observed and measured with tools like spectral analysis. The perceptual approach treads the rather muddier waters of psychoacoustics and individual cognition, where differences in age, musical training, and even adeptness with language can elicit vastly different descriptions or evaluations of the exact same sound from different individuals. All three approaches are of use to this study.

2.6.1 Phonation

Phonation is a term with some slight variation of meaning, overlapping with, and sometimes confusing concepts of *register*. Phoneticians and linguists use the term *phonation* generally to denote any production of speech sounds, and more specifically to describe different types of pulmonic vocal production used in speech or singing. For example, phoneticians distinguish between voiceless (whispering) and modal phonation (normal, full speaking or singing voice). But there are a number of other phonation types like “breathy,” “slack,” “pressed/harsh,” “yawny,” and “creaky.” These different phonation types are caused by different combinations of subglottal air pressure and vocal fold tension and adduction (closure), as well as

the involvement or configuration of other laryngeal structures.

For our purposes, it will be enough to define *phonation* as the process(es) by which a pulmonic sound is produced, and break the possible phonations into two large categories: *voiced* and *unvoiced*, with a ‘mixed’ zone where we find “breathy” phonation. Within the ‘voiced’ category, we also will have a subset termed *supraglottal* in which laryngeal anatomy other than the vocal folds play a significant role. The main parameters used to differentiate and describe phonation modes include: Vocal fold tension; vocal fold adduction; sub- and supra-glottal air pressure levels; and influence of other laryngeal structures. In Figure 2-14, we have included belting as a distinct phonation type. In the past, belting was often described simply as use of the modal or chest voice in the higher frequency range usually reserved for head voice, and as such was frowned upon by pedagogues as being stressful and potentially damaging to the voice. More recent research has, however, discovered that belt shows specific physiological differences from modal voice, and an increasing understanding of “healthy” belt technique has drawn a line between it and “pressed” phonation, which often stands in for “unhealthy” or defective belt technique. Brad Wells summarized the phonation differences between modal voice and belt:

According to numerous writers, belt singing commonly involves a higher larynx, a narrower pharynx, a less elevated soft palate than in classical singing, and a more speech-based vowel formation. Research reveals that, in contrast to bel canto singing, sound pressure levels are higher in belt, energy output by intrinsic and extrinsic muscles is greater, the closed quotient is consistently higher and the adduction levels of the vocal folds greater. Less vibrato, both in regards to amplitude and rate, also seems typical.²⁰

²⁰ Wells (2006). 67

FIGURE 2-14: PHONATION, TIMBRE AND VOCAL REGISTER

	Phonation type	Vocal fold tension/adduction; Other physiological characteristics	Timbral qualities	Register/ technique
Unvoiced	Breath	None, folds relaxed and open.	Low-mid-spectrum noise bands	
	Whisper	Moderate tension, partial adduction with small opening.	Mid-high-spectrum noise bands	
Mixed	Breathy	Moderate tension with weak/incomplete adduction allowing “leaking” of air.	Fundamental-heavy with weaker overtones and high-spectrum noise	
Voiced	Modal	Optimal tension/adduction/ subglottal pressure to create maximum vibration/resonance	Balanced spectrum; full, resonant tone	Modal “Chest”
	“Creaky”	Strong adduction but weak tension; folds closed tightly but are thick and slack, allowing high subglottal pressure to “bubble” through.	Sub-pitch voice, individual clicks/pulses audible; strong upper harmonics	Vocal Fry “Pulse” <i>Stroh bass</i>
	Falsetto	High tension; tight and thin fold edges vibrating; incomplete adduction of glottis (in untrained voices)	Strong fundamental, weaker overtones; “purer” sound; Sometimes breathy in untrained voices.	Head/ Falsetto “Loft”
	“Pressed”	High adduction and tension, resulting in longer closed phase of vocal fold oscillation	Bright but strained or constricted	
	Belt	Similar to pressed, but vocal apparatus tension is balanced by resonance manipulation to avoid vocal stress	Bright, full, brassy	
Supra-glottal	“Harsh” (Ventricular)	High adduction and tension + raised larynx/constricted pharynx and damping of vocal folds by ventricular folds	Rough, gravelly, growly.	Various kinds of throat singing
	“Hollow/ Yawny” (Faucalized)	Normal adduction, Expansion of pharynx by lowering/ forward tilting of larynx	“Dark/ Covered”	Helps create singer’s formant

Last on the list in Figure 2-14, *faucalized* or “yawny” voice features lengthening of the pharynx by lowering and tilting of the larynx. This is familiar to any classically trained singer, and is of prime importance in developing the “dark” end of bel canto *chiaroscuro*. By lengthening the pharynx, singers lower their overall formant ranges, thus improving resonance. This is also important in producing the “singer’s formant.”²¹

2.6.2 Phonation and Register

Phonation, the physiological mechanics of vocal production, plays a strong role in define vocal *register*, which generally is defined as a “phonation *frequency range* in which all tones are perceived *as being produced in a similar way and which possess a similar timbre.*”²² Male and female voices both possess the *vocal fry* and *modal* (commonly called “chest” register for both genders) registers. The registers above modal are commonly called *falsetto* for males and *head* for females.²³ Differences in timbre, agility, and dynamic control between chest and head registers are usually more pronounced for male singers. Both male and female singers commonly employ a “mixed” register that bridges the pitch and timbral ranges of chest and head registers. Finally, female voices and some male voices can sometimes access a fourth register, above the falsetto, commonly known as the *whistle* register. Though often assigned specific pitch ranges for male and female voices, most registers overlap considerably in terms of frequency range and

²¹ Sundberg (1987), 121

²² Sundberg (1987), 49. Italics are mine.

²³ Despite the fact that scientists have proven females have the ability to produce a falsetto phonation, musicians rarely use the term to apply to female voices, perhaps because the timbral difference is not as pronounced as for male singers. Though the term “head” is sometimes applied to male voices, it is less exactly defined, sometimes synonymous with falsetto and sometimes denoting a mixture of chest and falsetto.

can vary widely among individuals. Registral shifting, oscillation, and juxtaposition are common features of several world singing traditions, including yodeling and Korean *P'ansori*. Here, when we use the terms “chest,” “head,” “falsetto,” etc., we will use them predominantly as timbral descriptors rather than indications of pitch range.

2.6.3 Other articulatory features

Air source: Most vocal sounds used in music are *pulmonic*, using airflow caused by the lungs (both exhalation and inhalation), however, a host of tongue clicks, pops, hisses, and other *non-pulmonic* sounds can be produced by manipulating the air standing in the supraglottal vocal tract by means of the various articulators. Blowing a ‘raspberry’ by squeezing the air in the mouth out past the tongue using the cheeks is a familiar, if not very dignified, example. Other examples include the *tsk tsk* sound, gulps, kisses, and so forth. Non-pulmonic sounds, by nature are often short and percussive due to the physical limitations of the articulators and the small quantities of air involved. Various unvoiced consonants can be also produced as non-pulmonics.

Air flow direction: Whether pulmonic or non-pulmonic, sounds may be produced by *ingressive* or *egressive* airflow. Normal singing and speech are pulmonic and egressive. A gasp is an example of a pulmonic ingressive sound. The well-known *tsk tsk* sound is a non-pulmonic, ingressive sound created by suction of the tongue against the palate and/or teeth. Ingressive pulmonic sounds, when voiced, typically feature incomplete or “leaky” vocal fold adduction and thus a breathy, diffuse timbre, which is limited in dynamic range and agility.

3. SPEAKING OF TIMBRE: ANALYTICAL APPROACHES

3.1 Robert Cogan and Spectrographic Analysis

In 1984, Robert Cogan took advantage of technological advances to refine his timbral analysis system based on computer analysis and imaging of acoustic signals, better known as *spectrographic analysis*. Cogan argued that the spectrogram could be an invaluable tool for quantifying and comparing the physical properties of a sound, and thus, understanding and describing timbre. To do so, Cogan devised a list of thirteen opposing descriptors with which to analyze different spectral parameters in their sonic contexts:

- **Grave/Neutral/Acute:** Whether a sonority occupies low, middle, or high frequency ranges within the total spectral context of a musical selection.
- **Centered/Extreme:** A shading of the previous parameter – if sonorities are within the outer halves of the grave or acute ranges, they are extreme, otherwise they are centered.
- **Narrow/Wide:** Whether the distance between the highest and lowest spectral elements of a sonority are less or greater than half the total spectral range of a musical selection.
- **Compact/Diffuse:** Narrowness or wideness of individual spectral elements. Perhaps better thought of as the granularity or resolution of the spectral texture – whether elements are well-defined individual frequencies or noise bands, or a mix.
- **Non-spaced/Spaced:** Whether individual spectral elements within a sonority are separated by distances greater or less than an octave.
- **Sparse/Rich:** Whether a sonority or texture has less than or more than half the number of simultaneous spectral elements or events relative to the maximum number of simultaneous spectral events in the total context of the selection.
- **Soft/Loud:** The spectral intensity (amplitude) of an element or sound within the range of intensities for the entire sonic context or musical selection. Broadly divided into soft (*ppp-p*), neutral (*mp-mf*) and loud (*f-fff*).
- **Level/Oblique:** Whether a sound generally maintains a steady frequency(ies) or features changing frequency(ies).
- **Steady/Wavering:** Whether an element features frequency microfluctuations like vibrato. Cogan seems to differentiate microfluctuations from frequency *change* of oblique sounds in that microfluctuations are narrow, merely oscillating around a central pitch frequency, while obliqueness refers to a more *directional* change that happens or is maintained over a longer timespan than 5-20 oscillations per second, like a glissando.
- **No-attack/Attack:** Whether there is a noticeable difference between the onset of a sound and its sustain phase.
- **Sustained/Clipped:** Whether sonic elements feature noticeable interior gaps of silence, or whether the release of a sound is short or long.
- **Beatless/Beating:** Whether a sound features acoustic beating caused by close pitch adjacencies and/or inharmonicity of overtones.
- **Slow beats/Fast beats:** Dependent on the previous opposition, the rate of beating in a

beating sound.¹

Cogan would analyze musical selections using these parameters by assigning the music either a positive, negative, or neutral value for each pair. For example, a selection where the spectral energy was mostly occupying the low spectral ranges, he would term it “Grave” and assign a negative (-) value. A subsequent selection where the spectral energy was concentrated in higher ranges would be “Acute” and have a positive (+) marker. Cogan would then compile tables showing the progression of these markers over the course of a selection or an entire work.

His method, while meticulous and exhaustive, is also somewhat cumbersome and occasionally counterintuitive. In addition, the almost binary polarity of his positive/negative system seems perhaps too rigid for discussing something as subtle as timbre. However, many of his parameters offer useful criteria for how to evaluate and categorize timbres based on their spectral profiles. The following is an attempt to consolidate and simplify his list into parameters and terms which will be useful to our discussion of vocal timbre:

Spectral range: What range of frequencies does a sound activate? Most voiced sounds activate frequencies from about 120-5500 Hz, although some registers and phonation modes can activate much higher frequency ranges. Many unvoiced or non-pitched sounds like breath sounds or consonant transients can also activate much wider and higher spectral ranges. Spectral range helps determine perceptual features like *range*, *brightness*, and *darkness*.²

Spectral concentration: Is a sound’s spectral energy concentrated in one or more areas of the frequency range? How many and where are the formants (if any), and what partials or

¹ Cogan (1984), 134-140

² It has been shown that pitch frequency itself is independently related to the perception of vowel color, since a listener will perceive even a simple sine tone to have a changing vowel color, sweeping from [u] to [a] to [i] as the tone’s frequency increases.

frequencies of the spectrum are they amplifying?

Spectral density: How many individual spectral elements occupy the spectral range of the sound? How closely, and how evenly are the elements spaced in relation to each other? Generally speaking, high-density spectra correspond to perceptual qualities like *richness*, *fullness*, *warmth*, *noisiness*, while low-density spectra correspond to qualities like *thinness*, *coldness*, *purity*.

Spectral resolution: How well-defined or individuated are spectral elements one from another? Is a sound made up mostly of a fundamental with a harmonic series, as in a violin or clarinet, or of frequency bands, as in the sounds of many percussion instruments? Spectral resolution, like density, can affect perceptual features like how *noisy* or *pure* a sound is. Here, “resolution” corresponds to Cogan’s *compact/diffuse* opposition, which he describes as the spectral *width* of individual elements rather than of an entire sound.

Harmonicity/Inharmonicity: In the strictest sense, the degree to which the overtones of a periodic sound deviate from being integer multiples of its fundamental frequency. While this kind of inharmonicity is rare in standard vocal production (it is a topic of research in the field of vocal and speech disorders), we could use “inharmonicity” to refer to elements in a vocal sound other than the overtones of its fundamental. Inharmonic vocal elements could result from articulatory factors like breathiness, hoarseness, growls, irregular or unstable vocal fold oscillations, lip or tongue trills, buzzing (as in voiced fricative consonants, e.g. [v], [z], [ʒ], etc.), or perturbations of the airflow caused by saliva, mucus, or other obstructions of the vocal tract. Depending on the type and amount of inharmonicity, the perception of a sound’s purity, warmth, or noisiness may be affected.

ASR envelope: The attack-sustain-release profile of a sound. Are there different sonic elements for the different phases of the envelope, and how do the elements change over time?

Are there noticeable transitions or interruptions across the envelope, or does the envelope evolve smoothly? Attack in particular has been shown to be especially determinative in perceiving and identifying timbres, and envelope characteristics in general can affect perception of a timbre's *consistency, noisiness, or steadiness*.

In addition to examining and interpreting the overall spectral profile of a sound or piece of music, another measurement we can take is the *spectral centroid*. The spectral centroid is defined as the average frequency of a signal's partials, weighted by their amplitudes, divided by the sum of the amplitudes.³ This gives a value for the "center of mass" of a spectral profile, which can be shown as a *spectral centrogram* chart laid over the spectrogram.⁴ Spectral centroid offers a useful general picture of spectral energy, and is sometimes used as a general measurement of a sound's brightness, but this should be approached with caution: for instance, the spectral centroid of much of the Sarabande is higher than we might expect relative to timbres with much greater perceived 'brightness' – this is simply because the absence of low-range fundamentals (the absence of the low voices) necessarily shifts the centroid higher even though the overall timbre is not as rich in high-spectrum partials. However, spectral centroid can be used to make a few generalizations:

- 1) The greater the *distance between the centroid and the fundamental(s)* of the timbre, the brighter and/or richer the timbre will probably seem. If the centroid is closer to the fundamental(s) the sound will probably be perceived as purer and perhaps darker,

³ For those interested, the spectral centroid is calculated using the equation: $\text{Centroid} = \frac{\sum_{n=0}^{N-1} f(n)x(n)}{\sum_{n=0}^{N-1} x(n)}$

⁴ Due to different software features and capabilities, spectral centrogram charts in this paper have been generated using the program Sonic Visualiser, which has slightly different spectrogram display options than iZotope or Praat – hence the logarithmic scale and green color scheme.

depending on the fundamental frequency and loudness.

- 2) When taking the average centroid of The width of the centroid (is it a narrow, focused line, a wider band, or even a wide dispersal of values?) can indicate how much a sound is defined by a specific area of its partials, or whether the sound's energy is diffused across spectral ranges or may be fluctuating rapidly. These qualities can indicate noisy or polytimbral sounds or textures vs. monotimbral or timbrally dominated sounds.

3.2 Wayne Slawson and “Sound Color”

Wayne Slawson took the acoustics of vowel color as the basis for his theory of *sound color*.⁵ In this theory, different timbres are analyzed according to their formant structure, relative to reference vowel colors. The acoustic vowel space now familiar to us from our previous discussion of phonetics is adapted to reflect four dimensions of sound color, which Slawson has named *openness*, *acuteness*, *laxness*, and *smallness*. These dimensions are plotted by Slawson into the vowel space as shown in Figure 3-1. The first three dimensions correspond roughly to the open/close, front/back, and central/perimeter dimensions of the vowel quadrilateral. Acuteness corresponds to the front/back axis tied to Formant 1, and thus we may link it with the bright/dark spectrum. Openness easily corresponds with the phonetic open/close axis tied to Formant 2, and the quality of resonance or fullness. Smallness, without any analogous dimension in the vowel chart, is defined by Slawson as corresponding roughly to “the overall length of an acoustic tube or the overall size of other sorts of resonators” as expressed through the frequency levels of *both* F1 and F2.⁶ This makes it more analogous to the vocal characteristics of male/female or voice *fach*. Slawson’s description, and his plotting of smallness contour lines as shown in Example Figure 3-1 begs a distinction between smallness and openness, and a need to note that Slawson’s use of vowel symbols as labels for sound colors is purely a shorthand for sounds’ formant configurations, and not a limitation of his theory explicitly to vowel colors, nor

⁵ [Sound color vs. timbre.]

⁶ Slawson (1985), 56. This would seem to describe the overall size of the resonator, including diameter could apply to different timbres between individual voices, as well as broad differences between voice types and (perceived) speaker gender.

an attempt to claim non-vocal sounds as *being perceptually identical* to vowels with similar formant patterns.

FIGURE 3-1: SLAWSON'S FOUR DIMENSIONS OF SOUND COLOR, MAPPED ONTO THE VOWEL SPACE.⁷

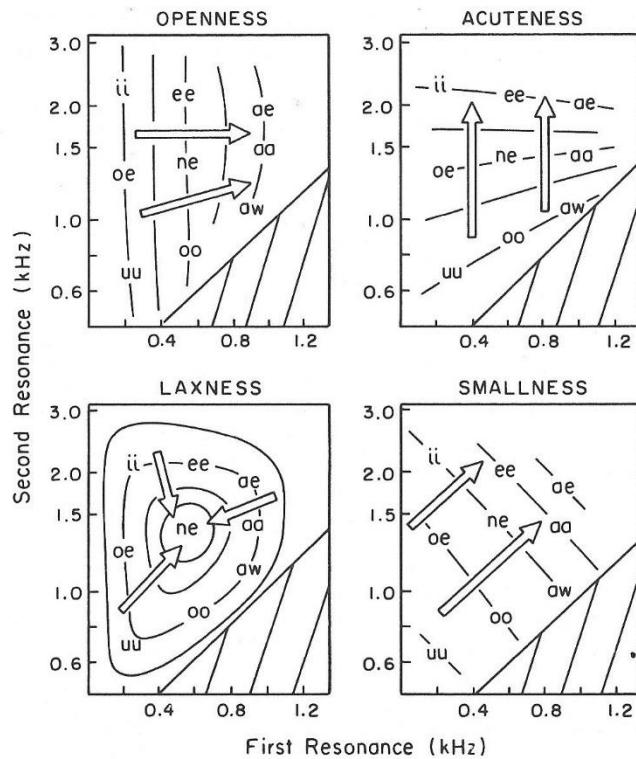


FIGURE 13: Contours of equal OPENNESS, equal ACUTENESS, equal LAXNESS, and equal SMALLNESS. The equal-value contours are plotted as functions of the frequencies of the first two resonances, F_1 and F_2 . Arrows indicate direction of increasing value. (Adapted from Slawson 1981.)

By limiting his definition of sound color to the arrangement of the first two formants,

⁷ Ibid., 55. Slawson's vowel nomenclature is a little unclear. It would seem to be as follows: ii = [i], ee = [e], ae = [æ], aa = [ɑ], aw = [ɔ], oo = [o], uu = [u], oe = [ø] (which is the sound of the German ö), and ne = [ə].

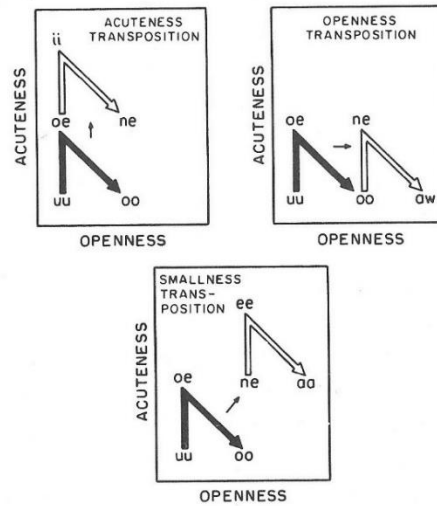
Slawson ignores (or simply fails to provide a descriptive/analytical language for) many aspects of sounds that he would perhaps call a part of their overall *timbre*, aspects like phonation, inharmonicity, registral placement, articulatory noise, and of course, the vast array of non-vowel-like sounds produced both by the voice and by instruments or electronics. Nevertheless, the foundations of his theory, derived, as they are, from vocal acoustics and phonetics, do offer a ready basis for discussing and analyzing a large segment of musical vocal sounds, as well as the possibility of deriving a methodology of compositional operations for sound color analogous to pitch transposition and inversion.

As seen in Figure 3-2, Slawson postulates these operations as repositionings, reflections, or rotations of sound color positions within his vowel-derived *sound color space*. As set forth by Slawson, these operations raise some important issues and questions about the nature of sound color and timbre. For example, and perhaps most problematic, is the question of whether timbre-space seems to possess a perceptual modularity akin to octave equivalence. This property of pitch is essential to the power of pitch operations to produce “varied invariance” upon which compositional structure depends.

An equally important question is whether operations on sound color have the same perceptibility as do analogous pitch operations, for example: can we *hear* that [u/i/o] is a transposition of [i/i/ə]? Additionally, are timbres perceptually or compositionally salient individually, or only in relationship to one another? We often speak and think of pitch and rhythm as being elements that help to determine musical profile: a melody is recognizably itself

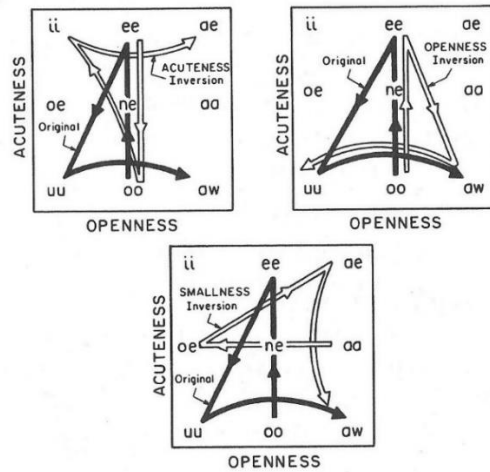
FIGURE 3-2A-B: SLAWSON'S OPERATIONS ON SOUND COLOR DIMENSIONS⁸

a) Transposition



Color transposition in the dimensions of ACUTENESS, OPENNESS, and SMALLNESS.

b) Inversion



Color inversion in the dimensions of ACUTENESS, OPENNESS, and SMALLNESS.

⁸ (Slawson, 1985), 71, 77

because it maintains pitch and rhythm (within certain perceptual boundaries), while a timbre is often thought of as a profile or quality intrinsic and complete in itself (yet until the 20th century, largely subservient to pitch and harmony): a melody *is made up of* certain pitches and rhythms, but a single pitch or sequence of pitches can *have* a certain timbre.

Can we say one sound color is a transposition or inversion of another, or can we only say that the *relationship or movement between* two or more sound colors is a transposition or inversion of the relationship or movement between a same-cardinality set of other colors? We can speak of one pitch or pitch class as being a transposition of another, but that description is hardly meaningful perceptually. We usually do not perceive one pitch as a transposition of another, but rather as an interval. Once we have an interval, we then can perceive another interval of the same class as a transposition or inversion of it. Do we therefore need to speak of *sound color intervals*?

Taken together, these questions raise important issues with Slawson's sound color/pitch analogy. Slawson deals with the octave equivalence problem by imagining his sound color space as being modular at its edges. Therefore, an increasing transposition of acuteness on sound color [i] would result not in a color that lies somewhere off the edge of the space, but "wrap around" to the low-acuteness [u]. In addition, he assigns "zero" values to the central horizontal and vertical lines of his chart, allowing axes of inversion for acuteness and openness, and a centerpoint of rotation for the laxness dimension. The space edge-modularity seems particularly counterintuitive: do we really perceive motion from [i] to [u] or from [i] to [æ], for instance, as continuing the respective directions of increasing acuteness or decreasing openness? Perhaps this is the case for the human voice, where, as we have seen, there are anatomical and acoustic limitations on vowel color: one cannot produce a more acute vowel than [i]. But in the realm of electronic sound, for instance, it would be possible, according to Slawson's theory, to continually

increase a sound's acuteness well past the spectral profile of [i] by increasing its F2 (and higher formants) while maintaining its F1.⁹

The laxness zero point on the schwa symbol, on the other hand, seems to be more sensible from an articulatory and acoustic standpoint. The schwa, often called the “neutral vowel,” is described by phoneticians as being the result of a relaxed, “pre-speech” positioning of the vocal tract, an anatomical zero point. This neutral center necessarily results from the fact that the F1/F2 movement of the cardinal vowels displays a modularity evident from a second glance at Example 12 (or grasped intuitively by slowly and continuously repeating either “yeaowee” or “why you”). The schwa would occupy a slice of that spectrogram where the formants are relatively evenly distributed (although not, interestingly, the most evenly).¹⁰

Despite these concerns, Slawson's theory is attractive and potentially useful in that it offers familiar musical concepts and terms with which to analyze and describe how a composer seems to be using sound color.

⁹ Even the theoretically unbounded capabilities of electronic sound still run up against the limits of human hearing, obviously.

¹⁰ Although if F4 is included, the schwa does have a rather symmetrical formant configuration.

4. PARTITA FOR 8 VOICES: BACKGROUND

4.1 Caroline Shaw and the Composition of *Partita*

Caroline Shaw was born in Greenville, North Carolina in 1982. Her mother began her musical education by teaching her violin at the age of 2. She began composing at the age of ten, her early inspiration drawn from Mozart and Brahms. Shaw went on to earn her Bachelor of Music from Rice University in 2004, and a Master's degree from Yale University in 2007, both degrees in violin performance. She continued composing simultaneously, however, and earned her Ph.D. in composition from Princeton University.

In 2009, Shaw became a founding member of Roomful of Teeth, and in 2013 became the youngest composer to be awarded the Pulitzer Prize, for *Partita for 8 Voices*. She continues to perform with RoT, and as a solo and chamber violinist based in New York City. Since winning the Pulitzer, her career has blossomed, and she has completed commissions for a number of top-flight instrumentalists and ensembles, as well as made cross-genre forays as a producer for Kanye West. Shaw has achieved enough notoriety and recognition in both classical and broader popular culture that she had a cameo appearance (as herself) in Amazon's original series *Mozart in the Jungle* (the only other living composer to achieve that distinction was Nico Muhly, another well-known, up-and-coming New Yorker).

Shaw composed the *Partita* from 2009-2011, in collaboration with Roomful of Teeth during their summer residencies at the Massachusetts Museum of Contemporary Art. The first movement composed, the Passacaglia, was inspired by the retrospective exhibition of the Wall Drawings of artist Sol LeWitt, and in particular, his *Wall Drawing 305*.¹¹ Over the next two

¹¹ Tsioulidas (2013)

years, Shaw completed the other three movements, first the Courante, and finally the Allemande and Sarabande.¹² The movements were taken up and performed individually by RoT at concerts, and recorded together for the group's album *Roomful of Teeth*, but presented out of order and interspersed among the other album tracks. The complete *Partita* was not performed in full and in order until its world premiere on November 4, 2013, at New York's Le Poisson Rouge.¹³ By this point, the work had already been awarded its Pulitzer.

4.2 Sol LeWitt's Wall Drawings and *Partita for 8 Voices*

Sol LeWitt (1928-2007), considered a trailblazing voice in both Minimalism and Conceptual art, combined the two aesthetics in his Wall Drawings, a series of works spread over his entire career, from 1969 to 2007, and which are currently the subject of a retrospective at the Massachusetts Museum of Contemporary Art (MassMoCA)¹⁴. The Wall Drawings primarily consist not of the actual drawings themselves, but of LeWitt's written instructions of how to realize each drawing on whatever walls are available. The instructions are terse, using a limited lexicon of terms and directions that LeWitt developed and codified which, to the uninitiated, seem at once rigorously exact yet inconceivably vague. LeWitt's instructions are based on a set of defined graphical forms and principles: types and directions of lines, for example, or different

¹² Woolfe (2013)

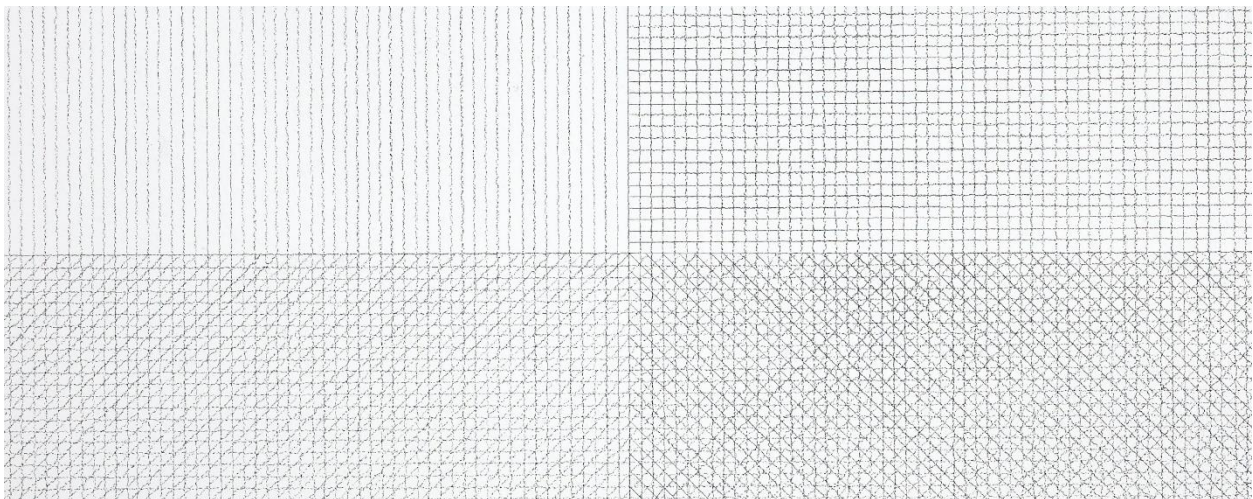
¹³ Tommasini (2013)

¹⁴ *Sol LeWitt: A Wall Drawing Retrospective*, which opened to the public on November 16, 2008, and will continue until 2033.

ways of dividing up a spatial field. The instructions then explore different permutations and variations of these elements.

FIGURE 4-1: LEWITT, WALL DRAWING 56¹⁵

A square is divided horizontally and vertically into four equal parts, each with lines in four directions superimposed progressively.



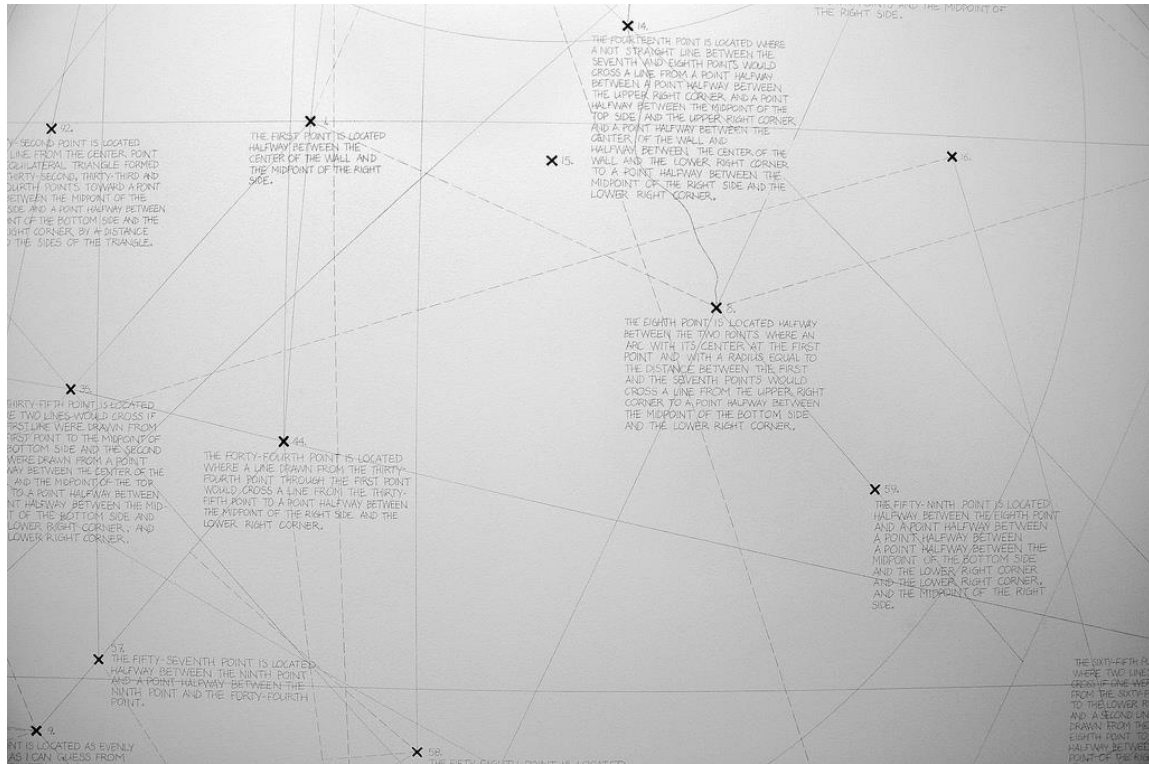
Shaw has said that *Partita* was inspired, in part, by LeWitt's Wall Drawings and in particular, by his *Wall Drawing 305*.¹⁶ Whereas many of LeWitt's drawings, like 56, are rigorously circumscribed in their materials and graphical elements, other drawings loosen the amount of control LeWitt applies, and begin to explore the instruction-lexicon concept itself

¹⁵ <https://massmoca.org/event/walldrawing56/>

¹⁶ <https://www.pulitzer.org/winners/caroline-shaw>

along with questions of where and with whom the nature of “a work” and creative agency reside. The instruction for *Wall Drawing 305* is simply “The location of one hundred random specific points. (The locations are determined by the drafters.)”¹⁷

FIGURE 4-2: LEWITT, *WALL DRAWING 305* (DETAIL)¹⁸



To fully grasp the concept and execution of this drawing, one must understand the word “location” as both noun and verb, as describing both the physical positions of the points in the spatial plane as well as the process of choosing their placement.

The points are random in that they may be placed anywhere on the wall. The draftsman uses Sol LeWitt’s vocabulary and geometric lexicon to guide the mapping of the points. This lexicon includes the corners, midpoints and center of each wall, which serve as reference points

¹⁷ <https://massmoca.org/event/walldrawing305/>

¹⁸ Photo credit uncertain. <http://www.harrylandia.com/2013/05/14/north-carolina-composer-wins-pulitzer/>

that are connected and traversed by lines and arcs. The one hundred points are specific in that they are created at the meeting of the junctures of these formal elements. As the draftsman maps out each generated point, he or she writes a description of how he or she arrived at that point next to it. This allows the viewers to trace the process of the placement of the points.

Wall Drawing 305 is one of a series of drawings in which LeWitt experimented with textual instructions that direct the draftsman to construct shapes on the wall. Called “location drawings,” these works are done in black pencil with geometric figures emphasized in crayon, foregrounding the process of drawing as a problem-solving mechanism.¹⁹

LeWitt’s Wall Drawings asks the Cageian questions: of what does ‘the work’ consist? Is a work of art a thing or an idea—or both? Where does the creation of a work occur—in the mind of the artist, or in the execution of that conception? Who is in control of the work, the person who conceives it, or the person who realizes it (when those are different)? For classical musicians, thinking of music in these dual terms is almost second-nature: A Beethoven symphony is both an ideal abstraction—the piece that Beethoven conceived in his mind’s ear and wrote down—and a specific instance—the performance of it in a specific time and place by particular musicians. The work can be both these things simultaneously, or it can be two different versions simultaneously: we will easily distinguish what we consider to be a poor performance of a piece from the abstract ideal of the piece itself.

The analogy of LeWitt’s drawing instructions to the concept of a musical score is a natural one. Both are sets of instructions in an agreed-upon language which allow an artist with the correct understanding of that special lexicon and the requisite skillset to recreate the original conception of another artist. In both cases, the instructions are both specific and open to interpretation or circumstantial variation within the bounds of the specifications – realizations of LeWitt’s drawings are defined and constrained by the size of the wall, variations in the materials at hand, etc.; a rendering of a musical piece is defined by performers’ technical ability and

¹⁹ <https://massmoca.org/event/walldrawing305/>

specific training, understanding of the piece's form and historical context, performance practice, the performers' specific instruments, the performance space, and so on. In another important way, the two concepts are similar:

By drawing directly on the wall, LeWitt limited the work's duration; ultimately the wall drawings are painted over. Yet, despite this temporary aspect of the drawings, the idea is permanent, and the drawings can be redrawn on another wall by another person.²⁰

Whereas we don't normally think of works of visual art as occupying or existing in a span of time, we do, again, conceive of a piece of notated music as both bound by the time it takes to perform and existing in an ideal, unchanging form outside of time. If we had to identify the location where that ideal form exists, we would probably choose the notated score—the instructions that allow us to recreate a specific instance of the work in time.

LeWitt asks the draftsman following his instructions for “specific random” points – that is, placed randomly, but whose placements and relationships are explained and communicated in exacting detail. Such a process will feel very familiar to many composers: sometimes we select or discover our materials or arrive at solutions led by our intuition, and then have to find ways to make that choice its own argument in the context of that piece, discovering its perhaps unsuspected relationships to other material, or indeed constructing those relationships, finding ways to draw connections to and from each point – and, in the end, finding the best instructions and language to communicate those choices and intentions to the performer.

²⁰ <https://massmoca.org/event/walldrawing11>

4.3 Special Vocal Techniques in the *Partita*

4.3.1 Belt

One of the most striking vocal timbres used in *Partita*, and one of the first which Roomful of Teeth studied in their workshops, is the bright, brassy sound of belt. This is a technique which RoT director Brad Wells has researched and written on in depth. Belt is a singing style with roots in early 20th-century American jazz and musical theater, and as discussed earlier, features

higher larynx, a narrower pharynx, a less elevated soft palate than in classical singing, and a more speech-based vowel formation. Research reveals that, in contrast to bel canto singing, sound pressure levels are higher in belt, energy output by intrinsic and extrinsic muscles is greater, the closed quotient is consistently higher and the adduction levels of the vocal folds greater. Less vibrato, both in regards to amplitude and rate, also seems typical.²¹

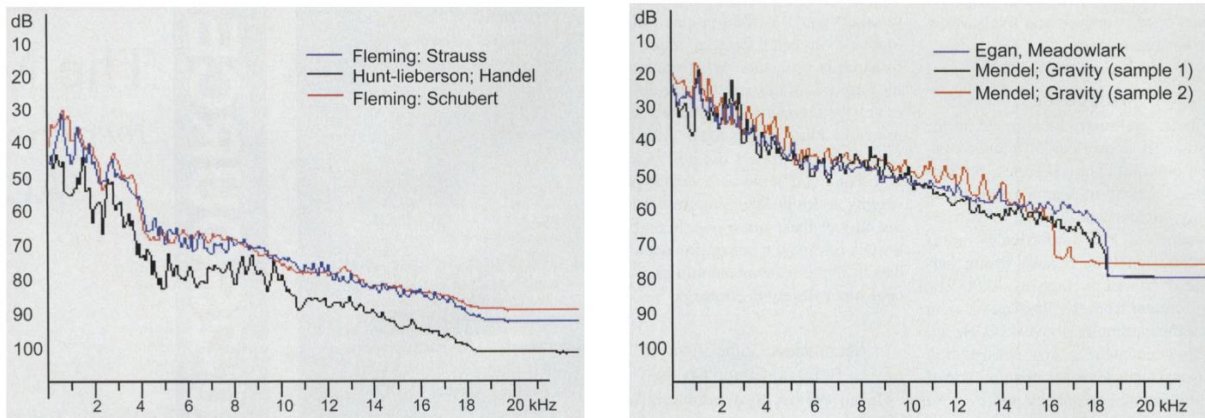
The physical means of producing belt result in a spectrum with a great deal more energy in mid-and high partials (above 1kHz), with the fundamental often less intense than the second partial, and less fall-off of energy above 4kHz, and sometimes even a slight peak in the 6-8 kHz range. This contrasts with the profile of a classical singer, whose voice shows strong fundamental and low partials (1kHz and lower), a significant peak from the ‘singer’s formant’, followed by a steeper fall-off above 4kHz.

Figure 4-3 shows the spectral analyses Wells performed on recordings of two classical sopranos and two contemporary musical theater singers belting. In the same article, Wells compares the spectral profiles of belt singing with those of various “ethnic” singing ensembles, including a Bulgarian women’s choir, American Sacred Harp singers, and Tahitian, Nigerian, Moroccan, and Taiwanese performers, and finds what he believes are significant spectral profile

²¹ Wells (2006) 67.

similarities, leading him conclude that belt technique

FIGURE 4-3A-C: SPECTRAL ANALYSES OF CLASSICAL VS. BELT SINGING²²



shares acoustic and therefore phonatory foundations with these other world singing styles, foundations which Wells locates in each style’s connection to “vernacular entertainment” and “colloquial language,”²³ tracing a phonatory line from speaking voice to chest voice to belt and its apparent sister styles. Indeed, Wells goes so far as to suggest that belt in its rawest form is a sort of proto-vocalism:

I posit... that belting in some form – usually quite “raw” or unrefined by conscious adjustments – has existed as long as humans have sung. Specific variations and refinements of the vocal approach have developed in certain locations based on particular desires or needs of the performers... The spectrum of traditional singing styles found around the world includes, without doubt, examples of "raw belt" vocalism, "free belt" and likely many somewhere in between. As Western choirs find transcriptions or arrangements of these styles of singing (Micronesian, African, Eastern European, among others), they should embrace belt technique as a means to understand the vocalism of the culture's music they desire to sing.²⁴

²² Wells (2006) 71-72.

²³ *Ibid.*, 75.

²⁴ Wells (2006), 75.

It seems quite likely that Wells' enthusiasm for and views on belt would have informed or at least influenced Shaw's use of it in *Partita*, where it performs important structural and expressive roles, as will be seen in Chapters 5 and 6.

4.3.2 Tuvan Throat-singing

Tuvan throat-singing is a Western catch-all term for several styles of singing that evolved in a mountainous region of what is now Russia bordering on Mongolia. Its exact origins unclear and shrouded in legend and aural tradition. It seems to have evolved as a practice of mimicking natural sounds like whistling wind, gurgling water, animal and bird cries, and so on. It may have been related to its practitioners' animist spiritual beliefs, in which animals and natural surroundings are inhabited by spirits, and "the spirituality of mountains and rivers is manifested not only through their physical shape and location but also through the sounds they produce."²⁵

The common characteristic of all the different styles of Tuvan throat-singing is the production of at least two distinct tones, a lower one produced via the vocal folds (and sometimes even the false vocal folds) and usually held as a drone, and others produced by isolating and amplifying the overtones of the lower pitch, which is accomplished by narrowing and moving vocal tract formant peaks to align with the desired harmonic . By moving the formant rapidly and precisely, the singer can create melodies and stylized imitations of natural sounds over the drone. Tuvan throat singing is performed both unaccompanied or with instruments, solo or in groups. Traditionally, Tuvan throat-singing has been passed on aurally and practiced only by men as a social and spiritual function, although more recently, professional

²⁵ Levin and Edgerton (1999), 80-82.

throat-singers and ensembles have attained wider success, and women have begun to study, practice, and perform as well.

Throughout the *Partita*, Shaw references three different styles of Tuvan throat singing: *xoömei*, *sygyt*, and *kargyraa*. The three styles refer to different general vocal ranges and different methods of producing the harmonics. *Xoömei* (sometimes spelled *khoomei* or *khoomei*) is often used as a collective term for any style of Tuvan throat-singing, as distinct from other types of vocalization, but it is also a style unto itself. In *xoömei*, a low-mid range fundamental is produced and the entire tongue body moves along the raised-lowered/forward-back axes (much like producing vowels) to tune the formant to the desired harmonic. In *sygyt* (“whistle”), the fundamental is, a mid-high range tone, and the tongue tip is kept behind the upper teeth, while the mid-tongue and tongue root do the moving, and rounded lips are also used to fine tune the harmonic. This produces a very high, whistle-like harmonic.²⁶ In *kargyraa*, a very low fundamental is used, and the false vocal folds and/or other supraglottal structures are also made to vibrate, usually at half the frequency of the vocal folds, producing a fundamental an octave below the glottal pitch. This extremely low “subtone”, though much weaker than the glottal fundamental, doubles the number of overtones available for amplification, and also gives added reinforcement to many of the overtones. This creates an extremely rich, resonant sound. In *kargyraa*, the formants are shifted by precise opening and closing of the mouth along with changing vowel color. *Kargyraa* is similar in timbre and production method to Tibetan Buddhist chant.²⁷

²⁶ The generally high tongue position of *sygyt* may have an effect similar to that of rhoticity, which, as we recall from Chapter 2, pushes the third formant down into the same range as F2, forming a super-powerful double formant.

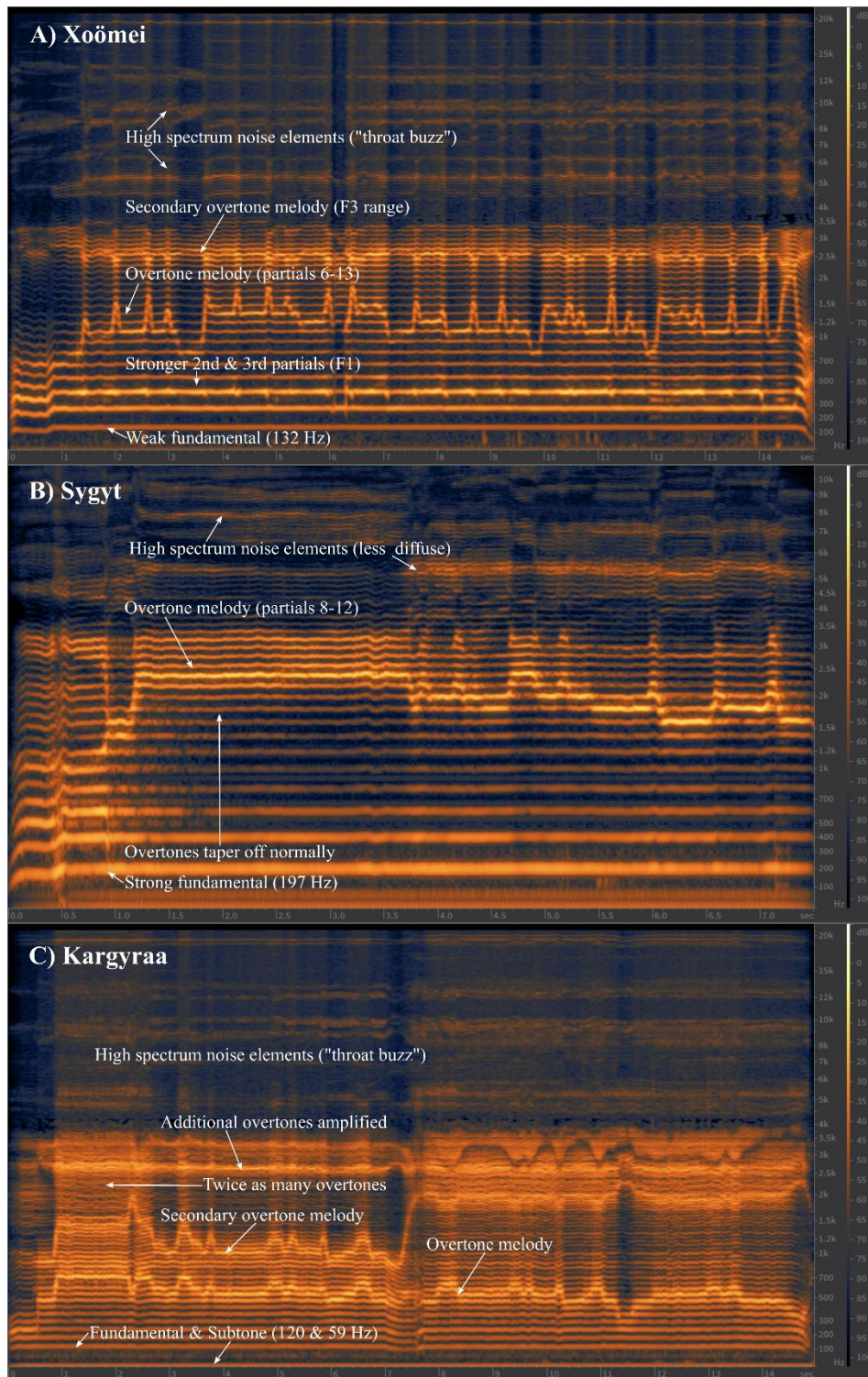
²⁷ This brief summary is paraphrased from Levin and Edgerton (1999) 85-86. This article also contains more detailed descriptions and x-ray photographs of the vocal tract positions used in *xoömei* and *sygyt*, as well as an excellent general summary of vowel formants and vocal production.

Figure 4-4a-c shows spectrograms of the three styles, illustrating their acoustic differences. Visibly evident are the much more densely packed spectrum of *kargyraa*, the more drastically attenuated mid-range partials of *sygyt* (which add to its more pinched, nasal quality) and that style's single strong overtone melody versus the additional areas of overtone amplification present in the other two styles.²⁸

Interestingly, Shaw does not use these techniques in ways that highlight the amplified overtones. She uses them instead for their buzziness, as drones which add additional brightness and noisiness to larger, multitimbral ensemble textures. The closest she comes to a full use of a Tuvan style is in the codetta of the Sarabande, where an overtone melody is clearly audible. This overtone singing, however, has a far subtler amount of buzz than *sygyt*, making it more of a Western-style technique, which we will describe in greater detail in the next section.

²⁸ These additional enhanced overtones are usually not strong enough to be perceived as separate lines, but reinforce or color the main overtone melody and, along with higher-spectrum elements, contribute to the characteristic bright buzziness of the overall timbre).

FIGURE 4-4A-C: TUVAN THROAT-SINGING STYLES²⁹



²⁹ The recorded samples used for these spectrograms were performed by Steve Sklar, an American composer, performer and teacher of Tuvan throat-singing, and are available online at <http://khoomei.com/pics/sygyt.aiff> (sygyt); <http://khoomei.com/sounds/skhoomei.aiff> (xoömei); and <http://khoomei.com/sounds/skarg.aiff> (kargyraa).

4.3.3 Other Overtone Techniques

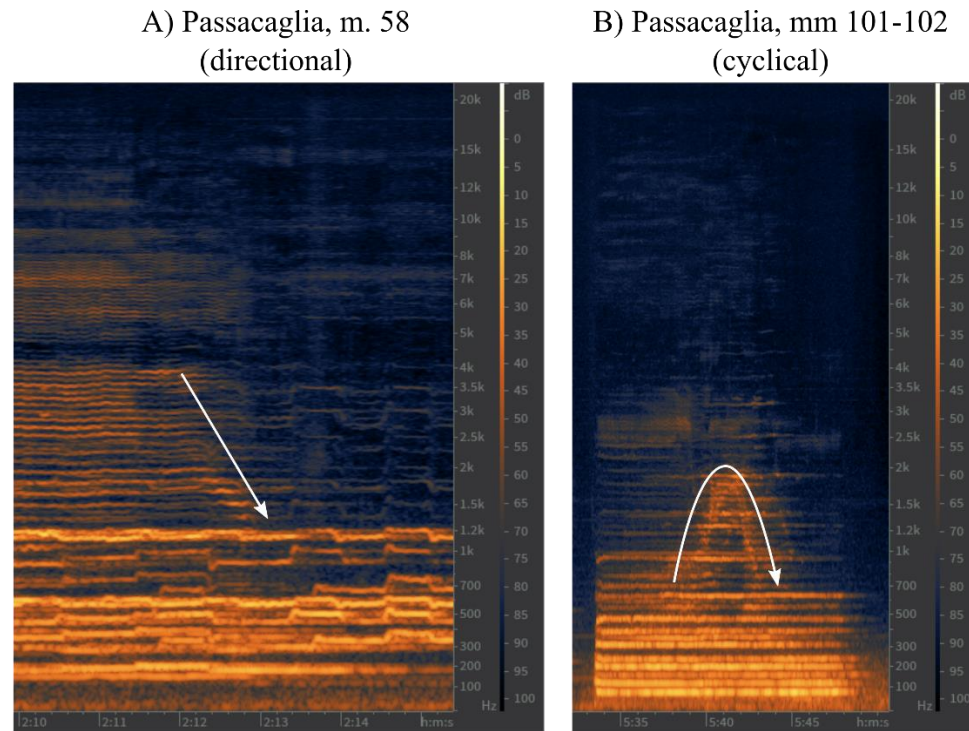
Overtone singing is not isolated to Tuvan culture. Styles of overtone singing are found in other parts of central Asia, Tibet, Africa, and the West, where it usually follows a more *sygyt* like technique, but eschewing the buzzy, gravelly phonation of the Tuvan style for a less noisy overall tone. Examples of such overtone singing in concert music generally begin with Stockhausen's *Stimmung*, although the Texan singer Arthur Miles used it in the 1920s as a novel substitute for the yodeling solos common in some styles of country music. Such overtone singing is used in the codetta of the *Partita*'s second movement.

Shaw also uses other techniques that isolate or enhance overtones. Most prominent of these is the technique for which she has coined the term "eat your sound." Shaw describes this in her performance notes as "A multi-step tongue filter developed by Roomful of Teeth," but no detailed direction for executing this technique is offered. By listening to its performance in the recording, we can surmise it is an overtone glissando performed by a combination of smooth tongue advancement/retraction and mouth opening/closing with lip rounding, causing continuous vowel color changes. In addition, a similar pinched, nasalized tone may be used to help attenuate undesired harmonics. The physical movements involved may be reminiscent of slow-motion chewing or taking a large bite of an imaginary foodstuff, hence the description. The resultant timbre when performed, as it usually is, by one or two singers in a larger texture, is a slightly pinched and nasal color with a "shimmering" quality that appears and recedes as the overtones traverse their glissando. Two examples of "eat your sound" glissandi, one unidirectional, one cyclical, are shown below in Figure 4-5.

Shaw often uses the "eat your sound" filter to give color and movement to the sustain or

release portions of a sonority’s envelope, as in Figure 4-5b, or, as shown in Figure 4-5a, as a way of “tapering off” a full-ensemble texture to a more reduced, spectrally sparser one.

FIGURE 4-5A-B: “EAT YOUR SOUND” GLISSANDI¹



4.3.4 P’ansori-derived techniques

P’ansori is a style of narrative performance art native to Korea. It is usually performed by a solo vocalist accompanied by a drummer. The vocalist performs in a mixture of singing and declamatory speech, along with appropriate dramatic movements or gestures to recite and depict verse tales that range from animal fables to love stories to historical epics. Originating as popular

¹ The only examples of this technique bearing the written notation “e.y.s” are found in the Passacaglia (mm. 42, 58, and 101-102). Based on the recording, however, other instances occur in the Allemande (mm.

4.3.5 *Katajjak*

Inuit throat-singing, or *Katajjak* (sometimes spelled *katajjaq*), originated not as music *per se*, but as a sort of game, a vocal version of “Simon says” mashed up with “telephone,” involving two singers (almost always women) facing each other and jointly creating hokey-style rhythmic/melodic patterns comprised of voiced and unvoiced breath sounds, low growls, grunts, hums, regular modal voice, and vocables or other nonsense syllables or sounds. The singers mimic and build on each others’ vocalizations, in a contest of skill and endurance: the first singer to break the pattern, run out of breath, laugh, or otherwise fail to continue is the “loser.” It should be noted that, despite the name, and some of the vocalizations’ similar buzzy, growly, or pressed qualities, *Katajjak* does not feature reinforced overtones as Tuvan or other throat-singing styles do.

Though originally a type of game or entertainment in informal social contexts, *Katajjak* has become more institutionalized and professionalized over the years into a performance art in its own right, with well-known practitioners, competitions, and other events. It has also been incorporated into popular and concert music styles both by Inuit and Western artists.

Shaw’s use of *Katajjak* techniques is concentrated in the Courante (with the exception of a brief foreshadowing reference in the Allemande), and consists mainly of rhythmic inhalation and exhalation, both unvoiced and semivoiced. She also uses a technique she has named the “Akinisie rumble,” a deep, breathy, sustained growling sound named after Akinisie Sivuarapik, one of the teachers with whom RoT studied *Katajjak*.

With a basic understanding of the origins and timbral characteristics of these special styles and techniques, we can now turn to analyses of the individual movements of *Partita*.

5. ANALYSIS – PARTITA FOR 8 VOICES

5.1 I. Allemande

Shaw’s Partita opens, as most Baroque partitas and suites do, with a movement titled “Allemande.” Shaw’s Allemande has more to do with American square- and contra-dancing than with Bach, however.³ In those dance traditions, the term “allemande” refers to a particular step in which partners turn around each other with hands held or arms linked, a move derived from similar steps in the eponymous Baroque dance.⁴

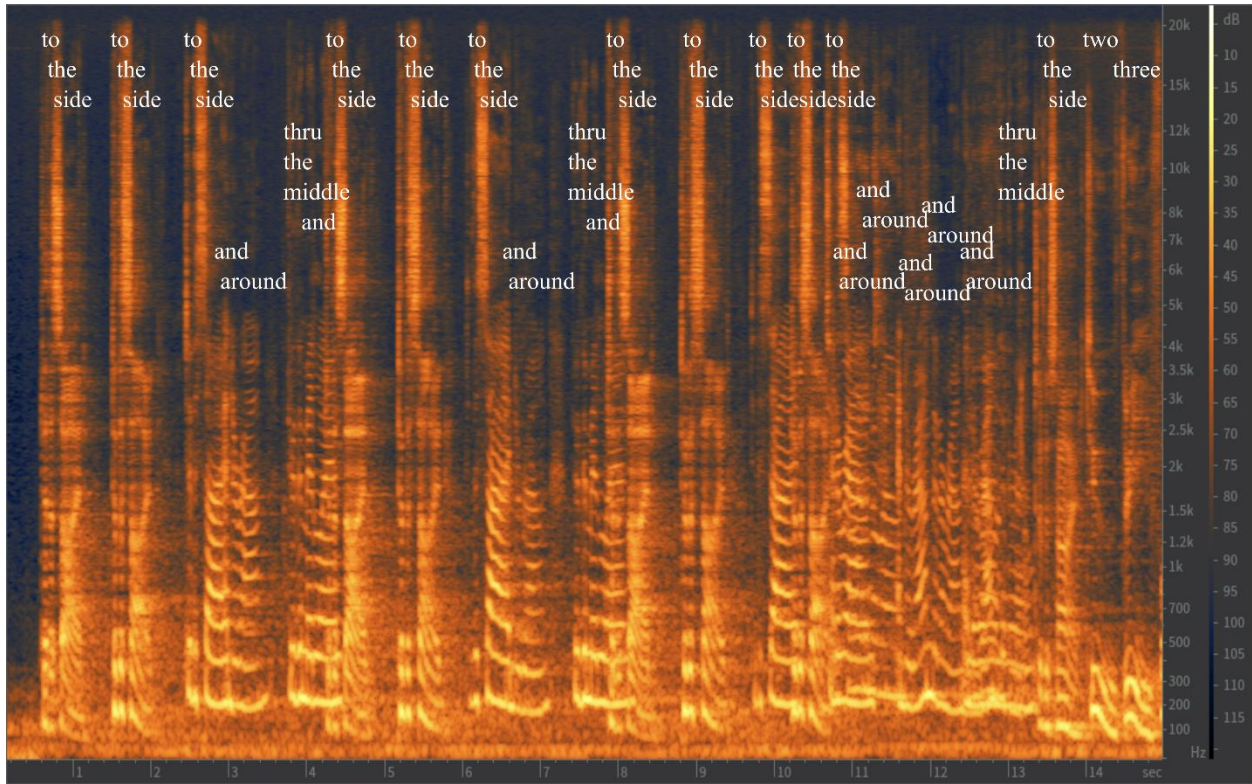
Shaw opens her Partita not with singing, but with speaking. The text is a combination of square dance calls and Sol LeWitt Wall Drawing instructions, mashing together down-home popular entertainment with high-concept abstract art. The contrast between sung and spoken voice is a primary element of this movement, where the spoken voice carries most of the actual text of the movement, while the singing is done largely on vowels. In those places where there is sung text, it is repetitive, mantra-like, and seemingly unconnected to the spoken text.

The spoken introduction shows a very sensitive usage of consonants and vowels. The first text, “to the side,” [tə ðə saɪd] stresses unvoiced plosive and fricative consonants [t] and [s], as well as one voiced fricative, [ð] which all have significant high frequency noise bands (up to 20kHz) well above most vowel frequencies. By contrast, the second textual snippet, “and around,” [ænd ə'raʊnd] has only voiced consonants [n] and [ɹ], and only one plosive, [d] which lack significant high-spectrum noise elements. Here the vowels are more to the fore, and along

³ The American square- and contra-dancing traditions themselves are, of course, distant descendants from the European Baroque dance tradition.

⁴ Another important distinction has to do with pronunciation. In square- and contra-dancing, “allemande” is usually pronounced [ˈæləmænd].

FIGURE 5-1: SPECTROGRAM SHOWING CONSONANT/VOWEL CONTRAST (MM. 1-8)



with the voiced consonants, the salient spectral range is 100-5000 Hz. These contrasts can be seen clearly in the spectrogram in

Figure 5-1. Both text segments end with a diphthong, [aɪ] and [aʊ], respectively. These two diphthongs are essentially inversions of each other, according to Slawson’s color theory – reflections around his “acuteness” axis, as shown in Figure 5-2. They are both roughly equivalent movements in terms of openness, and roughly equally opposite movements in terms of acuteness (front-back). This can be seen also in the different formant movements of each diphthong, where F2 rises dramatically for [aɪ], but falls for [aʊ], following the same downward contour as F1 and F3 (see Figure 5-3).

FIGURE 5-2: DIPHTHONGS AND ACUTENESS INVERSION (MM.1-2)

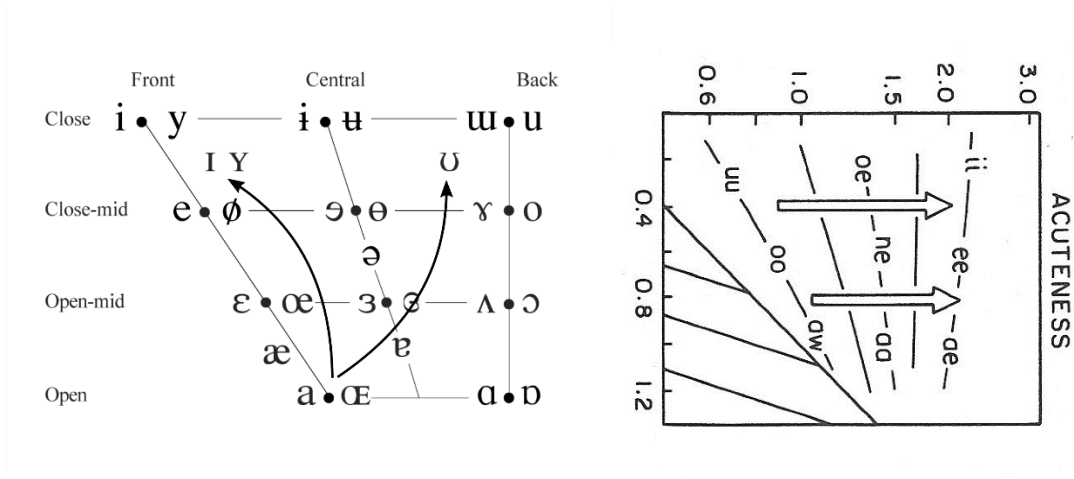
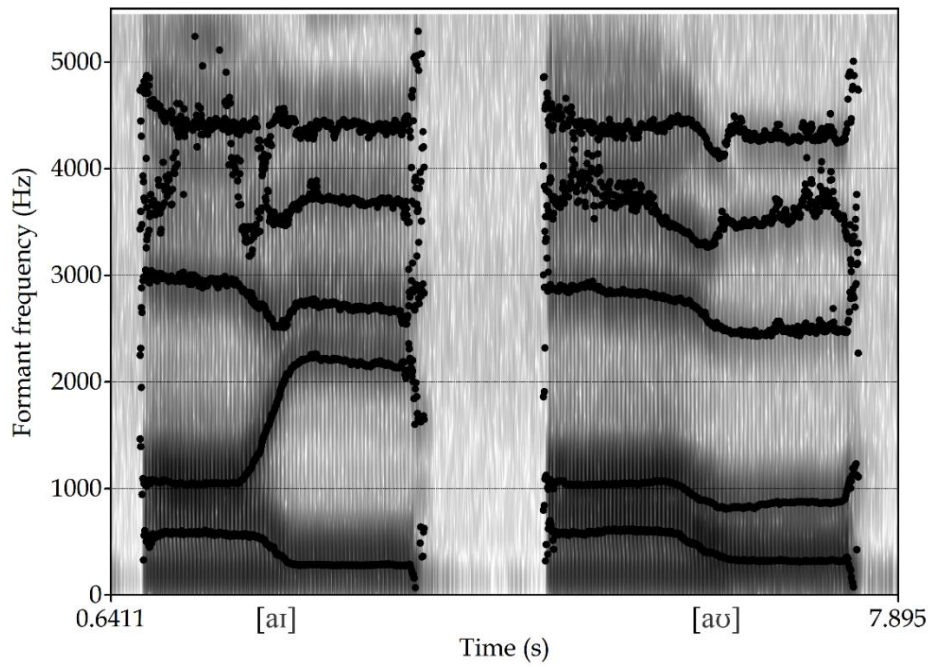
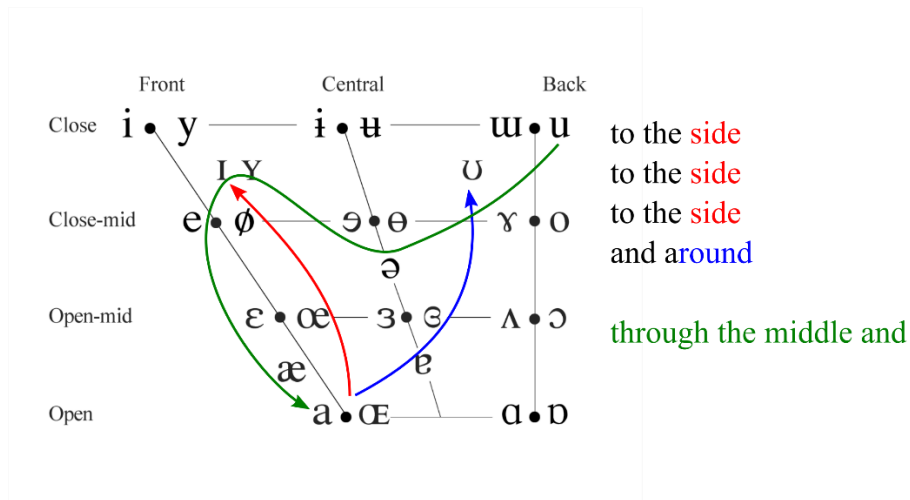


FIGURE 5-3: VOWEL FORMANTS OF [aɪ] AND [aʊ]



The phrase is rounded out by a third text snippet: “through the middle and,” which dovetails back into a new “to the side.” Not only does the text suggest a cyclical motion, but the prominent vowel colors of this final segment actually reinforce the meaning of the text and the cyclical phrasing, as shown in Figure 5-4. Here the vowel color does indeed move “through the middle” – the neutral schwa of “the” – and ends by reversing the vowels that make the [aɪ] diphthong. In addition, the return of fricative consonants [ð] and [θ] in “through the” reintroduces some high-frequency noise and thus prepares the way for the return of [t] and [s]. These characteristics help explain why these text segments complement each other so well and how they create a convincing, well-shaped phrase.

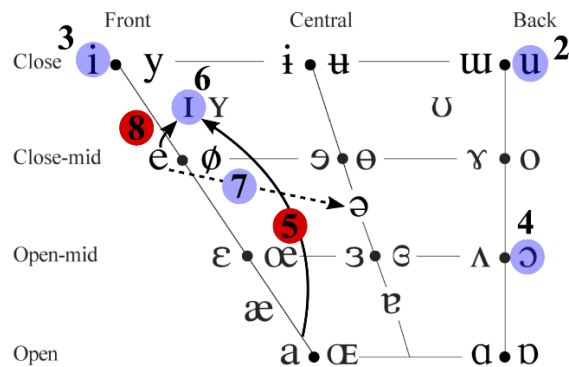
FIGURE 5-4: VOWEL COLORS IN ALLEMANDE OPENING PHRASE (MM.1-3)



The rest of the spoken introduction continues this usage of consonants and vowels to help shape phrasing and flow. If we refer back to Figure 5-1, we can see clearly how the alternating pattern of high-frequency consonant spikes and lower-frequency open vowels repeats, then is extended. The third time, the layering and repetition of “and around” fills in the upper spectral range with slightly higher density.

This is followed by a contrasting phrase in which voices count steadily from two to eight, like a bandleader or dance caller. The numbers feature a greater variety of unvoiced plosives and fricatives, as well as an expanded palette of vowels, most of which are pure: [tu/ ði/ fɔɪ/ faɪv/ sɪks/ sevən/ eɪt]. Only “five” and “eight” contain diphthongs (the [aɪ] of “five” providing a nice assonance with “side”). It is interesting that while this phrase presents a familiar, predictable textual progression in a steady, straightforward rhythm, the pairing of consonants (two/three; four/five; six/seven) and lack of vowel repetition, shown in Figure 5-5, create different levels of timbral variation, helping to counter this predictability, and providing a contrast to the previous phrase’s cyclical repetition.

FIGURE 5-5: VOWEL COLORS, “TWO THREE FOUR...” (MM. 8-9)⁵



This phrase also stresses other vowels [ɪ] (“six,” “midpoint”), [ɔ] and diphthong [ɔɪ] (“four,” “drawn,” “midpoint”) and [ɛ] (“seven,” “left”), even as it continues the [aɪ] diphthong assonance (“five,” “line,” “side,” “right”). Overlapping and emerging from this, the phrase

⁵ Numbers in red circles and curved lines indicate diphthongs. The dashed line connects the two syllables of “seven.”

“allemande left and around and around” gradually is taken up by all voices, first emphasizing repetitions of “around and around,” then of “allemande.” This closing phrase balances the varied vowel colors, noisy consonant punctuation, and [aɪ] assonance with a return to voiced consonants, diphthong [aʊ], and finally a glut of [æ] vowels, which morph seamlessly into the first sung material at m. 14, a melodic/harmonic motive shown in Figure 5-6, sung on the vowel [a].⁶

FIGURE 5-6: ALLEMANDE, MM. 13-17

The image shows a musical score for eight voices (numbered 1-8) in a single system, covering measures 13-17. The music is in a key with one sharp (F#) and a common time signature. The lyrics are: 1. mande al-le-mande al-le-mande al-le-mande; 2. al-le-mande al-le-mande; 3. round; 4. and a-round al-le-mande al-le-mande al-le-mande; 5. round and a-round al-le-mande; 6. and a-round al-le-mande al-le-mande al-le-mande; 7. left and a-round al-le-mande al-le-mande; 8. mand al-le-mande al-le-mande al-le-mande. A common melodic/harmonic motive is shown in a separate staff on the right, starting at measure 14, consisting of a sequence of notes: G4, A4, B4, C5, B4, A4, G4, F#4, E4, D4, C4. This motive is marked with a forte 'f' dynamic and a vowel box containing the letter 'a'.

The three phrases within the Introduction which emphasize the repetition of “and around

⁶ Different sources give slightly different pronunciations of [a]. The most consistent usage seems to be as the first sound in the [aɪ] diphthong (“side”). This makes it a more centralized color than the very front [æ]. The color the singers use in the recording seems much more like [æ] (the standard American pronunciation of “cat” or “sad”). This also is consistent with the belt-like phonation which, according to Wells (2006, 68.), favors modification of vowels towards [æ].

and around” and “allemande” follow a pattern of successive extension, so that the overarching theme of this introduction is the emergence of [a/ æ] as the primary vowel color of this movement, and, as we will see, a timbral reference point throughout the *Partita*.

The vowels [a] and [æ] are both open, front vowels, with medium-high first formants and relatively even spacing of F1-F4, amplifying overtones across the full vowel spectrum. In particular, upper partials boosted by F2 and F3 (in the 1-4kHz range) give these vowels their bright quality, and their openness permits a full, resonant tone. These inherent qualities are further emphasized by the singers’ phonation mode. Here, the singers use a very bright chest, even belt-like phonation. The spectral profile of belt, we recall, contains more high-spectrum energy than classical modal phonation, as high as 6-10 kHz, accounting for its very bright, brassy, even somewhat buzzy sound. The affect at Reh. B is quite striking, and when the same bright, belt-like timbre and vowel color is used later in the movement (at Reh. J), it has a feeling of formal return, or perhaps ‘timbral echo,’ even though the melodic material is different and Reh. J is functionally different (beginning the run-up to a climax, rather than the statement or restatement of primary material). Similar belt-like [æ] timbres occur at other key moments throughout the Partita, as we shall see, and though the motivic or harmonic material at these moments may be quite different, they are linked in affect and in the listener’s memory by this distinctive shared timbral quality.

The analyses in Figure 5-7 and Figure 5-8a-c show how the use of vowel color/phonation mode, timbral uniformity/variety, and timbral elision or smoothing at transitions play out across the movement as a whole. For instance, we can see that in the latter halves of sections 1 and 3,

FIGURE 5-7: ALLEMANDE – ANALYSIS OF VOWEL COLOR, FORM, AND OTHER TIMBRAL FEATURES

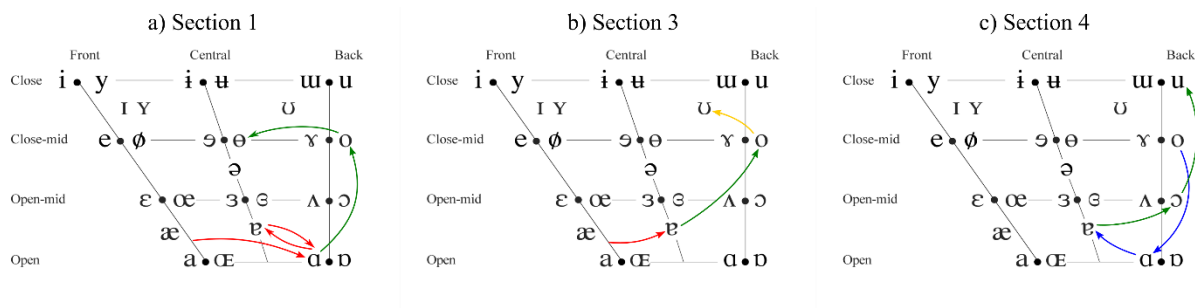
Structural	Meas./Reh.	Vowel/text/timbral techniques	Other features
Intro	1	text (spoken) “ <i>To the side...</i> ” etc.	Textured monotimbral
Section 1a Motive A[025]	14 (B)	[a]/[æ] ⁷ ; belt	Monotimbral; Very bright, full, brassy
1b A varied with references to mvts. 3 & 4	21 (C)	[ɑ/m/ɑ/m] + spoken intro text; register breaks	Multitimbral; solo voices pure but resonant; hums;
	29 (D)	[ɐ/m]; chest/belt; spoken intro text; <i>katejjak</i> (ref. mvt. 3)	Chest voice interjections (bright but less rich)
1a’ A motive in aug.	35 (E)	[ɑ] + pitch bends	Monotimbral; Belt/chest Bright, full, rich/balanced
Section 1c A/closing [0135]	42 (F)	[o] + pitch bends	Monotimbral; Chest Dark, rich, warm
	47	[ə] + pitch bends closing to [m]	Monotimbral; Chest Dark but less rich/warm
Transition	55	Text (spoken over [m]) “The detail of the pattern”	Multitimbral; reference to mvt. 4
Section 2 5 th -based motives [02479]	63(G-H)	Text: (Sung) “Find a way/fall away” Spoken: similar to Introduction	Multitimbral; Solo voices with light, clean, ‘head’ sound
Transition	78	[m → ɔ → ɐ]	Timbral cresc.: Neutral – dark – bright
Section ‘3a’	82 (J)	[a]/[æ] + text emphasizing [æ] [a] and (“allemande/and around/to the side/and through”); Moves to [ɐ] ⁸	Bright chest/”belt-ish” Textured/heterophonic monotimbre; brightness apex
Section ‘3c’ Circle of 5ths	90 (K)	o], some voices have heterophonic ornamentation; one high voice on [ɑ]	Timbral Heterophony; Textured monotimbre; pitch apex
	96 (L)	[m] with “quivery vibrato”	Textured/heterophonic monotimbre Reference to mvt. 2
Transition	102 (M)	[m → ʊ → m] + <i>xoömei</i>	

⁷ Although [a] is marked in the score, in the recording it seems to be mixed and heavily colored with the brighter [æ], especially to ‘punch’ the melodic apex notes.

⁸ Again, these vowels are based on the singers’ vowels as heard in the recording.

Section 4a	104	“Far and near are all around” (sung) Pad: [m → o]	Bitimbral texture: Solo voice- chorus - microcanon over progressively fuller, richer, brighter (finally noisy) low voice pad.
4b Ornamented descending melody	106 (N)	“Round and around and through” (sung) Pad: [a] → [ɐ]	
4c	109 (O)	“Toward you” (sung) Pad: [ɐ] + xoömei ⁹	
Closing	111	[ɔ] ¹⁰	Rapid richness reduction and darkening
	m. 112	[u] + pitch bends; amplified overtone	Dark, pure, with internal ‘warping’ effect

FIGURE 5-8A-C: SECTIONAL VOWEL COLOR PROGRESSIONS OF ALLEMANDE



there are similar movements of vowel color from open-front to closed-central or back vowels, and that Section 4 also has a similar progression in the context of a larger arch, first opening and brightening from [o] to [a] to [ɐ], before reversing course to conclude the movement at the closed-back extreme of [u]. These timbral changes are clearly visible in the spectrograms in Figure 5-9,

Figure 5-10, and Figure 5-11. If we compare, for example, Section 1a'-1c in Figure 5-9

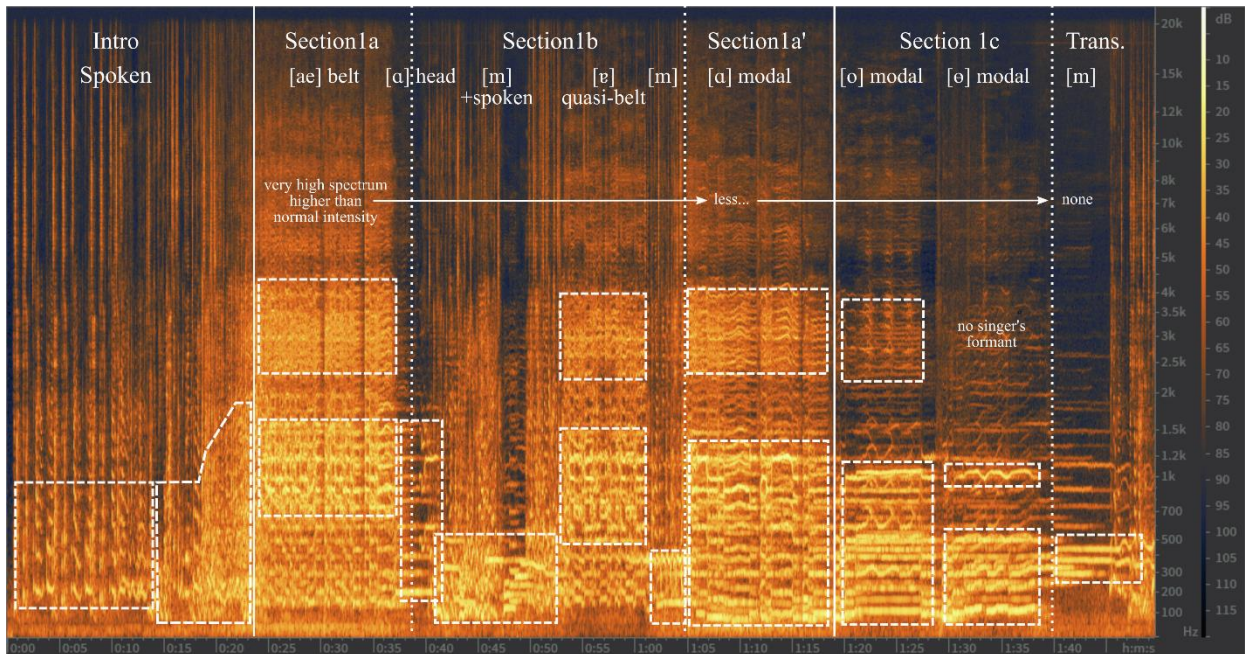
⁹ Not marked in score but clearly audible in recording.

¹⁰ Not given in score, but based on recording, where singers sustain the second syllable of “toward.”

with Sections 3a-c in Figure 5-10, we can see the similar shift caused by the vowel color and phonation changes, decreasing the presence and strength of higher partials, focusing from rich and/or bright down to darker and purer timbres. Conversely, Section 4 (in Figure 5-11) shows the increasing richness of the spectrum as the low voice pad opens from a hum to an [e], and buzzy Tuvan *xoömei* further enriches the upper spectrum.

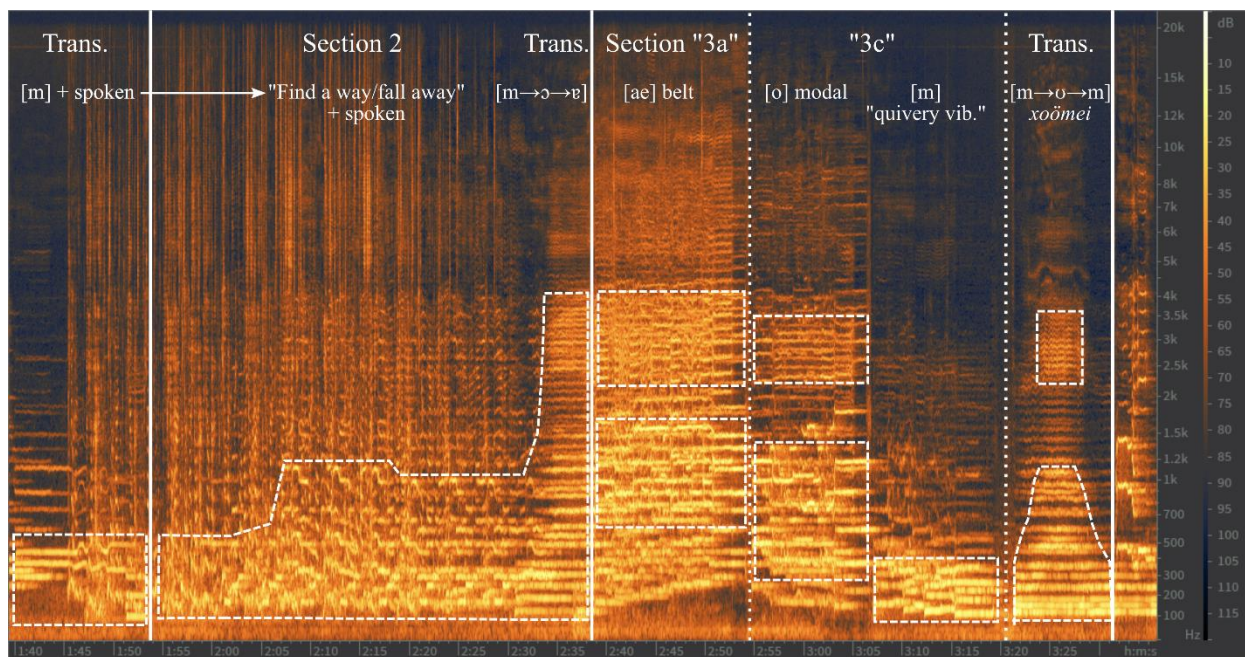
Returning to Figure 5-7, we can also see how timbral uniformity vs. timbral variety is used to create contrast and formal motion. For instance, Section 1a-b-a' has a ternary- or arch-type shape in this regard, where homophonic, monotimbral tutti statements of the main motive bookend a multitimbral central section that weaves together spoken voice, hums, head voice, register breaks, and Inuit *katajjak* (a style that will be described in detail in Section 5.3).

FIGURE 5-9: ALLEMANDE, SECTION 1 (MM. 1-54)



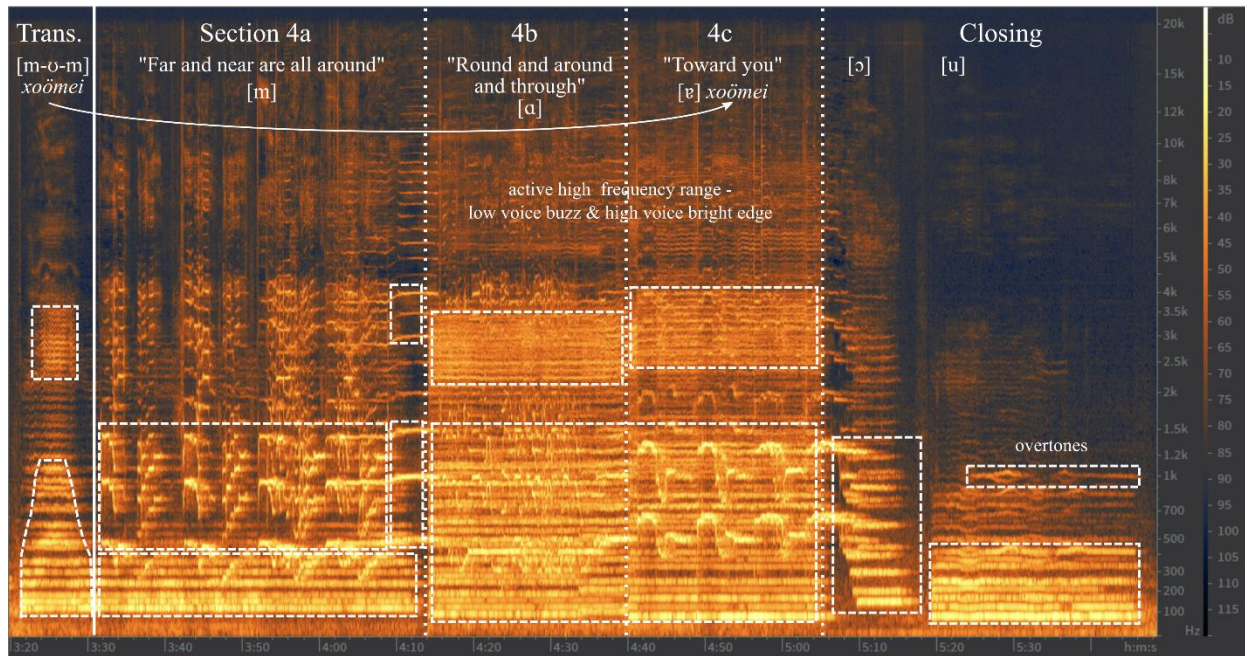
Similarly, Section 2 of the Allemande mixes spoken and sung timbres, and is flanked by sections where more unified timbres predominantly operate one at a time, in phrase blocks. Although closer to Section 1b in timbral variety, Section 2 seems to combine that with a similar trajectory to the Introduction, in that it is building out of a noisy texture from the lower spectral range to lead into the higher range of belt. Taken together, the Intro and Section 1 thus form a timbral arch, as do Sections 2 and 3.

FIGURE 5-10: ALLEMANDE, SECTION 2-3 (MM. 54-103)



Section 4 also has a similar arch, and so we could also see the overall form as being a “triple arch” in terms of timbral brightness/richness.

FIGURE 5-11: ALLEMANDE, SECTION 4 (MM.102-112)



Finally, the Allemande contains several motivic and timbral “quotations” or foreshadowings of the other three movements of the Partita. These links are catalogued in Figure 5-12. In some instances, the connection is quite straightforward, as in the *katajjak* quote from the Courante. In most cases, however, the links share timbral similarities but the occurrences in other movements are somehow varied, extended, or developed beyond their initial use in the Allemande. For instance, the quick yodel-like register breaks in m. 25 foreshadow the use of register breaks in the second statement of the Passacaglia, and the larger-scale exploration of chest/head register contrast throughout that movement. The use of chorusing and heterophonic elaboration of melodic lines by the women’s voices in mm. 96-109 foreshadows the men doing likewise in the Sarabande.

FIGURE 5-12: REFERENCES TO OTHER MOVEMENTS EMBEDDED IN ALLEMANDE

Allemande location	Description	Links to
m. 25	Main motive with yodel-like chest/head register breaks	Passacaglia, mm.11-20 , and Passacaglia register contrasts more generally
mm. 32-34	<i>Katajjak</i> hum-inhale-exhale motive	Primary material of Courante ; explicit at Reh. D and following
mm. 55-56	Oscillating whole-step; hummed and loosely sliding between notes	Passacaglia, Reh. C and following: “plainchantish improv” with vowel and registral shading.
mm. 96-81	Circle of fifths progression; [m], colored with heterophonic “quivery vibrato w/ornamental neighbor tones”	Sarabande, mm. 5-9 : Maj/min, slightly different voicing; [m-a] scoops; breathy voice; heterophonic belt ornamentation at mm. 29-33
mm. 103 & 109	Ornamented melodic line with unison chorusing; women	Sarabande mm. 25-31 : line with unison chorusing, heterophonic ornamentation and belt; men
m. 112	Overtone amplification ¹¹ (with pitch bend)	Sarabande m. 52 : overtone melody; Passacaglia mm. 101-102 : “Eat your sound” overtone gliss.

Elsewhere timbre is used to vary connected elements, as in the circle-of-fifths progression in Allemande mm. 96-81, which is hummed with a *P’ansori*-style “quivery vibrato”, while a very similar progression in the Sarabande is presented with the breathy, scooping hummed inflections that run throughout that whole movement, or the way the eighth-note rhythmic motive of the Allemande’s main theme turned into both noise and texture by the rhythm of the *Katajjak* in the Courante.

¹¹ Not marked in score but clearly audible in recording and seemingly deliberate.

5.2 II. Sarabande

Although Shaw's Sarabande does have the triple meter and accented second beat associated with the Baroque Sarabande, its form seems more akin to a chaconne or passacaglia, with a repeated harmonic progression serving as the basis for variations. This practice underlies this movement as well as the final movement, which is named Passacaglia. In both movements, harmonic development only creates structure at the phrase or section level, but not on larger structural levels. To create these larger shapes, Shaw continues to utilize many means, with timbral change chief among them. In the Sarabande and, we can argue, in the Courante, Shaw also utilizes timbral correspondences that play out on both micro- and macro- scales, at the level of both gesture and form.

More than any other factor, the Sarabande is defined timbrally by its tessitura. Aside from the very last chord, the tessitura is restricted to F#3-Eb5. Indeed, the majority of the Sarabande involves only the female (top four) voices of the ensemble, and when the men sing, it is melodic, not the harmonic and spectral foundation that they normally provide in the rest of the work (and that is the customary role of low voices in an ensemble). With higher fundamentals, the overtones are more widely spaced, which helps account for the airy, ethereal, delicate quality that prevails for most of the movement. This simple choice of range sets the Sarabande in a fundamentally¹² different timbral and emotional world than any of the other movements.

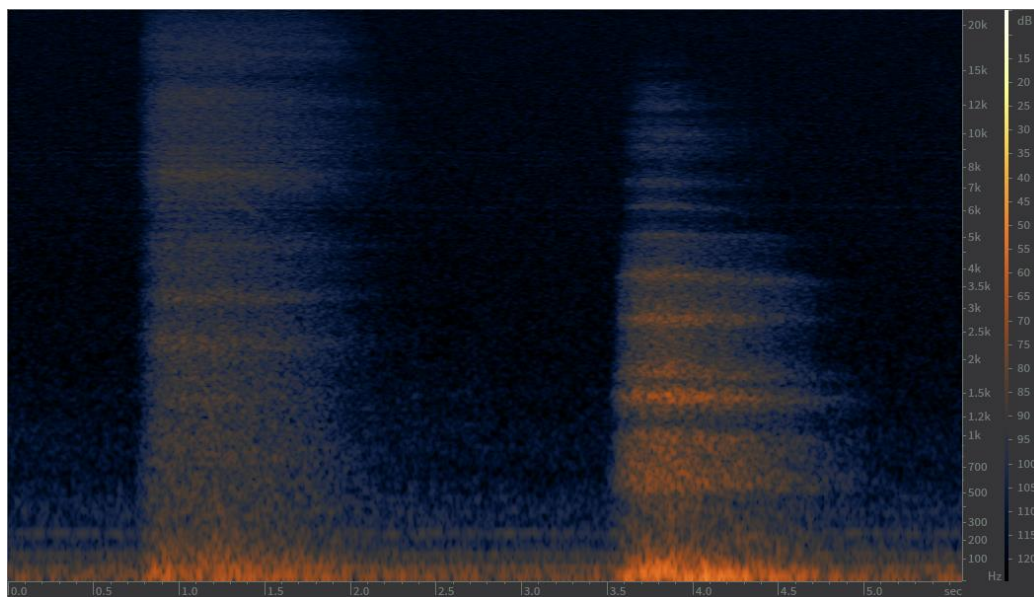
This airiness and delicacy leaves room for attention to timbral subtleties like breathiness and chorusing, and to envelope, the way a sound changes in quality over its duration. The chords that form the repeating progression which underlies this movement are ornamented by sliding

¹² I hope the reader will forgive the pun.

into the pitches with a simultaneous change from a closed-mouth “hmm” smoothly into an open [ɑ] with a down-up glissando, a sighing inflection that Shaw borrowed from Korean *P’ansori*.

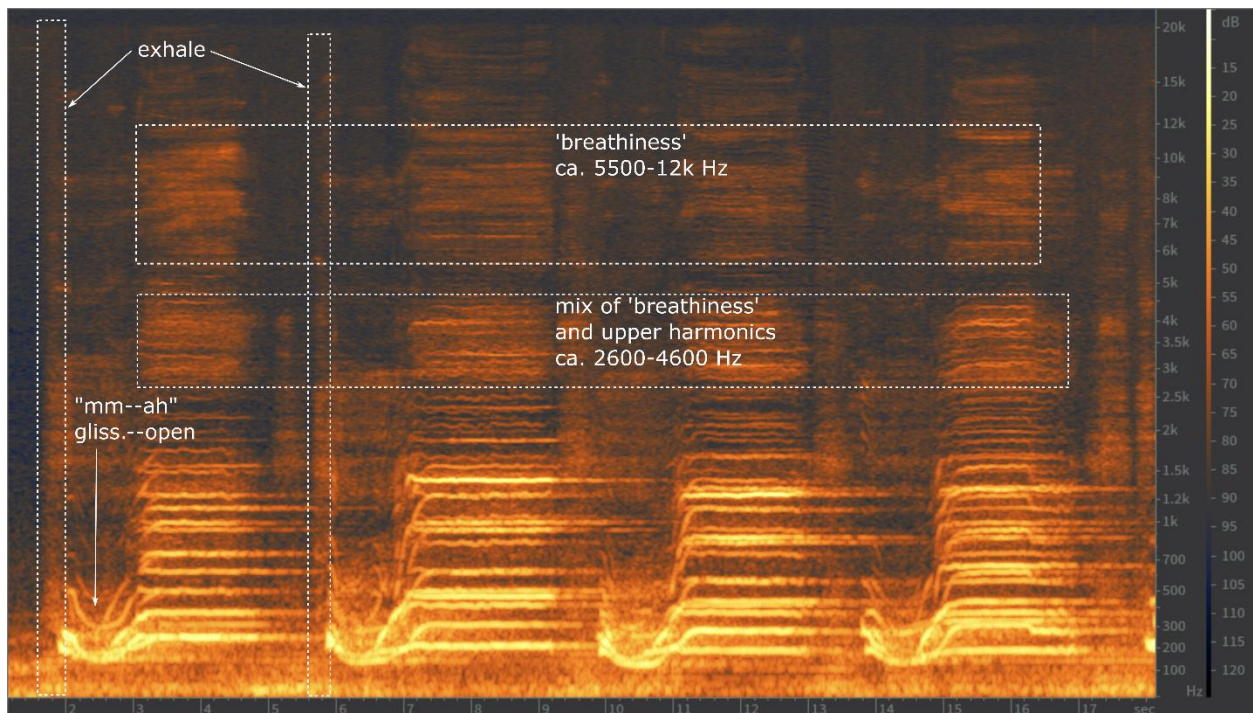
Although the gesture itself is fleeting and natural, it belies a rich and complex sound envelope, which becomes audible both through repetition and through the isolation of each gesture by framing silences. The exhalation with a closed mouth (that is, through the nose) produces a softer, more diffuse noise than an open-mouthed exhale, with its energy (what little there is) spread quite evenly over the whole spectral range. By contrast, an open mouth exhalation is louder, and though it still shows a wide and diffuse profile, it also clearly displays vowel formants, since as soon as air flows out through the open mouth, a vowel results (in this case, [ə]). The spectral profile of the nasal exhale is more like white noise, as shown in Figure 5-13. The very delicate breath attacks of the Sarabande’s scoop motive will be contrasted by percussive, glottalized breath attacks in the Courante.

FIGURE 5-13: CLOSED-MOUTH (NASAL) AND OPEN-MOUTHED [HƏ] EXHALATIONS



Closing the mouth and removing any hint of a vowel also makes for a seamless transition to the nasal consonant [m], as the vocal apparatus is already in position for it. As the voice traverses its glissando, the mouth remains closed, keeping the overtones of the fundamental almost completely damped. When the singers' mouths open and the pitches stabilize on the notes of a B major triad, the overtones spring to life. The singers maintain a breathy phonation mode throughout this section, without the strong chest core of modal classical singing, so almost all the energy remains in the fundamentals and lower partials, with upper partials still strongly attenuated. Instead, high-frequency elements in the breathiness produce a fuzz or 'halo' around the tone, which shows in Example 2 as a faint haze of high partials between 5500-12,000 Hz.

FIGURE 5-14: SARABANDE, MM. 1-4



The breathiness of the tone, and the scooping inflection of each chord, perhaps more identified in contemporary Western ears with a wide range of amplified popular and folk music styles than with Korean *P'ansori*, contribute a sense of intimacy and delicacy that is often cultivated by such pop styles.

Bit by bit, out of the ethereal chorale-texture, one or another of the four voices briefly emerge – sustaining a note across several chords, decorating the chords with an appoggiatura or neighbor-group, even offering a brief, rising-fourth or -fifth melodic motive. These solo voices become gradually more prominent in the second statement, and the statement ends with Voice 2 singing the fifth motive in a husky alto range, followed by the other three voices joining in sustaining a final unison Eb4.

This unison, and the darkness of the alto solo prepares us timbrally for Statement 3, in which the men's voices join in to ornament the harmonic progression in augmentation with a freely chanted unison melodic line. Voice 5, a solo, contributes further heterophonic ornamentation of this line, and as Statement 3 progresses, the other three male voices join in with this more florid melody. The melodic line is mid-low for tenors and on the high side for baritones and basses, so they all use a light head or mixed phonation, not as breathy as the women, but still soft-edged, to achieve a unified tone color. They sing on an, [o]¹³, whose first two formants are lower than those of the upper voices' [a], giving their sound a slightly darker and warmer timbre. Also contributing warmth and richness is the “chorusing” effect of the men's unison tripling. Taken all together, the high range, light phonation, and the chorusing, somehow conspire to give the mens' vocal timbre here a hint of fragility distinct from the upper voices, intensifying the sense of intimacy and making this moment extremely poignant.

¹³ Although this is the vowel specified in the score, the recording shows that the actual vowel the singers use sounds closer to [ɔ]. In any case, the relative disposition of the formants is still lower than [a].

After all this wispy and poignant delicacy, the second third of Statement 3 is a stark contrast. The upper voices continue the scooping chordal progression but now *fortissimo*, with no breathiness. The lower voices switch to an [a] or [ɐ] vowel as they belt the remainder of their melody in unison. The spectral ranges up to about 12,000 Hz that had been tentatively colonized earlier in the movement by the high-frequency haze of breath are now alive and densely populated by the high harmonics of belt.

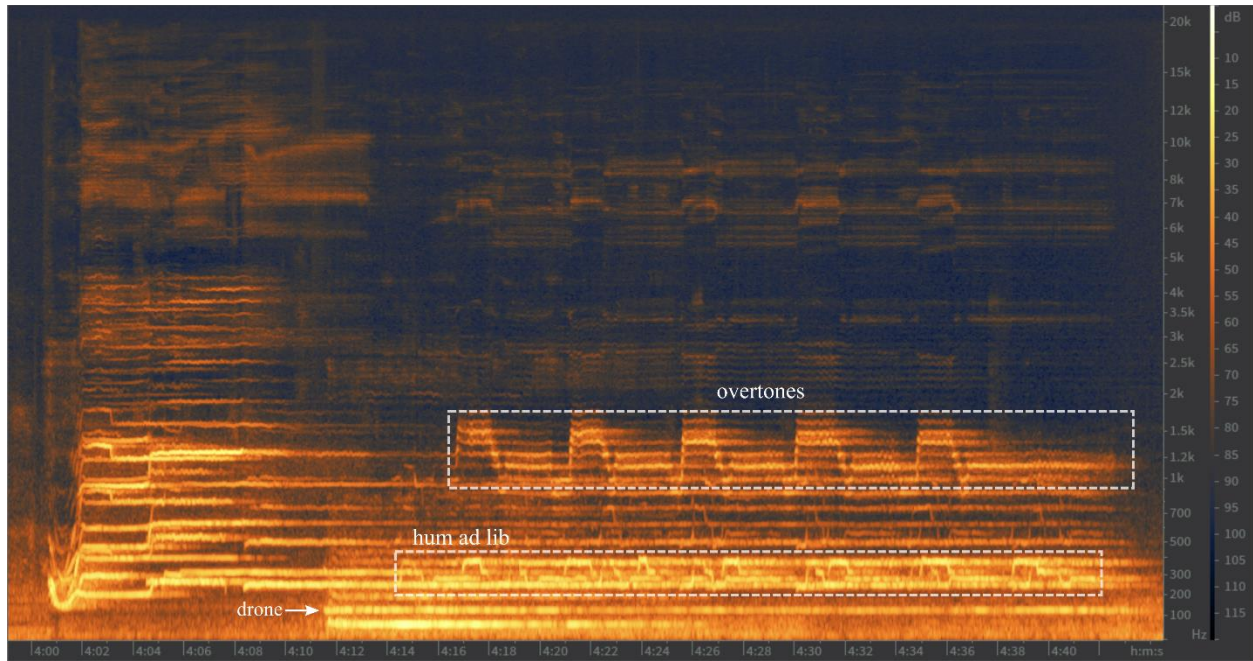
The vocal range of this climactic phrase of the melody is in the mid-high tessitura for the tenor voice but is quite high for baritone or bass voices, and as voices 7 and 8 are intended, according to the score, to be “low specialists,” the bright and quite wild quality is not merely the result of using belt, but of these voices belting in this range. We can hear physical effort, the intonation is less precise. Gone is the air of intimacy and delicate control, replaced by the sensation of a dam bursting.

This sense of catharsis or release is transitory, however. As Statement 3 winds to its close, the belters and chordal voices both gradually diminuendo and return to their previous tone qualities. When the fourth and final statement begins, hushed and breathy, like the first statement, it feels more like an afterimage than a recapitulation, the breathy haze like the lingering residue of those bright high harmonics, still glowing gently behind closed eyelids. Adding to this sense of fragmenting memory or fading afterimage is the interruption of the final statement by bars of silence (mm. 46 and 49), and by an ‘orphan’ sigh gesture – one which does not lead to a sung chord but rather cuts off abruptly after the glissando, without the mouth opening at all (m. 46).

Shaw concludes the movement with a brief coda, shown in Figure 5-15, consisting of a hummed B major triad over which a brief melodic motive is repeated ad libitum by two different voices in two different timbres. Several singers hum the motive, while one voice produces it as

overtone of a sung drone. Like the pitch bends in the Allemande's last chord, this gives shape

FIGURE 5-15: SARABANDE CODA (MM. 50-52): SPECTROGRAM, SHOWING OVERTONE MELODY



and movement to what we would expect to be a stable and resolved timbre. It also recalls, and explicitly expands upon, the amplified overtones in the Allemande's final chord. Melodically, this overtone melody clearly functions as an echo/afterimage of the rising melodic fifth that opened the belted section (as well as of fifth-based motives in Section 2 of the Allemande). But instead of pushing up past the fifth to scale degree 7, and then to a long, soloistic melodic descent emphasizing dissonances, it relaxes into triadic stability and circles around itself hypnotically. Spectrally, this overtone melody lies right within the belted passage's range of highest intensity (ca. 1000-1500 Hz). The overtone melody stands out even more because it is set in relief against hummed chords and the hummed melodic voice, whose upper partials are attenuated, creating the acoustic space for it to occupy. The overtone singing also produces a

certain amount of inharmonicity, in contrast with the “pure” hummed timbre of the other voices. It functions as one final reminiscence, both melodic and timbral, of the spectral richness and emotional affect expressed by the belted melody. It also echoes the overtone amplification during the final chord of the Allemande – the overtones expand up from the same B5, now a full-fledged melody instead of just a pitch decoration.

The Sarabande’s overall shape combines a variations form with a modified ternary or arch form which is as much the result of timbral changes as it is of melodic, rhythmic, or dynamic variation. This timbral progression is simple and, perhaps, obvious to anyone with ears to hear (or eyes to see, as Figure 5-16 hopefully illustrates), but its expressive power is doubtless a function of its directness. What may be more subtle, yet, I would argue, no less impactful, is the correspondence between the envelope of the opening gesture – from breath noise through pitched, but spectrally dampened “mm,” to more spectrally rich, open-mouthed, vowel-colored singing – and the motion over the course of the movement from breathy, choral chords, to slightly richer melodic unison singing, to the high spectral density and richness of belt (and then back). At the very least the envelope of both spans displays a similar sudden moment of spectral increase – whether the physical opening of the mouth, or the shift between two such timbrally different phonations as breathy voice and belt. Although there are certainly also visible differences, the spectrogram pictures of Figure 5-17a-b underscore this similarity on two quite different timescales – gesture and section.

FIGURE 5-16: SARABANDE, COMPLETE MOVEMENT

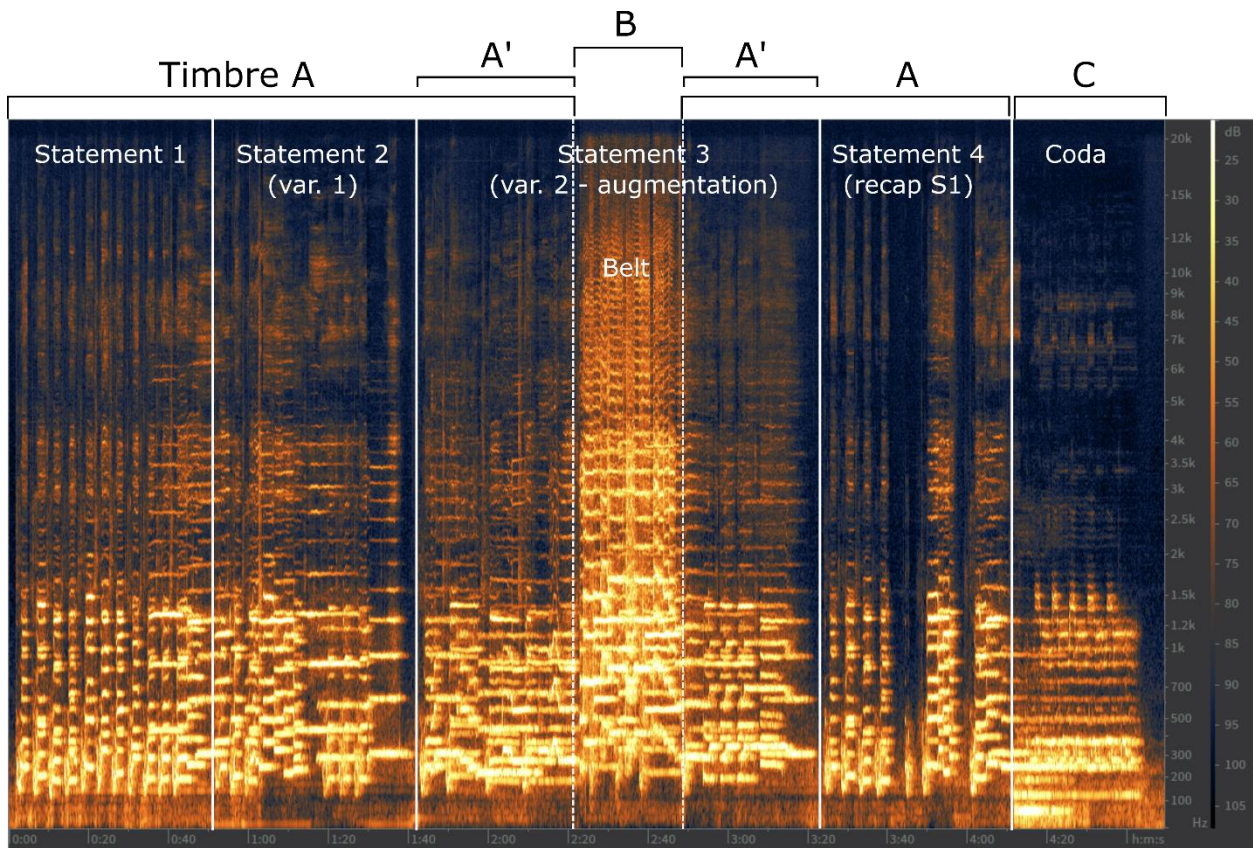
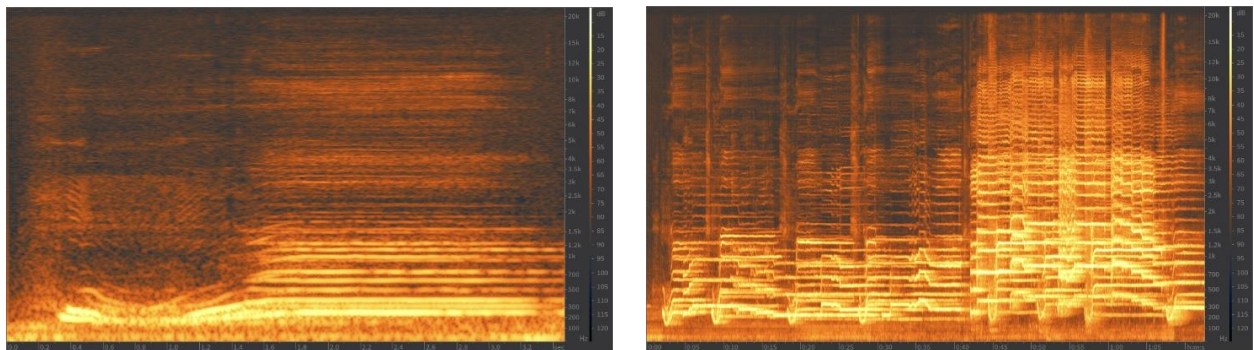


FIGURE 5-17 A) SARABANDE, FIRST CHORD B) SARABANDE, MM. 25-32



5.3 III. Courante

The third movement of *Partita for 8 Voices*, like the Allemande, is a delightfully incongruous mixture of musical and poetic elements. Both movements combine Western classical music tradition, folk music/entertainment traditions born of social contexts, and literary or visual arts references.

The New Grove Online Dictionary of Music's article on 'Courante' notes that:

by the end of the [17th] century there were two distinct types: the Italian 'corrente', a fast triple-metre dance (3/4 or 3/8), usually in binary form with a relatively homophonic texture, balanced phrases, virtuoso performance style and a clear harmonic and rhythmic structure; and the French 'courante', a 'majestic' and 'grave' triple-metre dance, usually in 3/2, characterized by rhythmic and metrical ambiguities, especially hemiola, frequent use of modal harmonies and melodies, and a contrapuntal texture.¹⁴

Shaw's Courante seems to combine aspects of both styles: It has the 3/2 meter, pervasive rhythmic and metrical ambiguity, and the contrapuntal aspects of the French style. These elements are balanced by (and often juxtaposed against) clear and often homophonic harmonic textures and phrase structures (derived from the central hymn-tune, of which more below), and a use of vocal color and technique which we can certainly describe as virtuosic in its variety and inventiveness. Often these stylistic elements are combined in non-doctrinaire ways, as when lively, contrapuntal (actually hocketed) textures are set against slow-moving, 'majestic' and 'grave', homophonic chords.

Timbrally, however, Shaw's Courante is dominated not by references to Western Baroque music, but by sounds derived from the practice of *katajjak*, or Inuit throat-singing. This practice is the basis for the rapid inhale-exhale gestures that form the surface texture of much of

¹⁴ 'Courante' from *Groves Online Dictionary of Music and Musicians*.
<https://doi.org/10.1093/gmo/9781561592630.article.06707>

the movement, as well as the imitative hocket and gradually-unfolding, procedural structure.

The third element in this musical/cultural gumbo is the 1855 hymn ‘Shining Shore’ by George F. Root, which is introduced in the movement’s second large section, and which becomes the basis for both textural variation and motivic development. The hymn also is a clearly-recognizable cultural object, if not actually a familiar tune. The first stanza of the text, written in 1835 by David Nelson, reads:

My days are gliding swiftly by/And I, a pilgrim stranger
Would not detain them as they fly,/those hours of toil and danger.
For oh! We stand on Jordan’s strand;/our friends are passing over;
And just before the shining shore,/we may almost discover.

Though it is not actually sung here, the text, with its description of swiftly-flying time and crossing over the river Jordan (a common metaphor in American hymns and spirituals for changing of spiritual states – from slavery to freedom, life to the afterlife, etc.), offers a poetic subtext for this Courante. The word ‘courante,’ itself, is derived from the Latin verb *currere*, which is translated variously as “to run,” “to hurry,” or “to flow swiftly.” It is used equally to describe people, waters, time, and (as in its past participle, *cursus*, from which we derive the word “course”) the idea of progression or transition over time from one place or state of being to another (as in “the river’s course,” or “the course of one’s life.”).

Timbrally, this Courante also seems to embody the multifarious implications of its etymology. The movement realizes two progressions which, despite a twist or turn along the way, have clear overall trajectories. One of these progressions plays out over the course of the first section, a motion from unvoiced breath to sung pitch to harmony. Another progression, which occupies the third section of the movement, involves gradually accelerating tempo, as well as gradually increasing timbral complexity and spectral density.

Formally, Shaw’s Courante breaks down into three large sections: mm.1-63; 64-113; and

114-210 (end). The first section begins with a *katajjak*-style breathing game, and then gradually unfolds the timbral progression from breath to voice to pitch to harmony (a similar trajectory to that explored in the Sarabande) but also introduces a secondary motive in a contrasting registral space. Section 2 introduces the hymn tune in 4-part chorale style, and then weaves the main motive from the Allemande (which is now revealed to be derived from a fragment of the hymn's pitch material) into the *katajjak*. Section 3 reiterates the entire procedure while gradually increasing in tempo, starting over, as it were, with the pure *katajjak*, then layering the hymn tune in rhythmic variation over it, then developing the secondary motive both harmonically and rhythmically before settling back into an accelerating *katajjak*-groove coda that finally collapses like exhausted, breathless, giddy *katajjak* singers might.

Section 1 opens with voices 1-4 (the women) beginning a game of *katajjak*, trading completely unvoiced exhalations for the first three measures, then adding inhalations and becoming semi-voiced starting in m. 4, as their syncopated imitations become more rhythmically active (as can be seen in the top two voices in Example 3.1). In contrast to the breath sounds and breathiness found in the Sarabande, these are sharply articulated with glottal attacks. Interestingly, later in this movement, hummed pitch elements (mostly in *katajjak* sections) are also articulated with glottal attacks, as noted in the score and evidenced by the recording. Sounds that were continuous and soft-edged in the Sarabande become, in this movement, much more clearly delineated. This delineation and layered rhythmicalization takes the general breathiness of the Sarabande and creates an activated, rough sound-texture into which the pitched elements of this movement are woven like the colors and images in a tapestry.

FIGURE 5-18: COURANTE, MM. 12-15 ¹⁵



After twelve measures of hocketing voiced and unvoiced exhalations and inhalations, voice 3 introduces a new pattern into the *katajjak* that will become the main rhythmic and timbral motor of this movement. As shown in Figure 5-18 this motive consists of a hummed pitch followed by an eighth-note exhale-inhale. As in the Sarabande, this motive is as much a physical, vocal gesture as a musical idea: the exhale acts as a release of the pitch, a gesture we will also find later in the Passacaglia. The inhale, of course, prepares the following pitch. But even when no pitch follows, as in the pickup to m. 14, the exhale remains, for it is as much, if not more so, a reaction, a rebounding from the exhalation, than a preparation for anything. This gesture is a simple, microscaled reminder of the nature of respiration as a system of dynamic opposition.

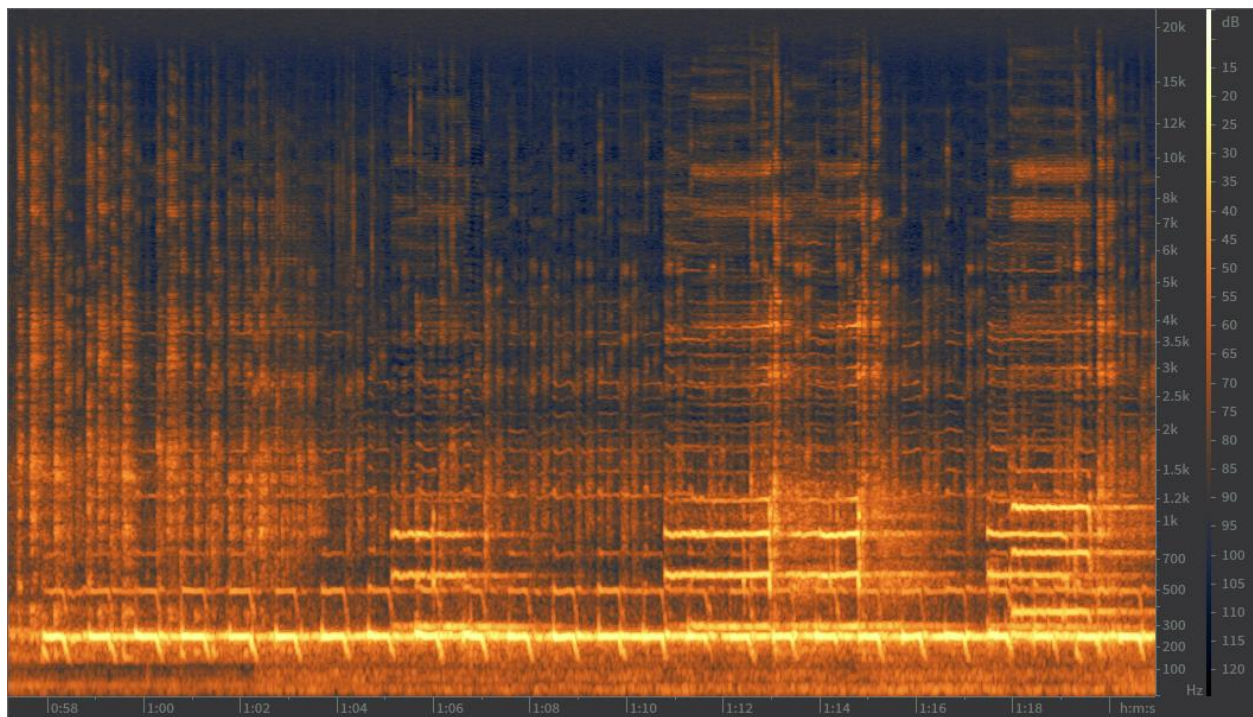
¹⁵ The following notation key appears in the front matter to the Partita:

	<p><i>These are textured breaths, related to the Inuit throat singing tradition. They are featured primarily in Courante.</i></p> <p>Audible exhale. Typically on “ah”</p> <p>Audible inhale. Typically higher in pitch, and on “oh”</p> <p>An inhale-exhale gesture, as in Inuit throat games. These can be more or less “noisy” depending on the dynamic context.</p>
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Note that the final notation uses the symbols for “exhale-inhale” but Shaw’s written note says “inhale-exhale.” The recording also sounds like an exhale-inhale, and that gesture seems much more natural, especially when the tempo increases.

This gesture of release is in a sense also the retrograde of the Sarabande gesture: where that began with breath through hum and opened into steady pitch as the mouth opened, this starts with steady pitch and releases into breath with the opening of the mouth. If we look closely at the spectrogram of this section (shown in Figure 5-19), we see that this release also includes a slight drop in pitch as the mouth opens and the voice changes phonation from flow to breathy. Though not as pronounced as the upward scooping in the Sarabande gesture, it is nevertheless supportive of this retrograde reading.

FIGURE 5-19: COURANTE, MM. 13-28



The falling pitch and exhale release of the hum is also a gesture of release of pent-up physical energy, which mirrors, in the smallest scale, the *katajak* singers' game of maintaining

energy until “something gives.” This sensation of energy being maintained until something gives is clearly operative in the coda and ending of the movement, which drives increasingly faster to a sustained climax that breaks, as if in exhaustion, to a downward-sliding, semi-voiced exhalation:

FIGURE 5-20: COURANTE, MM. 206-209

The image shows a musical score for eight staves, numbered 1 through 8. Staves 1-4 are vocal parts, and staves 5-8 are piano accompaniment. The score is in G major (one sharp) and 3/4 time. The vocal lines feature long, sustained notes with slurs, and the piano accompaniment consists of sustained chords. A box labeled 'xöömei' is placed above the fifth staff. The score ends with a double bar line and repeat dots on the right side of each staff.

If we look again at Figure 5-19, we also see that the first pitches entering in m. 13, as a result of being hummed softly, evenly, and without vibrato, are almost entirely comprised of the fundamental, with slight second partial and negligible harmonics above that. As successive voices introduce the other pitches of a B minor triad – first a D, then an F# – we can see the other low partials become stronger. The D in m. 21, sung on an “oh” has almost equally stronger second and third partials, and when the F# enters in m. 26, its 3rd partial is actually the strongest.

Once the unfolding of this triad is completed, the *katejjak* continues by itself for a few more measures. This textural contraction following a stretch of expansion creates a pattern of flow and ebb which give internal structure to the large formal sections. The second phase of the first involves motivic, harmonic, and registral/timbral expansion. As the *katajjak* continues, the

four low voices sing low fifths and triads that harmonize the *katajjak*'s B3 in different ways – as the third of G major, the root of B minor, and the fifth of E major. From simple triadic construction, Shaw has progressed to chromatic harmony.

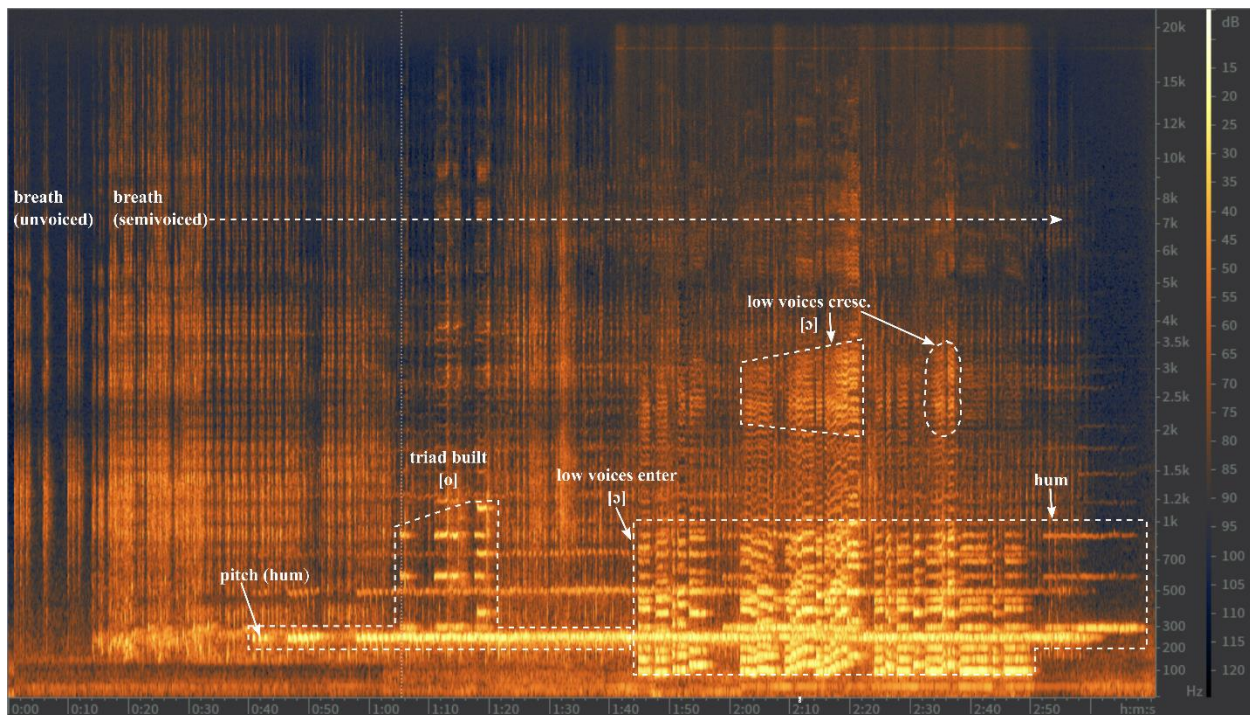
More significantly, this is also the first extended use of the low male register (the Sarabande's brief coda notwithstanding) since the Allemande. The low voices also introduce a new vowel color, [ɔ], whose formants are slightly higher than those of "oh" [o]. This begins to activate higher harmonics of the low voices in the range of the singer's formant (2500-3500 Hz), a move that is extended when the low voices introduce an ascending tetrachord motive that crescendos as it rises (Figure 5-21).

FIGURE 5-21: COURANTE, MM. 44-48: RISING TETRACHORD MOTIVE

The musical score consists of eight staves, numbered 1 through 8. Staves 1, 2, 3, and 4 are in treble clef with a key signature of one sharp (F#). Staves 5, 6, 7, and 8 are in bass clef with a key signature of one sharp (F#). The score shows a rising tetrachord motive in the low voices (staves 5-8) starting in measure 44. The notes in this motive are G2, A2, B2, and C3, which rise chromatically. The dynamic marking *mf* (mezzo-forte) is placed below the notes in measures 45, 46, and 47. A watermark "not for pu" is visible across the score.

Both the melodic ascent of this motive and the accompanying crescendi strengthen the singer's formant overtones. After reaching a dynamic peak (which can be seen in Figure 5-22), this new motive diminuendos back to single chords, and then drops out, leaving the *katajjak* once again, but now its single hummed pitch, having expanded from B3 to a B3-D4-A4 ostinato, and then contracted again while our ears were focused on the low voices, shifts from B3 to D4 (the dominant of the G major tonality of the following section), dropping the *katajjak* breath motive and becoming an asynchronous humming that dwindles into silence.

FIGURE 5-22: COURANTE, SECTION 1 (MM. 1-64)



The second section begins with the introduction of the hymn by the upper voices in four-part chorale style, with no *katajjak* accompaniment. The sudden absence of the constant rhythmic pulsation sustained through the whole first section suspends that sense of consistent forward momentum even as the melodic and harmonic palette is suddenly expanded. Although

this represents a dramatic expansion for the movement thus far in terms of melody and harmony, we shall see that it serves as a timbral baseline for this second section. The first expansion of this second section consists of humming the hymn's first double period, opening to [ɐ] for the first phrase of the second double period, and closing from [o] back to a hum for the final phrase. Once again, we see a tapered shape in terms of both registral and spectral expansion and contraction, similar to the shapes of the first section, a shape that complements the melodic and harmonic structure of the hymn tune. Here, however, the [ɐ], having a more widely and evenly spread formant profile, represents a step farther along the vowel color/spectral trajectory from [o] and [ɔ] in terms of overall brightness and richness.

Following the presentation of the hymn tune, the upper voices return to the pulsation-based momentum of Section 1 by resuming the *katajjak* in m. 82 (reh. D). Now they elaborate the breath game with melodic motives that combine to form a hocketed melody that vamps on the pitches in the final phrase of the hymn tune, while also clearly recalling the main motive of the Allemande, as shown in Figure 5-23.

FIGURE 5-23A-C: COMPARISON OF HYMN, HOCKET AND ALLEMANDE MELODIC MOTIVES

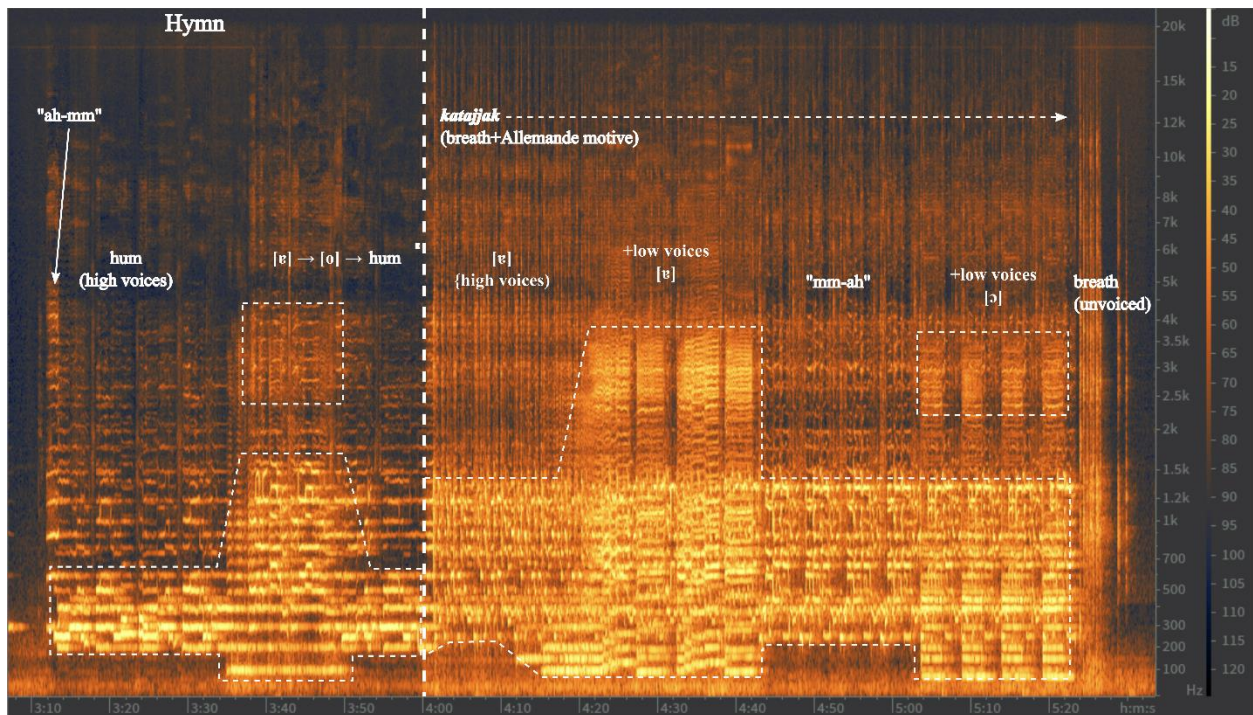
a) end of hymn tune

b) composite hocket melody

c) Allemande motive

The return of the *katajjak* also coincides with a return to the [ɤ] vowel. This, combined with the *katajjak* breath sounds, re-introduces higher spectral elements and marks the beginning of a new expansion-contraction cycle which plays out over mm. 82-113. After the upper voices resume the *katajjak*, as before, a registral and spectral expansion takes place in mm. 86-97, as the low voices rejoin the texture, pulse-humming a low G fifth, then accelerating and opening from the hum to an [ɤ] and bringing back the rising tetrachord motive. On the brighter, richer, vowel, the low voices have even more energy in the singer's formant range than in mm. 44-48, as compared by Figure 5-22 and Figure 5-24. This is not only formally satisfying, it is orchestrationally helpful, since the texture of the upper voices here is also more dense and active than in mm. 44-48. The change in vowel helps the low voices cut through the texture, as well as contributing to a greater spectral richness relative to the previous iteration of this material.

FIGURE 5-24: COURANTE, SECTION 2 (MM. 64-115)



In m. 98, the low voices drop out, once again contracting the registral and spectral profile. As this happens, the upper voices, while continuing the same *katajjak* breath-melody hocket, vary their articulation, from all open [ɐ] to “mm-ah.” In addition, where previously two voices had the in-out breath motive on every beat in the *katajjak* pattern, now not every beat contains the breath motive, and not every breath motive is given by two voices. These changes subtly thin and variegate the spectral texture, attenuating some upper overtones on the hummed pitches and removing breath noise from many of the beats. When the low voices rejoin the upper voices at m. 106, they also participate in the subtle spectral contraction by returning to the vowel [ɔ], which reduces the energy activated in the singer’s formant range.

Thus we can view Section 2 in different ways: either as consisting of three large expansion/contraction cycles, where the third cycle collapses from pitch straight into breath rather than tapering off like Section 1 did, or of two large cycles, where in the second large cycle (mm. 82-113) we call mm. 106-113 part of the tapering off of the widest part of the expansion (90-96), and view mm. 97-106 as being an interruption of sorts. We can support this reading by comparing the similar character and function of mm. 50-58 and mm. 106-113, where the latter is a simplified version of the former and both act as places of repose following the rising tetrachord motive (although this second time around, the sense of resolution is counteracted harmonically by the second inversion voicing of the chord).

In any case, when Section 2 collapses in m. 114 back into completely unpitched exhalations, we clearly find ourselves back at the movement’s starting point. After a pause of uncertain length and character, the breath games begin again as before, though this time abbreviated, and in the lower voices rather than the upper voices. This is the first time that any of the lower voices have partaken in the *katajjak*, perhaps out of respect for the traditionally-female origin and culture of the practice, or perhaps simply because Shaw wanted to save the timbral

and textural change for the final section. The male breaths themselves are not vastly different timbrally from the female breaths (perhaps a bit louder), although they do have a lower overall frequency range and formant profile. Naturally, once the low voices begin interjecting pitches into the *katajjak*, the difference becomes clear. Unlike the upper voices, the lower-voice *katajjak* remains strictly a rhythmicized, texturalized pedal drone, with no melodic hocketing. Its main function is to act as the unceasing motor driving the remainder of the movement forward. The upper voices return to the hymn tune, singing it in a rhythmic variation on [e], and then, in m. 138, segue seamlessly into the rising tetrachord motive, the first time in the movement they have had that material.

Unlike the previous sections, where the expansion from a high register to a lower register also added significant higher-spectrum elements, expanding from the low to higher registers means that Section 3 could start out with a comparatively rich spectral profile. To help accentuate the sense of timbral growth, Shaw does a few things to control the expansion of the spectral profile: most importantly, she keeps the low voices humming their *katajjak* pitches almost without exception until the final coda. When she finally does allow non-melodic voices to open from a hum to a vowel, she uses special timbres that will enrich the expanding profile with complex high- and low- spectrum elements. For instance, Shaw instructs certain voices in Section 3 to sing some of their pitches using the Tuvan throat-singing techniques of *xoomei* (e.g. voice 4 in m. 132) and *kargyraa* (voice 8 in mm. 144-148). These techniques both activate high partials as well as noise elements, and *kargyraa*, where the false vocal folds are also vibrating, can add a pitch an octave below the sung pitch¹⁶ (in this case, a B1 reinforcing the sung B2, the lowest pitch frequency found in the *Partita*), as well as a roughness or rumble to the timbre akin

¹⁶ Levin and Edgerton (1999), 86.

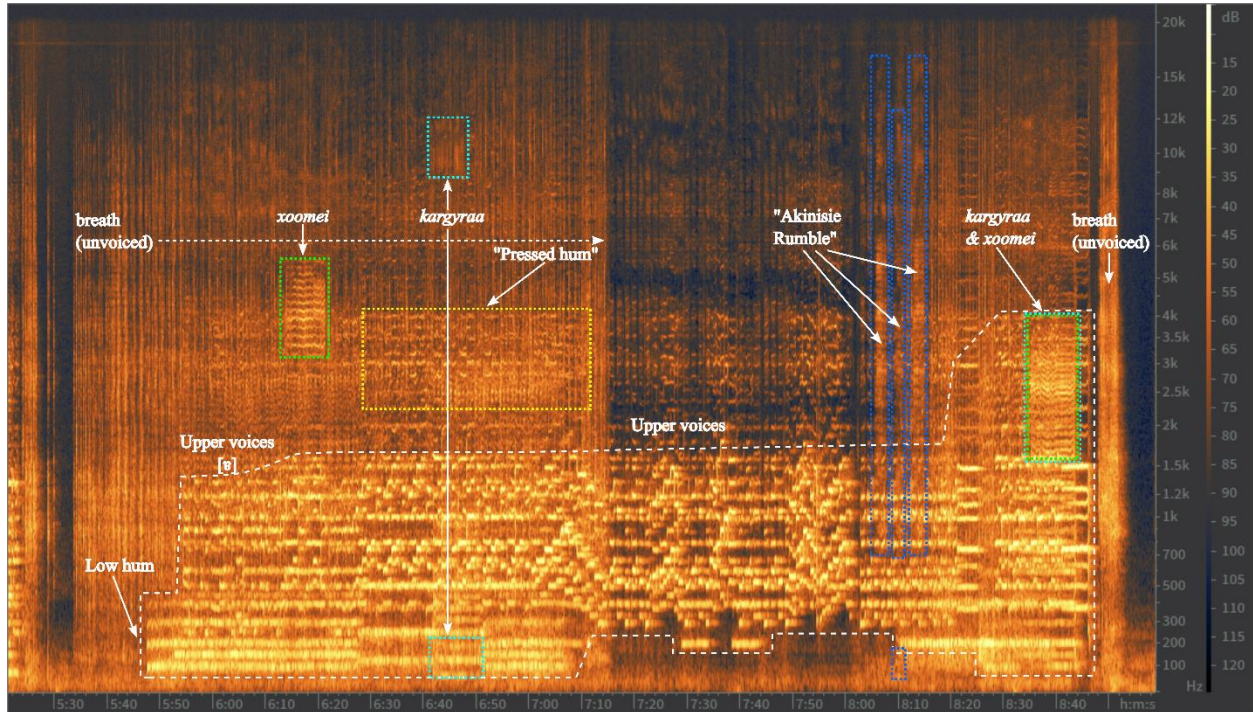
to the pulsation of vocal fry, or the “Akinisie rumble,” in mm. 185 and following. Interestingly, the *kargyraa* in m. 144 also coincides with the first arrival of voice 1 on a B5, the highest sung pitch in the entire Partita. These techniques are used similarly to intensify spectral complexity in the final subsection of the movement (mm. 185-end).

Figure 5-25 shows Section 3 of the Courante, with the aforementioned features identified. It also shows the overall shape of Section 3, which could be read in one way as an inverse shape to most of the other sections and subsections of this movement. Whereas previously the prevalent shape was one of expansion from a spectrally and registrally confined profile to a wider, richer profile and then contraction, Section 3 attains a comparatively rich profile fairly quickly, which is then further intensified, suddenly contracts to a narrower and less rich profile (mm.160-184), where it spends quite some time developing the rising tetrachord motive, before expanding and intensifying once again as it drives to the movement’s end. One other timbral clue in support of this reading is the The “Akinisie rumble,” which Shaw uses to bridge out of the reduced section back into the final coda. The low, rattle- or growl-like timbre of this technique both recalls and foreshadows the *kargyraa* drones that precede and follow it within Section 3. In addition, because it is unvoiced, the rumble also contributes mid-and-high frequency noise, further linking the breathiness of *katajjak* with the buzz of the Tuvan techniques.

Another reading, however, could be that Section 3 has a shape closer to that of Section 2, but with the first two subsections of Section 2 (the hymn and the *katajjak*) combined, the following sections bringing in the tetrachord motive corresponding to each other (with the *katajjak* and tetrachord roles reversed in Section 3), and the reduced-profile sections of mm.97-106 and mm. 160-184 corresponding to each other despite dealing with different motivic material. In the case of Section 3’s ending, however, the timbral trajectory is clearly toward brighter, richer, more complex and more intense, as opposed to the aforementioned ways that

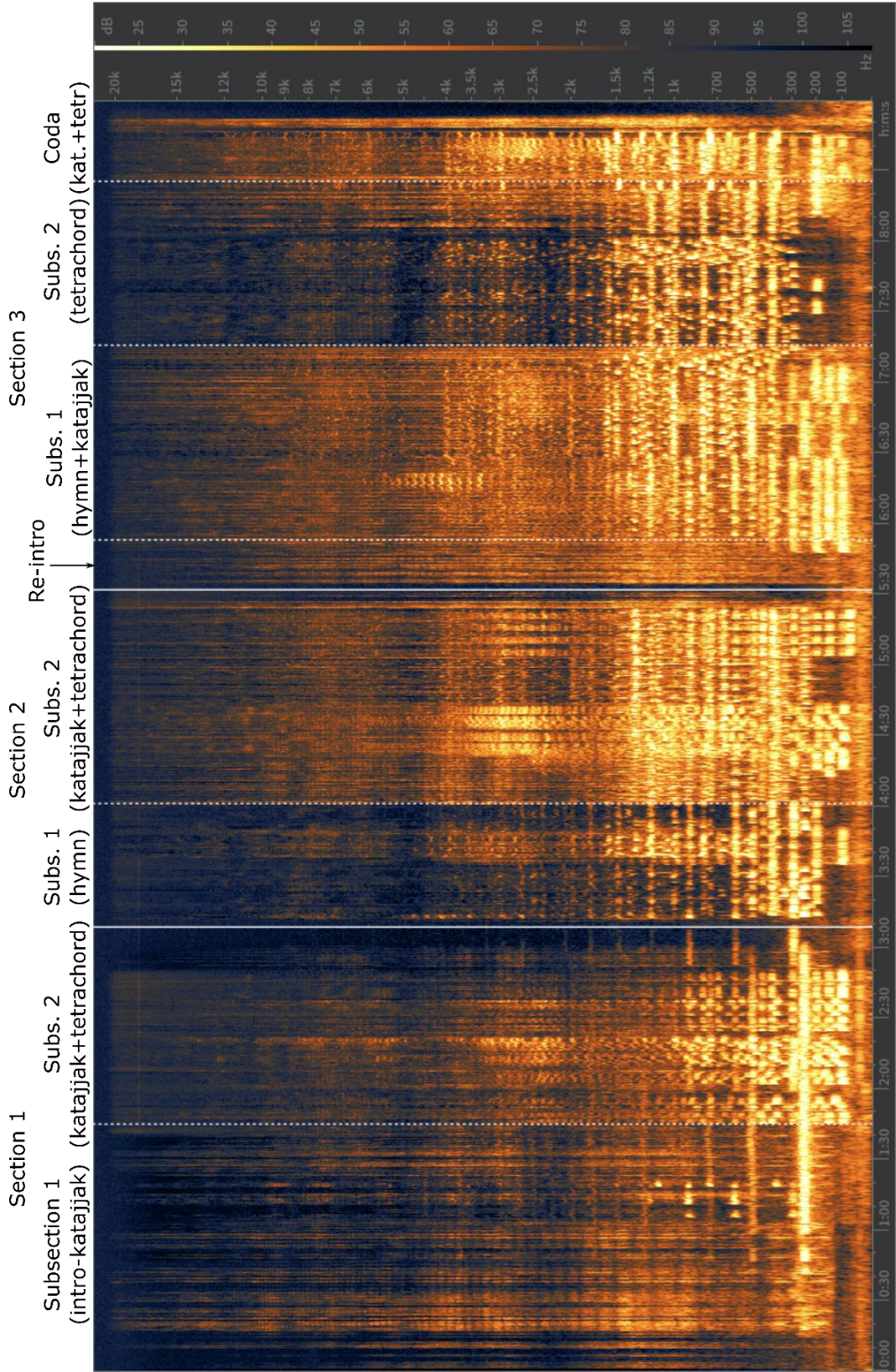
Section 2's ending is arguably a reduction in most of those timbral parameters.

FIGURE 5-25: COURANTE, SECTION 3 (MM. 116-END)



However we parse it, Section 3's larger function is fairly straightforward: from timbral and motivic reprise of the opening, it moves through, combines, and surpasses the materials and processes operating in the first two sections, completing the movement's large-scale trajectory. The forward current of the whole movement is overwhelmingly directional, yet it proceeds by cycles of flow and ebb which are accomplished by a combination of registral, textural, and timbral expansion and contraction. Figure 5-26 is an overall formal mapping of the entire movement onto its spectrogram.

FIGURE 5-26: COURANTE, OVERALL FORMAL DIAGRAM



5.4 IV. Passacaglia

FIGURE 5-27: SHAW, PARTITA: IV. PASSACAGLIA, MM. 1-30

IV. Passacaglia

The musical score for "IV. Passacaglia" (mm. 1-30) is presented in four systems. The tempo is marked $\text{♩} = 48$. The score includes vocal lines and piano accompaniment across four staves (1-2, 3-4, 5-6, 7-8).

System 1 (mm. 1-2): The vocal line begins with a half note G4, followed by a half rest. The piano accompaniment consists of a steady eighth-note bass line. Dynamics include *p* and *mf*. Performance instructions include *chest* and *head* for the vocal line, and *sim.* for the piano. The system is divided into sections labeled a, b, c, d, e, f, g, h, i, j, and Tail.

System 2 (mm. 3-4): The vocal line continues with a half note G4, followed by a half rest. The piano accompaniment continues with eighth notes. Dynamics include *mf* and *p*. Performance instructions include *chest* and *head* for the vocal line, and *sim.* for the piano. The system is divided into sections labeled a, b, c, d, e, f, g, h, i, j, and Tail.

System 3 (mm. 5-6): The vocal line continues with a half note G4, followed by a half rest. The piano accompaniment continues with eighth notes. Dynamics include *mf* and *p*. Performance instructions include *chest* and *head* for the vocal line, and *sim.* for the piano. The system is divided into sections labeled a, b, c, d, e, f, g, h, i, j, and Tail.

System 4 (mm. 7-8): The vocal line continues with a half note G4, followed by a half rest. The piano accompaniment continues with eighth notes. Dynamics include *mf* and *p*. Performance instructions include *chest* and *head* for the vocal line, and *sim.* for the piano. The system is divided into sections labeled a, b, c, d, e, f, g, h, i, j, and Tail.

Like the Sarabande, the Passacaglia is built on a harmonic progression which forms the basis of repeating variations. With no real harmonic development and much less melodic material than the other movements, the Passacaglia relies even more on timbre and texture for its shape and sense of progression. In this movement, shifts and contrasts between vocal register and phonation types are of great importance. This is most evident in the first large section of the movement, shown in Figure 5-27. The basic harmonic progression of the Passacaglia consists of five pairs of chords (labeled *a – j*), and this first large section repeats this progression verbatim three times. While pitch and rhythm remain identical for all three statements, in statements 2 and 3, not only do the vowel color and dynamic change, but so does the phonation/vocal register of the second chord in each pair (*b, d, f, h, and j*). All three statements feature a “tail” section (e.g. mm 8-10 and similar), which returns to the same dynamic, standard vocal production and the [ɔ] vowel of the opening, a timbral refrain of sorts.¹⁷

In statement 1, the singers sing the vowel [ɔ] using a light modal phonation, maintaining a single timbre for the whole statement. In statement 2 (Reh A), the vowel changes to [ɐ] and the first of each chord pair is in a heavier chest voice while the second is sung with a register break into a breathy head voice. This results in a less resonant tone and markedly softer dynamic. In statement 3 (Reh. B), the first of each pair is belted on [æ] and the second is a “semi-pitched exhale if possible.” In the recording, these exhales are short and gestural, and any pitch is mostly indeterminate, almost a “yip”. Each statement thus progressively removes the “core” and increases the breathiness of the tone on the second of each pair, and its prominence as the

¹⁷ Interestingly, in the recording, only the first statement tail actually is sung on [ɔ]. In statements 2 and 3, the singers use an [u] instead, resulting in a slightly purer, darker tone, due to a reduction of energy in higher partials (demonstrated in example 24). Whether this was done to help increase the contrast with the statement heads is not known. It reduces somewhat the contrast between the third statement and its recapitulation at the end of the piece, when the change to [u] in the “tail” is actually notated in the score.

“release” of the envelope of the sound. Concurrently, the registration of the first chords and their vowel color successively becomes brighter and richer, and the increasing dynamic also makes attacks more pronounced in each statement. This not only increases the contrast between each statement, but also increases the timbral contrast within each statement, between the body and the tail, and between each half of a chord pair.

FIGURE 5-28: FORMANT FREQUENCIES OF FIRST THREE VOWELS IN PASSACAGLIA.

Gender	Formant	Peterson & Barney	Hillenbrand	Ladefoged	Fant	Saulle	Avg	Formant pitch center
/ɔ/								
M	F1	570	652	590		589	600	D5
F	F1	590	781				686	F5
M	F2	840	997	880		918	909	A5
F	F2	920	1136				1028	C6
M	F3	2410	2538			2747	2565	E7
F	F3	2710	2824				2767	F7
/ɛ/								
		[a]	[a]	[a]	[a]	[ɛ]		
M	F1	730	768	710	680	750	728	F#5
F	F1	850	936		860		882	A5
M	F2	1090	1333	1100	1070	1130	1145	D6
F	F2	1220	1551		1195		1322	E6
M	F3	2440	2522		2520	2833	2579	E7
F	F3	2810	2815		2830		2818	F7
/æ/								
M	F1	660	588	690		635	643	E5
F	F1	860	669				765	G5
M	F2	1720	1952	1660		1825	1789	A6
F	F2	2050	2349				2200	C#7
M	F3	2410	2601			2817	2609	E7
F	F3	2850	2972				2911	F#7

Figure 5-28 shows the average formant frequencies for [ɔ], [ɐ], and [æ], and corresponding closest musical pitches.¹⁸ Based on this data, the lower two formants of [ɔ] and [ɐ] should both strongly reinforce the resonances of the D major triad as Shaw has voiced it here. The third vowel, [æ], is less resonant of the D triad's lower partials, but helps accentuate some of its higher partials. More importantly, the overall rise in formant frequencies (particularly F2) from [ɔ] to [ɐ] to [æ] shifts more spectral energy to the upper partials of each voice. Finally, the increase in dynamics and shift in phonation from modal to belt also intensifies higher spectral regions, first the band around 3000 Hz associated with the "singer's formant," and then the higher overtones above 5000 Hz, as can be seen in the spectrogram in Figure 5-29.

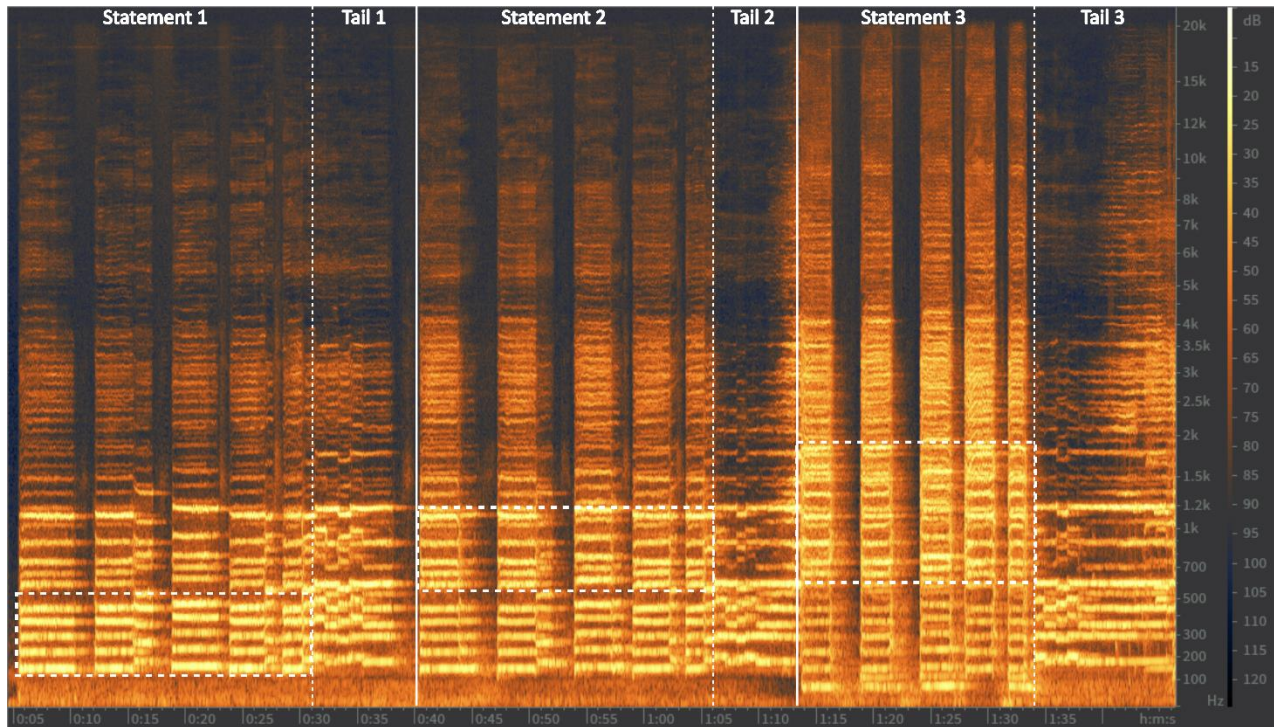
Especially striking here is the visible shift of the region of greatest intensity, shown by the dotted-line boxes. In Statement 1, it is clearly in the 100-600Hz range, in Statement 2 it is spread more evenly from 100-1200Hz, with a slightly greater average intensity in the 600-1200 Hz range, and in Statement 3, it is clearly in the range between about 600-2000Hz. Not only does the region of greatest intensity rise in frequency, each subsequent statement also shows a reduction in intensity of the 100-600Hz range where the fundamentals and lowest overtones of each chord are located. This can also be seen by comparing the average spectral profiles for the first chord of each statement, as seen in

Figure 5-30. The accompanying dynamic increase, from *p* to *mf* to *ff* also accentuates this shift,

¹⁸ Because formant frequency ranges can vary considerably between individuals, we derive these averages from several sources which surveyed the formant frequencies of American English speakers. For the vowel [ɐ], which was not included in these surveys, I have used my own Praat analysis data, combined with the data for [a] from the aforementioned sources, as well as data for [a] from Fant's survey of Swedish vowels. Since [ɐ] is open-central while [a] is open-front and [ɑ] open-back, I hope this process should approximate the correct vowel color.

as louder phonation normally causes greater intensity gains in the overtones, especially in the higher partials, than in the fundamental.¹⁹

FIGURE 5-29: SPECTROGRAM OF PASSACAGLIA, MM. 1-30

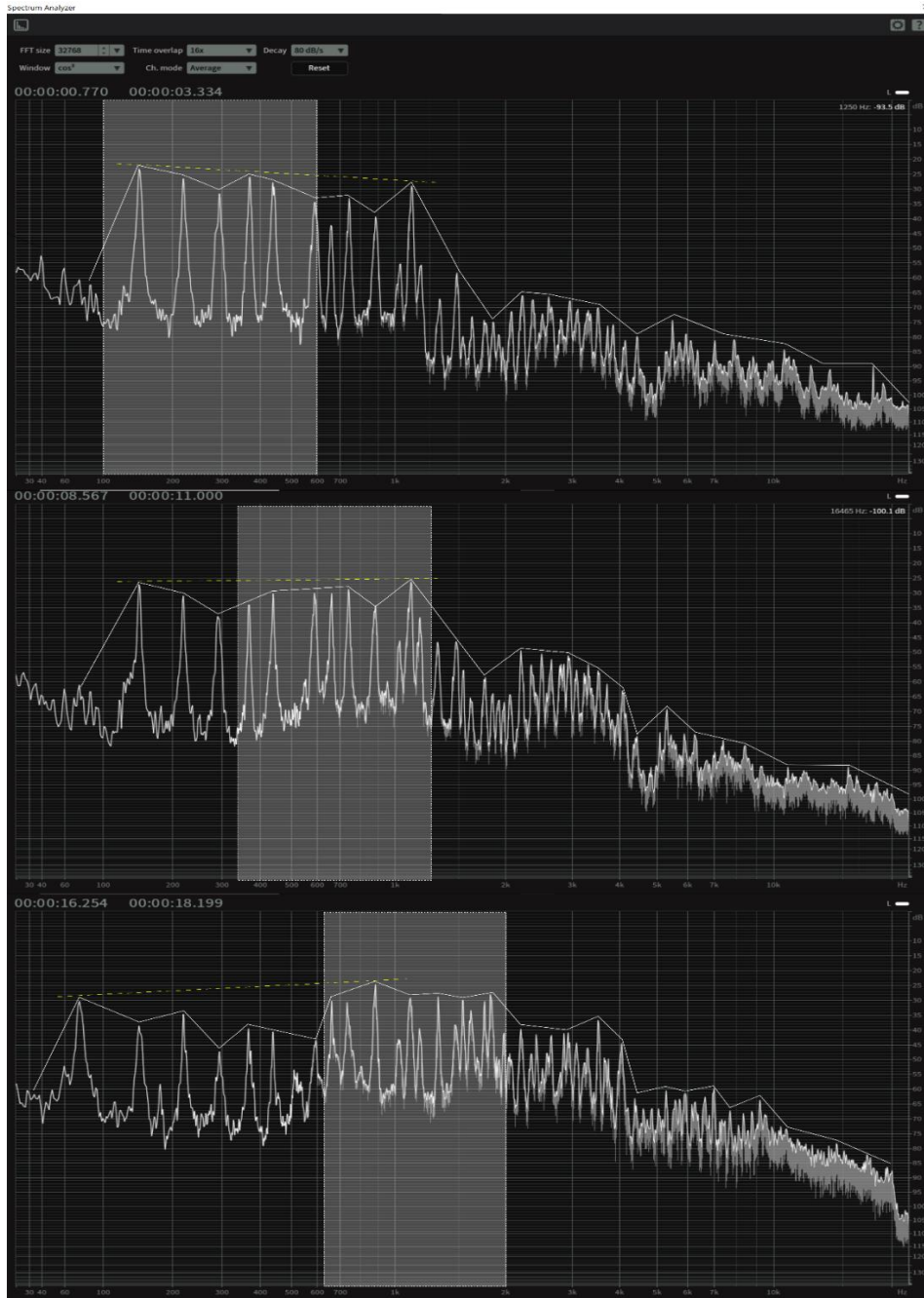


Also visible in our spectrogram and spectral profiles in the first two statements is a very strong peak around 1100 Hz. This peak is so pronounced it is easily audible as overtones in the recording. This is likely because the third partials of some soprano notes (C#6 and D6) fall very close to the F2 center. This peak may be further exaggerated by reinforcement from the fifth tenor partial and perhaps even the seventh bass partial (C#4 and Db). In the third statement, this peak is attenuated somewhat, and surrounded by peaks of equal or greater intensity, so the

¹⁹ (Sundberg, 1987) 74-75.

overtones are subsumed into the overall regional peak.

FIGURE 5-30: PASSACAGLIA, AVERAGE SPECTRAL PROFILES OF FIRST CHORDS OF STATEMENTS 1, 2, AND 3



The third statement, like the second, uses a dynamic and vowel crescendo (from ə to æ) to push into the next statement (which also marks the beginning of the second large structural section). These crescendos traverse, in the course of seconds, the same vowel and timbral changes that also played out over the course of this entire section. But unlike the second statement's crescendo, which opens fully into the bright belted sound, the Statement 3 crescendo breaks apart into several different timbres, as shown in Figure 5-31.

FIGURE 5-31: PASSACAGLIA, MM 31-38

The musical score for Figure 5-31 consists of eight staves. Staves 1, 2, 3, 4, 5, and 8 are vocal lines, while staves 6 and 7 are piano accompaniment. The key signature is one sharp (F#) and the time signature is 3/4. The score begins with the tempo marking 'poco piu mosso'. A rehearsal mark 'C' is located at measure 41. The score is titled 'IV. Passacaglia'. The vocal lines feature dynamic markings of 'f' and 'p'. The piano accompaniment features dynamic markings of 'f' and 'p'. The score includes vowel annotations: [æ] and [u] for the vocal lines, and [ə] for the piano accompaniment. The piano accompaniment also includes the annotation 'xöömei'. The score includes the instruction 'plainchantish improv on these two pitches' for the vocal lines. The score includes the instruction 'poco piu mosso' for the tempo. The score includes the rehearsal mark 'C' at measure 41. The score is titled 'IV. Passacaglia'.

Most unusual is the direction to voices 1 and 4 to continue the dynamic crescendo while the vowel crescendo reverses direction, moving from the front/open [æ] to the back/closed [u]. This seems to be working at cross-purposes, for as the dynamic increases (boosting higher overtones more than the fundamental) F1 and F2 both sweep down, counteracting the

prominence of those higher partials. The result is a sense of incompleteness and non-resolution, which serves the transitional nature of this moment, and contrasts with the parallel moment at m. 93, when dynamics and vowels crescendo in conjunction to full brightness and spectral intensity (this is the only notated *fff* in the entire Partita) before the very last chords of the movement, and of the entire work.

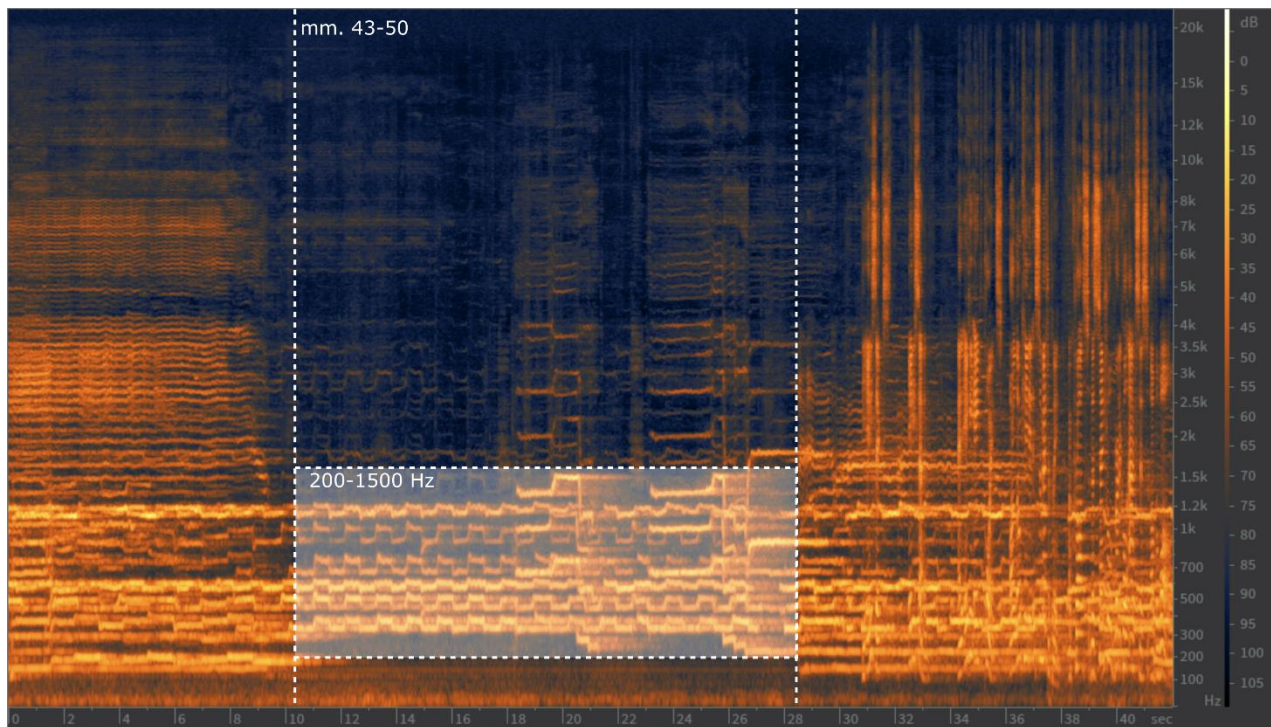
The vowel diminuendo at m. 31 also serves to transition voices 1 and 4 to a new timbre, marked “plainchantish,” in which they ad-lib, still on [u], on two-pitch cells. The description “plainchantish” suggests a lighter, mixed vocal register like that currently favored by early music performers and scholars. Voices 2, 3, 5, and 8 sing a fourth statement of the passacaglia progression on [e] in a moderately bright chest voice (like Statement 2), while voices 6 and 7 sing very bright and buzzy *xoomei*-style drones.²⁰ This opening, with its terraced increase in brightness and richness, followed by a breakdown into a multi-timbral mixture, is reminiscent of the first main section of the Allemande, but with the direction of the timbral terracing reversed (and of course, different elements in the mixture).

The deployment of the timbres in this multitimbral section reverses the usual associations of brightness with higher pitches, instead making the lower voices more bright and piercing and the upper voices light and pure. The “plainchant” ad-libbing morphs into an even lighter, “floaty head voice” in mm. 41-43, coupled with a dynamic diminuendo and an “eat your sound”

²⁰ The idea of juxtaposing plainchant and *xoomei*, two traditions separated by thousands of miles and very unique historical-cultural contexts, seems here more about timbral contrast than cultural reference, since neither timbre is being used to explicitly evoke the particulars of either style.

diminuendo²¹ by the low voices which filters out the high-frequency buzzy phonation of the *xoomai* drones, The removal of the lower voices deactivates more than just the low spectral range, however. The “plainchantish” and “floaty” head voices emphasize their fundamentals and low partials more strongly than higher overtones,²² and indeed, the fact that those fundamentals are higher to begin with (being sung by one of the tenors and three of the women) and the vowel is still [u] decreases their spectral richness further. The spectral energy is focused sharply in a low-mid frequency range (200-1500 Hz) relative to the full movement, as is clear from a look at the spectrogram in Figure 5-32.

FIGURE 5-32: PASSACAGLIA, MM. 43-50

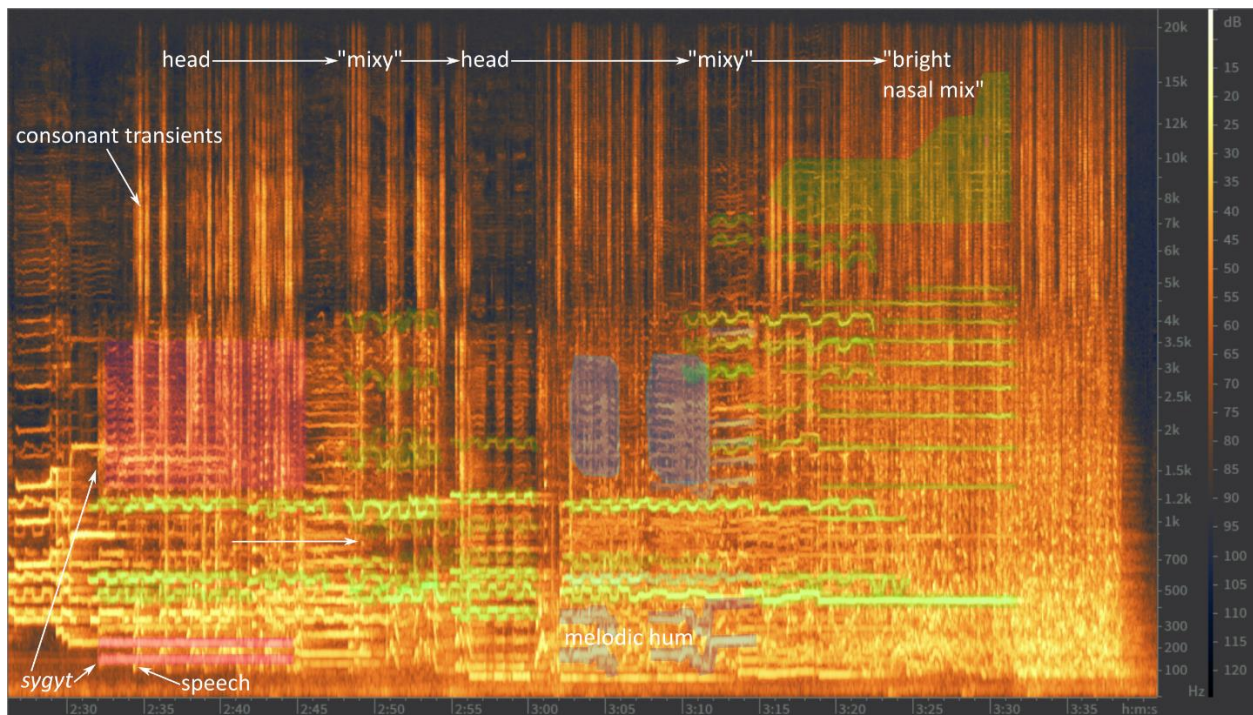


²¹ This technique is a “multi-step tongue filter” which bears a sonic resemblance to the tongue-filtering of Western overtone singing. It results in both a dynamic diminuendo and an overtone glissando.

²² Sundberg (1987) 69-70.

Following this spectral reduction, Shaw starts reintroducing higher spectral elements, as illustrated in Figure 5-32 and Figure 5-33. First, voices 2 and 6 sing a short melodic phrase on [ø] in octaves. The timbre is similar to that of the undulating voices: light, clear, with perhaps a tiny bit more edge and brightness. We can see from the spectrogram that the vowel and the octave doubling both light up overtones mostly in the 1100-4000 Hz range, and though they are sparse and relatively weak, they are more present than the higher partials of the two-note singers.

FIGURE 5-33: PASSACAGLIA, MM. 47-73 (FROM 2'30"-3'30")



Voices 4, 7, and 8 enter at rehearsal E with Tuvan-style “*sygyt*”drones, whose pinched, nasal timbre features a deliberately dampened fundamental with amplified overtones in the 2-4

kHz range, fill that range in more densely. The return of spoken text (another Sol LeWitt line drawing instruction) peppers the texture with the high-frequency spikes of consonant transients, while the voices continuing the two-note undulations are instructed to move from head voice to a “mixy” voice (mixing in chest register), and then back. The mixing in of chest voice brightens and enriches the timbre by increasing the prominence of higher partials, and in our spectrogram this is so. Compare, for instance the sections in Figure 5-33 labeled “mixy” with those labeled “head.” In the “mixy” sections, the overtones of the undulating two-note lines are active up to about 4000 Hz (even more the second time), while in the “head” sections, they remain for the most part below 1900 Hz.

As more and more voices switch over from singing to speaking, the overall spectral profile morphs from the focused spectral range and single, pure timbre of Figure 5-32 to the multi-timbred, broad-band²³, noise-dominated profile of Figure 5-33. Interestingly, as pitch gives way to the tangle of speech, the lone soprano that remains, holding an A4 into m. 73, migrates once more from the floaty head voice through “mixy” now going further to a “bright nasal mix,” while also changing to an [I] or [i] vowel. The nasality recalls the earlier *sygyt* drones and along with the changing vowel, activates higher overtones particularly around 3000 Hz, and even as high as 10-15 kHz. It is as if this last holdout is not simply trying to maintain the world of pitch as long as possible, but is making one more solitary attempt to reclaim the higher spectral ranges of the chest/belt register. Ultimately, she is overtaken by the wash of spoken noise, which rises to a dynamic crescendo, suddenly cuts out, then begins again.

With the sudden resumption of the chaotic talking, the gradual removal of pitch begins to

²³ Although the complex mixture of modal phonation (vowels) and unvoiced vocal tract perturbations (consonants) in speech spreads sonic energy over the full spectral range, the greatest energy in this passage is concentrated between 80-600 Hz, where most of the fundamentals and lowest partials of modal phonation lie.

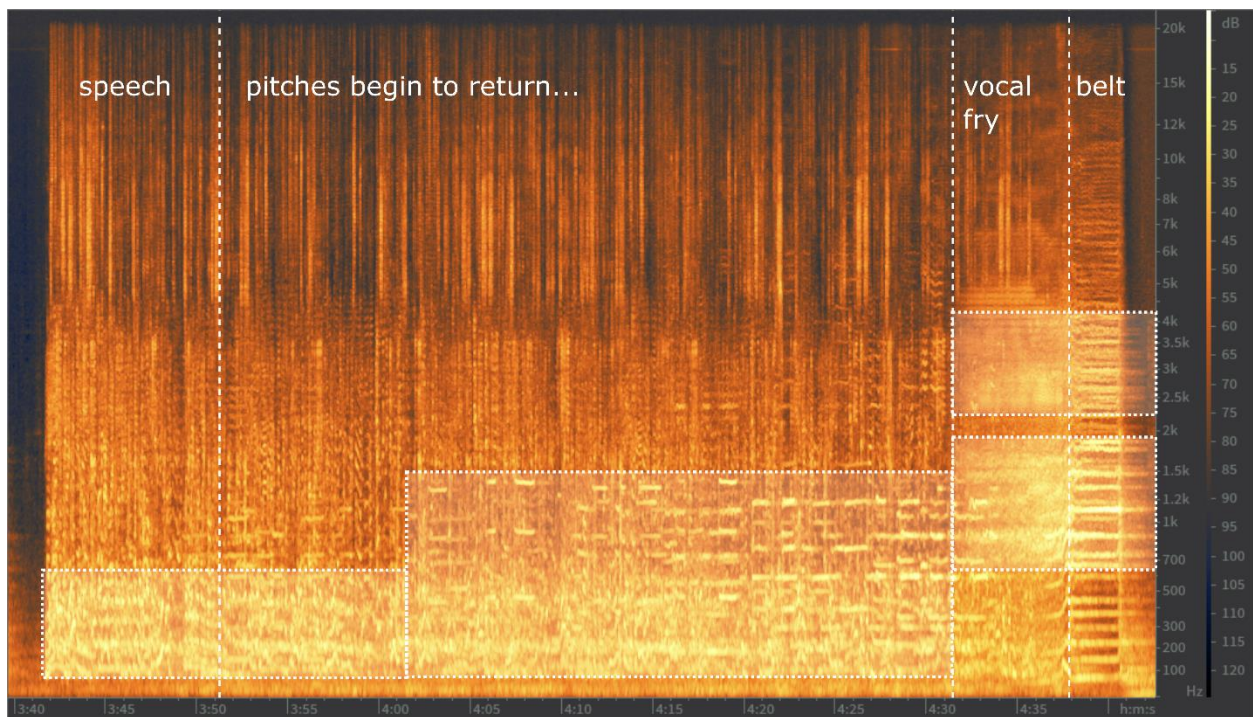
reverse. We might expect that this procedure would be a mirror reversal – the voices switching over one by one to singing until they overwhelm the speaking. Instead, one by one, the voices begin injecting pitches of the passacaglia progression in pointillistic fashion into their spoken text, which continues to dominate the overall texture. As the harmonic texture slowly reconstitutes, we are aware of the implied trajectory back to pitched singing, but though the density of pitch does gradually increase, pitch durations remain brief, and harmonic alignment between voices remain unsynchronized. Meanwhile, the density of the spoken texture does not appreciably thin; overall it seems to drive toward a similar type of dynamic climax as before, but it is unclear exactly what to expect.

It requires an unexpected and heretofore unheard timbre to serve as the bridge to the recapitulation of pitched singing we have been expecting. As the pointillistic singing/spoken wash intensifies, voices begin switching quickly to vocal fry register, creating a noisy, crackling, timbre which then ‘glissandos’ up to a belted D major triad, recapitulating Statement 3 of the passacaglia progression. Simultaneously low and high, vocal fry sits on the boundary between pitch and noise, and so it makes a natural bridge between the two. Although fry is the lowest vocal register in terms of fundamental frequency, its formant-amplified upper partials are much more prominent than its fundamentals, which gives it its distinctive rattling or crackling quality. Because the fry and the belt are both on the vowel [æ], the fry “prepares” the ground, spectrally, by noisily amplifying the vowel’s formants and frequency ranges that will also define the timbre of the belted pitches (as can be seen in Figure 5-34. It is almost as if the “buzz” of the belt has arrived first, and the pitches are “slid into” the noise, rather than the other way around. In addition, as there has been a trajectory in this movement from chest register up to the pure, high, “floaty head” register and back, the use of fry offers a trajectory in the opposite direction.

The spectrogram also reveals a shift in area of greatest spectral intensity in this section

comparable to that of the opening of the movement, even though the bulk of this section is spoken voice rather than singing. Indeed, the way that [ɐ] and ultimately [æ] emerges out of this chaotic speech texture recalls the Introduction to the Allemande. Rather than bringing the vowel out through word repetition, Shaw brings it out by giving it steady pitch and timbre in an otherwise chaotic texture, and linking each glinting point together in a harmonic web.

FIGURE 5-34: PASSACAGLIA, MM. 74-85



This wonderful climax thus offers a kind of apotheosis of the relationship between “noise” and singing as Shaw has constructed it in the *Partita*. Trevor Wishart, in discussing Pierre Schaeffer’s concept of *grain* as a timbral parameter, writes:

“... In between the extremes of impulse perception and pitch perception we perceive a pitched object with a certain amount of ‘grittiness’... this internal ‘grittiness’ is the grain of the sound-object... It is important to realise that there is a perceptual threshold at which we cease to perceive individual events as individual events and begin to experience them as contributing to the grain of a larger event. As a result, at sufficiently high speed, any sequence of sound-objects may

become fused into a larger object with grain... If we applied the same process to a string of speech sounds we approach the conception of a multiplex..."²⁴

Just as in the Allemande introduction or the Courante's opening section, Shaw has built something like a multiplex, a noise-texture made of individual speech events. We perceive it as a single texture even as we are still able to pick out individual voices lines of text if we shift our focus. We might call this a "chunky" multiplex. This is juxtaposed with a multiplex (vocal fry) whose grittiness still easily perceptible, but far less reducible to the ear, and with pitch, a multiplex whose grain is simply so small we no longer perceive it. Contrasting these three timbres and eliding vocal fry and modal voice into belt draws our attention to these perceptual thresholds and the fungibility of the boundaries between pitch and noise, speech and song.

Following the recapitulatory belted statement of the passacaglia, there is a brief coda using only the first three chords of the passacaglia progression on an [u]. With its low F1 and F2, and return to non-belted more 'covered' classical vocal register, the fundamentals and low partials are emphasized, resulting in a pure, well-balanced timbre which is given a boost of warmth and richness in the very last chord by the subtle upper harmonics of a low *strohbass* Eb whose hint of pulsation also recalls the earlier vocal fry. A final "eat your sound" harmonic glissando provides a shimmer of nasal color, and like the pitch bends at the end of the Allemande, suggests a timbral, rather than dynamic, *messa di voce*.

We can summarize these detailed analyses in the chart in Figure 5-35. From this analysis we can see how a rounded binary form overlays the variations structure of the Passacaglia, and how timbre helps create that shape. Specifically, the B section is multitimbral while the A section and its reprise move in monotimbral blocks. The A sections either ramp up to or away

²⁴ Wishart (1996), p. 68.

FIGURE 5-35: PASSACAGLIA: OVERALL ANALYSIS

Structural	Meas./ Reh.	Vowel/text	Other timbres/ techniques	Timbral description
A₁	1-10	[ɔ ; ɔ]	Light, modal/mixed	Pure, somewhat dark; steady, even, smooth
A₂ (Var 1)	11 (A)	[ɐ ; ɔ] <	Chest/head break	Full, rich warm; contrast with thin, breathy head voice
A₃ (Var. 2)	21 (B)	[æ ; ɔ] <	Belt/semi-pitched exhale release	Bright, rich, brassy; explosive release gesture
Trans.	30	[ɔ] < [æ]/[u]	<i>Xoömei</i>	Cresc. to multitimbre;
B₁ (Var 3.)	33 (C)	[u]; [ɐ]	“plainchantish” head voice ostinato; brighter chest voice; <i>xoömei</i> drone	Multitimbre; bright and buzzy lower voices contrast with light, pure high head voice
Extension/ trans.	43 (D)	[u]; [ɐ]	“floaty” high head voice; melodiv motive	Light, pure, clear head voice
B₂ (Var. 4; augmenta- tion)	51 (E)	[u]; [ɔ] Spoken: “The eighty-sixth...” etc.	“Floaty head” ostinato; spoken voice; <i>sygyt</i> drones	Multitimbre: light, pure head voice
	61 (F)	[ɐ]; →[i]; voices progress- sively switch to spoken text	head→mix→”nasal mix”; hummed melody; spoken voice gradually takes over	Multitimbre; over increasingly rough/noisy texture, light h.v. becomes brighter/edgier, finally bright but pinched
B₃ (Var. 5; retrans).	74 (G)	Spoken text continues; emerging [ɐ] < [æ]	Gradual reintroduction of pitch; vocal fry cresc. transition	Noisy, rough texture gradually interpen- etrated with pure, thin, neutral pitches;
A₃' (Var. 3)	85 (H)	[æ ; u] < [æ]	Belt/semi-pitched exhale release	Bright, rich, brassy; explosive release gesture
Coda (incomp. Var.)	96 (I)	[u]	“eat your sound” filter	Dark, pure, slightly warm; final overtone shimmer

from the bright, buzzy, spectral saturation of belt while the B sections explore shadings of the lighter, purer head voice, and contrast that with bright and/or noisy timbres like speech and Tuvan techniques. The B section’s combination of singing, speaking, humming, and other

timbres recalls the second section of the Allemande, which also combined similar elements. As mentioned before, the retransition to the A' reprise in the Passacaglia also recalls the Introduction of the Allemande.

6. CONCLUSIONS

In her note in the score of *Partita*, Shaw writes that the piece was “born of a love of surface and structure... and of our basic desire to draw a line from one point to another.” Like the Sol LeWitt drawing that served as inspiration, *Partita* draws a web of connections and relationships within and across its movements, between sounds that may seem at first glance to be random or intuitive. These connections are multi-directional and drawn using many means. Timbre is one important means of drawing these connections, and certainly the way which most distinguishes *Partita* from more conventional works which rely primarily on melodic, motivic, or harmonic means.

The Allemande is the keystone to the entire work. It lays out, in both explicit and subtle ways, the materials, techniques, and procedures that underlie and connect the following three movements. Shaw draws explicit connections to other movements via motivic, harmonic, and timbral quotations (refer back to Figure 5-12): More broadly, Shaw establishes several highly distinctive timbres and techniques that will connect and echo at key moments across the four movements. In particular, the very bright, rich, somewhat noisy vocal timbres (belt or very bright modal chest voice in particular) signify structural climaxes, and dark, relatively pure colors areas of repose, and to close three of the four movements. In between those two timbral poles, Shaw uses changes in vowel color and/or phonation to create variation and sectional shape. In particular, Shaw is fond of “terracing” vowel color/phonation changes, as she does in the closing areas of each section of the Allemande (which progressively darken), as well as in the opening statements of the Passacaglia (which progressively brighten). This terraced usage creates timbral direction while emphasizing timbral contrast across phrases or repetitions of a phrase or motive.

In contrast to this technique, Shaw uses gestures whose timbres emerge, disappear, or

transform smoothly. One of the most distinctive examples first heard in the Allemande is the “eat your sound” filter; related to that are the various “vowel hairpins” where the singers smoothly open from and/or close to a hum (a technique that becomes the basic motive of the Sarabande). Shaw uses these gestures mostly to elide or smooth transitions and seams, or to color and complicate otherwise stable sonorities. Shaw also creates textures where one timbre is gradually mixed into, or emerges from another, like the pointillistically hummed pitches that gradually emerge out of the *katajjak* in the Courante.

In the Allemande, Shaw also sets up polarities of timbral unification or steadiness versus timbral variety and variability. Unified timbres with internal steadiness are often used homophonically to introduce or recapitulate primary motivic or harmonic materials and to emphasize structural arrival points. By contrast, multi-timbred textures, or gestures with internal timbral change or motion (like vowel morphing and the “eat your sound” filter) are used in intermediary or transitional sections, to create or build forward momentum. The Sarabande is unique in that it uses such a transient gesture as the basis of the larger unfolding of the movement.

One of Shaw’s special interests in *Partita* is exploring the boundaries of the singing voice – with speech (Allemande), with breath (Sarabande and Courante), with vocal fry (Passacaglia) – and the way the singing voice emerges from these other timbres. The whole first section of the Courante, for instance, is a super-slow-motion unfolding of singing (frequency), and ultimately harmony (overtones), emerging from breath, the same trajectory contained in the micro-scale of each of the Sarabande’s breathy scooped inflections. The introduction of the Allemande makes the connection between the speaking voice and the chest/belt register, and the Passacaglia expands that connection to include head voice at one extreme and vocal fry at the other.

If we compile our analyses of the overall timbral qualities and shapes of each movement

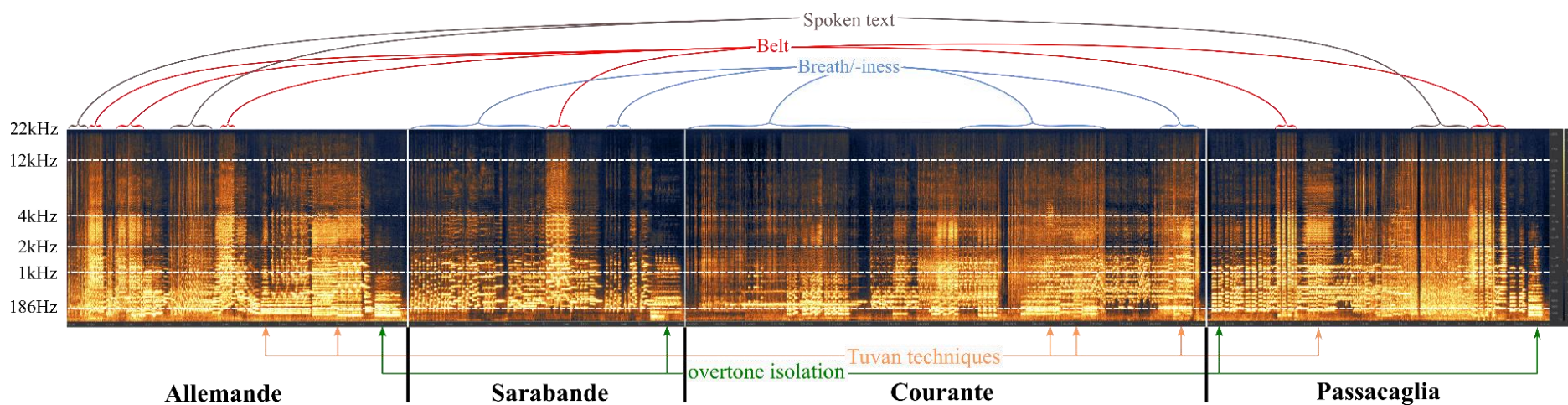
of *Partita* (see Figure 6-1), we can make some generalizations about the work as a whole:

FIGURE 6-1: *PARTITA*, LARGE-SCALE FEATURES

	Dominant/ salient timbres/ techniques	Spectral profile	Timbral variety	Other features	Formal features/shape
Allemande	Speech; Belt; Vowel color terracing; phonation/register contrast; ‘grab bag’ of other timbres and techniques	Highly varied; many wide/ high spectrum elements (both noise and harmonics)	High	Spoken and sung text	Triple arch:
Sarabande	Breathy voice; hum; belt interruption	Mostly low and narrow; one wide/high interruption	Low	Low and high ends of vocal ranges are absent; no text	Ternary/arch passacaglia- type harmonic variations
Courante	Breath; hum; modal voice (getting to full/rich but not overly bright); ‘rough’ sounds (“Akinisie rumble, <i>kargyraa</i> , <i>xoömei</i>) near the end	Gradually widening; but high elements mostly breath or throat singing noise;	Low increasing to high	Gradual expansion back to full vocal range spread; no text	3-stage crescendo
Passacaglia	Vowel color terracing; phonation/register contrast (esp. female chest v. head voice); belt; speech	Highly varied; many wide/high spectrum elements (both noise and harmonics)	High	Spoken text	Rounded binary passacaglia/ developing variations

The grand-scale shape of the work seems to be a > < in terms of spectral width and richness, timbral variety, and tessitura. The outer movements are linked by important timbral similarities, especially the use of spoken voice and text, which are both completely absent from the inner two movements. As a timbre, speech (especially several voices speaking simultaneously) is chaotic and noisy, a “grainier” sound, mixing low-medium spectrum frequencies that are periodic but usually unsteady (vowels) with wider- and higher- spectrum noise bands (consonants). This matches the higher level of timbral, registral, and formal variety in these movements. In contrast, the middle movements share a sense of “focus” on a different kind of noise element, breathiness, whose timbre is more blended and uniform, spread evenly over wide frequency bands. Although there is of course, timbral variety in the middle movements (increasingly so in the Courante), each of these movements is similar in its tendency to maintain at least one timbral idea or element as a through-line. In the Sarabande, it is the repeated scooping attacks of the upper voice chorale, and in the Courante, the percussive *katajjak* groove is the obvious timbral through-line. Each middle movement also displays such “single-mindedness” in other ways: the Sarabande’s single repeated harmonic progression, restricted frequency range; the Courante’s unfolding, movement-long progressive expansion of both tessitura and spectral richness, which, while multitimbral at many moments, is strongly unidirectional as an overall *process*. The Courante also features humming throughout, and the upper voices mostly maintain a clear, light, head register whose spectral profile is low-partial heavy (most of the increasing spectral richness is the result of re-introducing the male voices in very low ranges, and from the addition of high-partial-amplifying Tuvan throat singing techniques). The spectrogram in Figure 6-2 helps visualize this big-picture analysis, particularly the importance of the frequency ranges above 2kHz, and the conspicuous emptiness of the low range

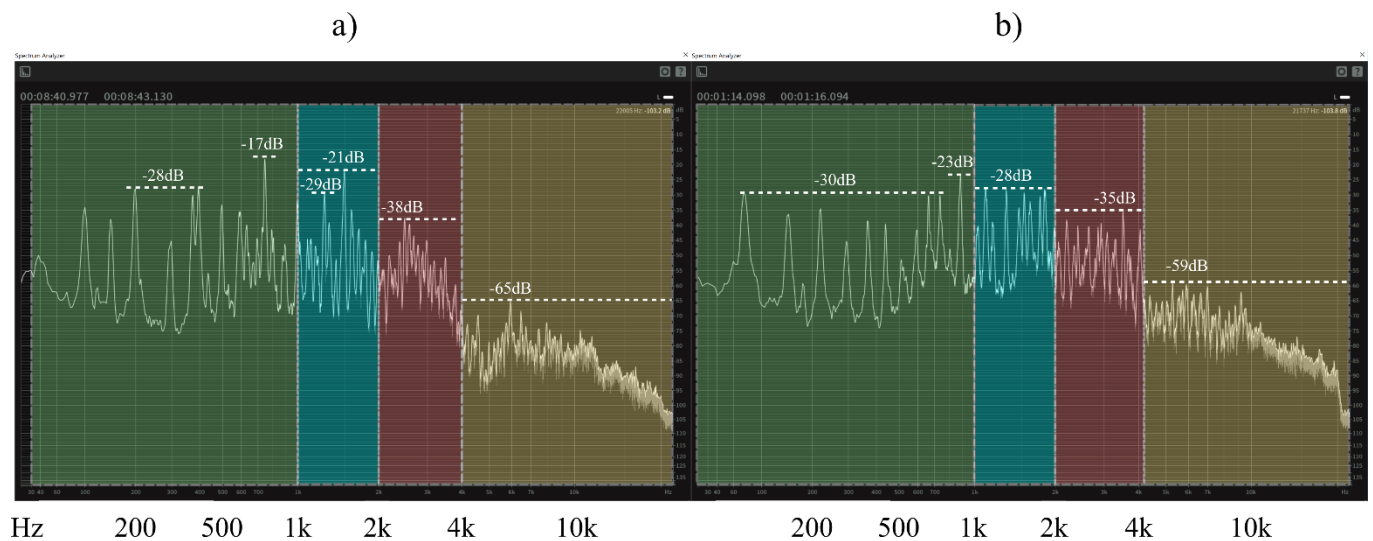
FIGURE 6-2: COMPLETE *PARTITA* SPECTROGRAM



in the Sarabande, and the way those ranges are then repopulated in the Courante.

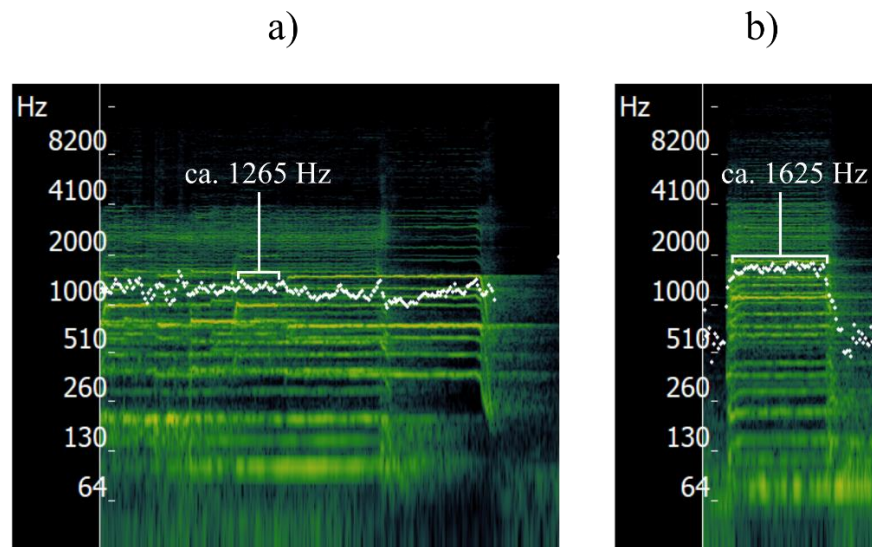
By beginning the Partita with ensemble speaking and belt, Shaw establishes maxima of both sung vocal timbre and noise, and by bombarding us in the Allemande with a dizzying array of other timbres and techniques, Shaw establishes a maximum of timbral diversity. She narrows her focus in the Sarabande, restricting tessitura, concentrating on one drastic timbral contrast, and then spends most of the Courante getting back to the timbral richness she began with. Interestingly, although the climax of the Courante is at least as timbrally diverse and more exciting in many ways – louder, faster, more rhythmic, wider tessitura – than almost anything in the Passacaglia, it is the return of both belt and speech-noise-wash in the Passacaglia that completes the timbral recapitulation of the Allemande. We can compare, for instance, the climatic chord at the end of Courante – which combines loud mixed-head singing by the women with noisy, buzzy Tuvan singing by the men – with the first belted chord of the Passacaglia. The spectrum analysis in Figure 6-3a-b shows how in the ranges above 1kHz, while the Courante chord has some higher high peaks, the belted chord's energy remains higher, most crucially, in the 2-4 kHz range and the the 4-10kHz range.

FIGURE 6-3A-B: SPECTRUM ANALYSIS: A) COURANTE, M. 208; B) PASSACAGLIA M. 23



Taking the average spectral centroid of both sonorities, as shown in Figure 6-4a) and b) confirms that the centroid of the Passacaglia belt falls in the expected 1600-1700 Hz range, while the centroid in the climax of the Courante peaks at an average of 1265 Hz, a difference about equal to a major third.

FIGURE 6-4A-B: SPECTRAL CENTROID: A) COURANTE, M. 208; B) PASSACAGLIA M. 23

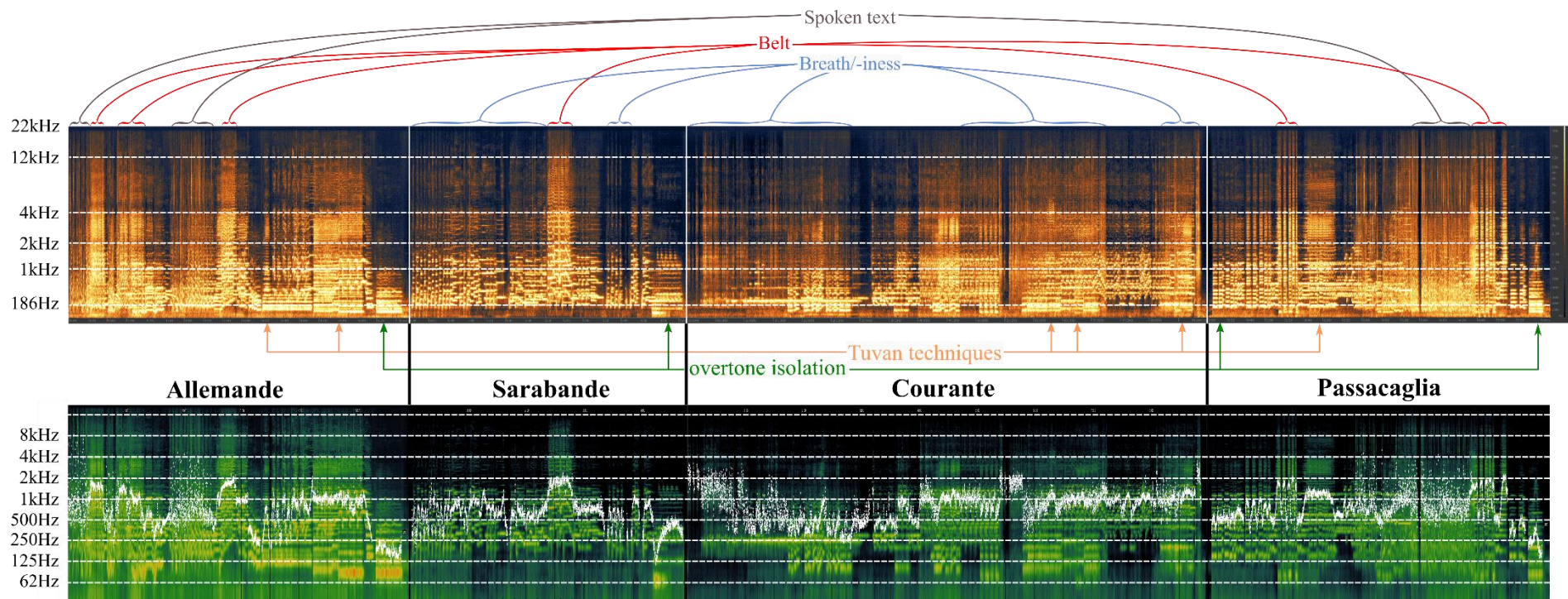


Tracking the spectral centroid for the entire *Partita* (shown in Figure 6-5) also reveals some interesting things: The belt occurrences stand out very strongly as peaks at or close to 2kHz in the centroid line, and the terracing of vowel and phonation is quite visible, stepping down in the first two sections of the Allemande, stepping up at the start of the Passacaglia, and back down at its end; the centroid for much of the Sarabande (except the central belt episode) is higher than we might have expected, but this is because, lacking the low mens' voices, the fundamentals being sung are also much higher – but the distance between those fundamentals and the centroid is much less, on average. The centroid also remains mostly within the 500-1000Hz range. This

confirms what we asserted earlier and what our ears tell us: that although the fundamentals are higher, the overall timbre here is less bright and less rich, and the spectral range is much narrower. The breathiness of the women's tone is not evident in the centroid – the line does not show any of the diffusion so evident in the beginning of the Courante. It likely does not have enough amplitude relative to the sung pitches to affect calculation of the centroid.

The beginning of the Courante is perhaps the most surprising result: Rather than being an arch, as we described earlier, the centroid of the opening section is a descent. This is due to how high-frequency much of the breath noise in the opening *Katajjak* is, even higher than the belt centroids. However, the energy is also widely diffused. The centroid makes very clear how this first section is about coalescing more focused timbres out of this diffuse energy, as semivoiced breaths, single pitches, and then harmonies are gradually introduced. The centroid descends closer and closer to the fundamentals, showing a very pure tone (hums, remember). The centroid line remains quite diffuse, however, until the low voices enter. This is in a sense the reverse proportion seen in the Sarabande: there, the breathiness was a subtle color or halo around the pitch. Here, the pitch is a hesitant, muted color trying to shine through the haze. The remainder of the Courante shows the gradual return of brighter timbres with higher-range pitch overtones, and the long trajectory back to a brighter, richer pitch timbre. The bursts of breath noise at the end of Sections 2 and 3 of the Courante, in fact, complete this upward trajectory in terms of the centroid, and when combined with the opening breath noise, give the entire movement a valley-shape rather than a single, sustained rise.

FIGURE 6-5: COMPLETE *PARTITA* SPECTROGRAM, WITH SPECTRAL CENTROID



In the Passacaglia, we can also see clearly the other use of noise texture – how, after arching up and starting to descend, the centroid disintegrates as speech overwhelms pitch, and then re-integrates with the final return of belt. This underscores both the similarity to the opening of the Allemande, as well as how the Passacaglia’s speech texture is even noisier and more chaotic than the Allemande’s.

In the end, *Partita* is indeed about drawing lines – lines connecting musical materials and points in time, yes – but also lines connecting spectral ranges and vocal registers; lines connecting visual art, music, and dance; lines connecting conception, instruction and execution, composer and performers; lines connecting language and music, speech and singing; noise and pitch; lines connecting the larynx, the tongue, and the lips, the chest and the head. Vocal timbre, style, and technique are among the most audible and striking means of making these connections, yet, as in Sol LeWitt’s Wall Drawing, the connections and relationships that result are evident or mysterious depending on one’s vantage point and focus of attention. Listening with the auditory equivalent of standing back from the wall, the arrangement and connection of points can be experienced in a holistic way, as pattern, aesthetic, expression, without necessarily being aware of the rules, principles, and decisions underlying the artistic product as it is presented and consumed. Yet step closer, focus in, and in many cases, the keys to understanding the undergirding interconnection of the work as a whole are sitting right there on the surface.

7. REFERENCES

- Campbell, M., & Greated, C. (1987). *The Musician's Guide to Acoustics*. New York: Schirmer.
- Cogan, R. (1984). *New Images of Musical Sound*. Cambridge, MA: Harvard University Press.
- Cogan, R., & Escot, P. (1976). *Sonic Design*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
- Delattre, P. (1951). The Physiological Interpretation of Sound Spectrograms. *PMLA* 66, no. 5, 864-75. doi:10.2307/459542.
- Edgerton, M. E. (2004). *The 21st-Century Voice: Contemporary and Traditional Extra-Normal Voice*. Lanham, MD: Scarecrow Press, Inc.
- Fagnan, L. (2008). Research Report: "Chiaroscuro" Resonance Balancing: The "Bel Canto" Answer to Choral Tone and Intonation Problems. *The Choral Journal* 49, no. 5, 51-61. doi:<http://www.jstor.org/stable/23556992>
- Fales, C. (2002). The Paradox of Timbre. *Ethnomusicology*, 46 (1), 56-95. doi:<http://www.jstor.org/stable/852808>
- Farahat, M. (1991). On the Staging of Madrigal Comedies. *Early Music History* 10, 123-43. doi:<http://www.jstor.org/stable/942452>
- Gann, K. (1997). *American Music in the Twentieth Century*. Belmont, CA: Wadsworth/Thomson Learning.
- Kravitt, E. F. (1976). The Joining of Words and Music in Late Romantic Melodrama. *The Musical Quarterly* 62, no. 4, 571-90. doi:<http://www.jstor.org/stable/741557>
- Ladefoged, P. (1982). *A Course in Phonetics* (2nd ed.). New York, NY: Harcourt Brace Jovanovich.
- Ladefoged, P. (2005). *Vowels and Consonants* (2nd ed.). Oxford: Blackwell.
- Leech-Wilkinson, D. (2002). *The modern invention of medieval music: scholarship, ideology,*

- performance*. Cambridge; New York, NY: Cambridge University Press.
- Lefkowitz, D. S. ((Forthcoming)). *Analysis of Post-Tonal Music: A Parametric Approach*. Berkeley: University of California Press.
- Levin, T. C., & Edgerton, M. E. (1999). The Throat-singers of Tuva. *Scientific American*, Vol. 281, No. 3, 80-87.
- Lowder, J. B. (2013, April 17). The Strange, Beautiful Music That Won the Pulitzer This Year. *Browbeat (Slate.com)*. Retrieved from http://www.slate.com/blogs/browbeat/2013/04/17/partita_for_8_voices_pulitzer_prize_winning_composition_by_caroline_shaw.html
- Monk, M. (1976). Notes on the Voice. *Painted Bride Quarterly*, 3, no. 2.
- Osmond-Smith, D., & Berberian, C. (2004). The Tenth Oscillator: The Work of Cathy Berberian 1958-1966. *Tempo*, 58(227), 2-13. doi:<http://www.jstor.org/stable/3878673>
- Phillips, C. H. (1969). *The Singing Church: An Outline History of the Music Sung by Choir and People*. (Rev. ed.). Hamden: Archon.
- Ruccia, D. (2016, April 27). Roomful of Teeth Sings the Sounds of the World. *IndyWeek.com*, pp. <https://indyweek.com/music/features/roomful-teeth-sings-sounds-world/>.
- Sander, H. (1970). Sprechstimme in Choral Music. *The Choral Journal*, 11(2), 7-11.
- Slawson, W. (1985). *Sound Color*. Berkeley/Los Angeles: University of California Press.
- Sundberg, J. (1987). *The Science of the Singing Voice*. Dekalb: Northern Illinois University Press.
- Tommasini, A. (2013, Nov 5). The Pulitzer Prize Was Nice and All, But a Work Is Finally Fully Heard. *The New York Times*, p. C2. Retrieved from <https://www.nytimes.com/2013/11/06/arts/music/caroline-shaws-partita-has-premiere-by-roomful-of-teeth.html>

- Tsioulicas, A. (2013, April 15). Caroline Shaw, 30, Wins Pulitzer For Music. *Deceptive Cadence*, from *NPR Classical*. Retrieved from <https://www.npr.org/sections/deceptivecadence/2013/04/15/177348405/caroline-shaw-30-wins-pulitzer-for-music>
- Uberti, M., & Lindley, M. (1981). Vocal Techniques in Italy in the Second Half of the 16th Century. *Early Music*, 9(4), 486-95. doi:<http://www.jstor.org/stable/3126691>
- Wells, B. (2006). Belt Technique: Research, Acoustics, and Possible World Music Applications. *The Choral Journal*, 46(9), 65-77.
- Wishart, T. (1996). *On Sonic Art* (New Revised ed.). (S. Emmerson, Ed.) Amsterdam: Harwood Academic Press.
- Woolfe, Z. (2013, April 17). With Pulitzer, She Became a Composer. *The New York Times*, p. C1. Retrieved from <https://www.nytimes.com/2013/04/18/arts/music/caroline-shaw-award-winning-composer.html>