GENDERING THE VIRTUAL SPACE: SONIC FEMININITIES AND MASCULINITIES IN CONTEMPORARY TOP 40 MUSIC

by

MICHÈLE DUGUAY

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July 26, 2021 Mark Spicer

Date Chair of Examining Committee

July 26, 2021 Norman Carey

Date Executive Officer

Supervisory Committee:

Johanna Devaney, Advisor

Stephanie Jensen-Moulton, First Reader

Jonathan Pieslak

Mark Spicer

THE CITY UNIVERSITY OF NEW YORK

Abstract

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This dissertation analyzes vocal placement—the apparent location of a voice in the virtual space created by a recording—and its relationship to gender. When listening to a piece of recorded music through headphones or stereo speakers, one hears various sound sources as though they were located in a *virtual space* (Clarke 2013). For instance, a specific vocal performance—once manipulated by various technologies in a recording studio—might evoke a concert hall, an intimate setting, or an otherworldly space. The placement of the voice within this space is one of the central musical parameters through which listeners ascribe cultural meanings to popular music.

I develop an original methodology for analyzing vocal placement in recorded popular music. Combining close listening with music information retrieval tools, I precisely locate a voice's placement in virtual space according to five parameters: (1) Width, (2) Pitch Height, (3) Prominence, (4) Environment, and (5) Layering. I use the methodology to conduct close and distant readings of vocal placement in twenty-first-century Anglo-American popular music. First, an analysis of "Love the Way You Lie" (2010), by Eminem feat. Rihanna, showcases how the methodology can be used to support close readings of individual songs. Through my analysis, I suggest that Rihanna's wide vocal placement evokes a nexus of conflicting emotions in the wake of domestic violence. Eminem's narrow placement, conversely, expresses anger, frustration, and violence. Second, I use the analytical methodology to conduct a larger-scale study of vocal placement in a corpus of 113 post-2008 *Billboard* chart-topping collaborations between two or more artists. By stepping away from close readings of individual songs, I show how gender stereotypes are engineered en masse in the popular music industry. I show that women artists are generally assigned vocal placements that are wider, more layered, and more reverberated than those of men. This vocal placement configuration—exemplified in "Love the Way You Lie"—creates a sonic contrast that presents women's voices as ornamental and diffuse, and men's voices as direct and relatable. I argue that these contrasting vocal placements sonically construct a gender binary, exemplifying one of the ways in which dichotomous conceptions of gender are reinforced through the sound of popular music.

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Introduction

In a 2015 *Slate* article, music critic Chris Molanphy reflects on the history of featured-artist songs. He notes that two main collaboration models emerged in the 1990s and continue their popular hold today: "the featured bridge rapper" and the "featured hook singer" (2015).[1] The two genre crossover models Molanphy identifies indeed apply to many commercially successful collaborations that have appeared on the *Billboard* charts in recent years. Consider for instance the four collaborations between Rihanna and Eminem. "Numb" (2012) and "Love the Way You Lie, Part II" (2010) follow the "featured bridge rapper" structure.[2] Featured artist Eminem provides a rapped verse for Rihanna's sung ballad. "Love the Way You Lie" (2010) and "The Monster" (2013), conversely, adopt a "featured hook singer" structure.[3] As a featured artist, Rihanna complements Eminem's rapped verses with a sung chorus.

Wishing to explore the formal structure of these collaborations in more depth, I spent a significant amount of time in the last few years engaging in close listening to *Billboard* chart-topping hits in which one or more artists were featured. In early 2018, I assembled a YouTube playlist of post-2008 commercially successful collaborations. The playlist was not limited to the two crossover models outlined by Molanphy. It encompassed several musical genres and included country duets, collaborations between rappers, and paired-up pop acts. When listening,

[1] Other, albeit less frequent, collaborations types exist. For example, men and women artists featured in the same song can both sing or rap.
[2] Other examples of recent collaborations adopting this structure include "Drunk in Love" by Beyoncé ft. Jay-Z (2013), and "Good for You" by Selena Gomez ft. A$AP Rocky (2015). In these songs, rapping men are enlisted to perform a verse or bridge to accompany a woman's singing voice.
[3] This structure also appears in In "Feel This Moment" by Pitbull ft. Christina Aguilera (2013), and "One Dance" by Drake ft. WizKid and Kyla (2016). Women appear as guest artists tasked with performing a hook or chorus.

I paid attention to the ways in which these musical collaborations were structured. As I listened, two observations emerged.

First, I noticed a deeply gendered division of labor between artists. While an overwhelming number of men performed rapped sections, only a few women—such as Nicki Minaj, Cardi B, and Iggy Azalea—appeared as rappers in commercially successful collaborations. As a result, if I heard any song with a singer, I would automatically expect to hear a man's voice performing a rapped second or third verse. This expectation was often fulfilled; any deviation from this norm would cause me a sense of surprise.[4] The "featured sung hook," conversely, seemed to me more commonly sung by women. I quickly became accustomed to hearing rapped verses by men alternating with catchy sung hooks performed by a woman. Songs like "Empire State of Mind" by Jay-Z featuring Alicia Keys (2009) became a sort of sonic trope to my ears. A man's voice, like Jay-Z's, advances a narrative through the verses, while a woman's voice like Keys' provides emphasis of overarching themes via a repeated sung chorus.

Second, I began to notice the different ways in which voices were presented in the recordings. I noticed that men's voices tended to have a focused and clear sound. In rapped verses, for instance, male vocalists were mixed in such a way that I could readily associate myself with them. In "Empire State of Mind," Jay-Z sounds like he is located directly in front of me. Alicia Keys' voice, conversely, is more diffuse and reverberated. Overall, I realized that women's voices were often mixed with more delay, added harmonies, and reverberation. While this was especially common in sung/rapped crossover hits, I also heard these sonic configurations in collaborations that were completely rapped or completely sung. I began to

[4] See Chapter 4 for more data on the different collaboration types. The woman singing/man rapping configuration is the most common, representing 40% of all collaborations between men and women appearing on the *Billboard* Hot 100 year-end charts between 2008 and 2018.

wonder—to what extent could we generalize the mixing of men's and women's voices across styles of vocal delivery and musical genres? How are men's and women's voices characterized in quantifiably different manners, both within and across genres of music? How might these trends relate to broader cultural narratives about gender?

Analyzing Vocal Placement

This dissertation aims to answer the above questions by further studying the way voices are treated in recent Anglo-American popular music. I establish a methodology for analyzing *vocal placement*—the apparent location of a voice in the *virtual space* created in a recording. When listening to a piece of recorded music through headphones or speakers, one hears various sound sources as though they were located in a virtual space (Clarke 2013). For instance, a specific recorded performance—once manipulated by various sound recording technologies—might evoke a large concert hall, an intimate setting, or an otherworldly space. Vocal placement refers to the way a singer's voice is positioned within this space.[5]

Vocal placement can be conceived as the sonic "packaging" of a recorded voice. In other words, it refers to the way in which a recorded voice is presented to a listener. Imagine, for instance, a scenario in which someone records your singing voice for a pop single. Your original vocal performance, once recorded, can be manipulated through different technological effects—which may include EQ (changing the balance of a sound's different frequencies), panning (placing the voice left, right, or center), pitch correction (adjusting the pitch, whether in a subtle way or making obvious use of Auto-Tune), reverberation (adding reflections of the sound to add

[5] The definition of vocal placement offered here is distinct from the use of "vocal placement" in vocal pedagogy and technique. In this context, vocal placement refers to the physiological space controlled by the singer to change the color and timbre of their voice.

depth and space), and so on. Mixing engineers could choose, for instance, to place your voice in the very center of the virtual space created in the recording. Alternatively, they could decide to position your voice to the extreme left, make it move from side to side, or to enhance it with an echo that spreads across the virtual space. Once completed, this manipulated performance is then released for public consumption.

As an analyst interested in studying vocal placement, I take the perspective of a listener who has access to the final product: a released recording of your altered vocal performance. I cannot listen to your original performance, nor can I trace the process through which your voice was manipulated. I therefore cannot analyze the recording and mixing process undergone by your recorded voice.[6] I can, however, make statements about the ways in which your voice is presented in this final recording.

The scenario described above represents the analytical orientation used throughout the dissertation (Figure 0.1).[7] My methodology for analyzing vocal placement focuses on the ways in which voices are made to sound in the final product. This methodology can address the following questions: is the voice located to the right or left of the virtual space? Is the voice reverberated across the virtual space? Since I do not study the recording, mixing, and producing process that has led to the sounds heard on the released piece, the methodology cannot answer questions such as "how reverberant was the space in which the vocal performance was recorded?" or "how was the original performance modified through EQ and other technologies?"

[6] An analyst could choose to adopt a different analytical perspective by asking the studio for pre-mixed copies of the recordings, and interviewing artists, mixing engineers, and producers. While such an approach is outside the scope of this study, it would undoubtedly provide valuable insights on the various mechanisms through which vocal placement is produced.
[7] I will discuss the reasons for this listener-centered analytical approach in Chapter 1.3.

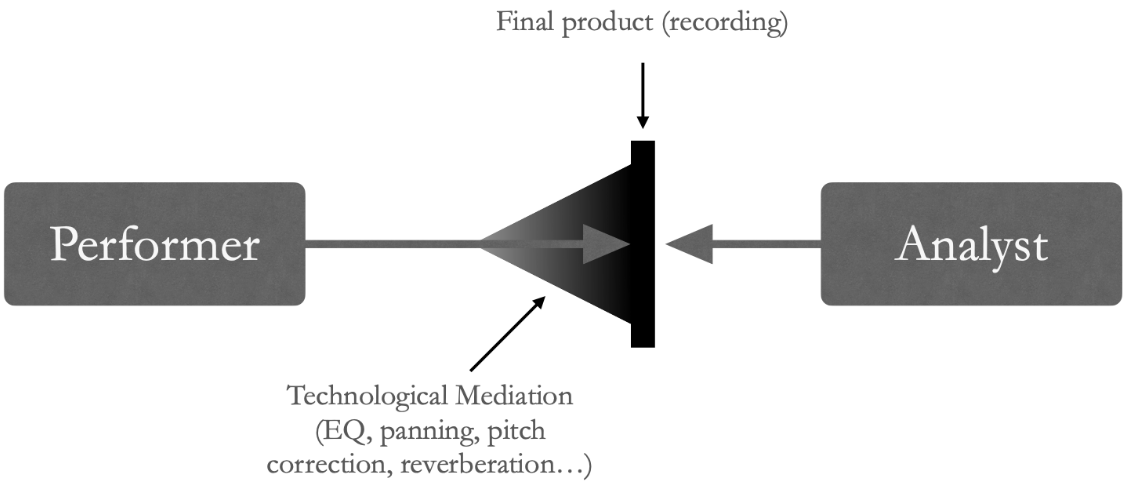

Figure 0.1 Analytical positioning used in the dissertation. The analyst studies—and only has access to—a final product (the recording).

Vocal placement, I argue, is a central musical parameter that contributes to the formation of gendered meanings in popular music. Through this dissertation, I therefore explore how these sonic trends—the reverberated and wide woman's voice, along with the narrow and focused man's voice—contribute to cultural narratives about gender in the popular music industry. My methodology for analyzing vocal placement combines close listening with music information retrieval tools to locate recorded voices in virtual space according to five parameters: width, pitch height, prominence, environment, and layering. Through this multivalent mode of analysis, I create visual depictions of voices' placement within virtual space. By using the methodology to analyze Anglo-American popular music recordings from the late 2000s through the late 2010s, I show how commercially successful songs frequently juxtapose wide and reverberant women's voices with narrow and centered men's voices. This contrast is not dependent on vocal delivery style—singing or rapping—but instead characterizes how men's and women's voices are treated in general. I argue that such contrasting vocal presentations sonically construct and reinforce a gender binary.

By studying vocal placement, I do not wish to suggest that specific producers or mixing engineers purposefully manipulate voices to make statements about gender.[8] Instead, I want to bring attention to the way gendered meanings can be encoded in an often-overlooked aspect of recorded music. Tara Rodgers writes that "ideologies of sound production circulate unmarked for a particular politics of gender" (2010, 15). In the context of vocal placement, there are specific conventions that dictate how different vocalists are represented. My preliminary listening analysis, for instance, indicates that it is common to treat a singing voice in the chorus with reverberation or layering. These conventions are so widespread, however, that audiences familiar with popular music often take them for granted. By analyzing vocal placement in a corpus of songs and highlighting trends in how artists are sonically presented, I aim to bring attention to these unmarked sonic constructions of gender. In *The Race of Sound*, Nina Sun Eidsheim argues that sonic attributes of the voices—such as timbre and pitch—are cultural constructions. She asks: "what are the hallmarks of vocal masculinity? … how do we recognize culturally coded signals of masculinity in a person's voice?" (Eidsheim 2019, 91). In this dissertation, I expand this question to include voices presented in commercial recordings. Through what treatments and manipulations of the voice—echo, reverberation, panning—might gendered meanings be encoded? What is masculinity or femininity made to sound like in the American popular music that reaches the *Billboard* charts?

To begin exploring these questions, I assembled a 113-song corpus featuring all musical collaborations that appeared on the 2008–18 *Billboard* Year-end Hot 100 charts and include at least one male and one female vocalist. I refer to this newly-assembled corpus as the

[8] Examining the extent to which this occurs is outside the scope of this study. Refer to the Conclusion to this dissertation for further discussion of new avenues of research that consider the recording, mixing, and producing process.

Collaborative Song Corpus, hereafter the CS Corpus. By studying this corpus of works in which men's and women's voices are directly juxtaposed within the same song, I can draw conclusions about the ways in which vocal placement is used to sonically differentiate artists according to gender. In "The Monster" (Eminem ft. Rihanna, 2013), for instance, Rihanna's voice takes on an ornamental quality as it echoes in the virtual space, while Eminem's more salient vocals position him as the primary subject of the song.

My primary objective in the corpus study is to locate the sonically engineered sound of gender. As I discuss in Chapter 1, this dissertation approaches gender as a social construction that is not biologically determined. This social construction nonetheless shapes the way in which listeners perceive voices: several studies show that listeners automatically ascribe a gender to individuals based on vocal pitch and timbre (Steinskog 2008; Pernet & Belin 2012; Skuk & Schweinberger 2014; Skuk 2015; Hawkins 2016). Even if gender is a social construction, then, it still shapes the way in which listeners approach recorded voices in popular music. When listening to collaborations on the *Billboard* charts, some listeners would likely assign a label of "man" or "woman" to the voices they hear based on pitch and timbral cues. I am interested in the ways in which vocal placement contributes to this sonic gendering of voices through the spatial differentiation of men's and women's voices. In the corpus study, I therefore categorize vocalists according to their public gender identity at the time of the song's release to study the ways in which vocal placement and gender interact. I identify each artists' gender based on their pronouns and on statements made in interviews, social media, and other venues. This classification process allows me to make statements about how constructed notions of femininity and masculinity are sonically presented through vocal placement while acknowledging the fluidity of gender identity.

In the corpus study, I do not make overarching statements about vocal placement and race, but I do address the intersections of race and gender as they play out in the public personas and sonic representations of individual artists. As such, I understand the link between race and gender as intersectional. I choose, however, not to categorize artists according to race for the corpus study. Matthew D. Morrison discusses the notion of Blacksound (2019), which encapsulates the different formations of "sonic blackface" that are characteristic of American popular music.[9] White and non-Black artists such as rappers Iggy Azalea and G-Eazy or singer Bruno Mars often assume sonic characteristics that implicitly associate them with commodified notions of Blackness. By categorizing all white artists together, for instance, I would ignore the phenomenon of Blacksound. In order to account for this dynamic, I present gender as an overarching framework and address its intersections with race on a case-by-case basis.

In this dissertation, I provide two main contributions to the field of music theory. First, I develop a reproducible methodology for precisely analyzing vocal placement within the virtual space. This non-score-based musical parameter is crucial to the formation of meaning in recorded music, and my proposed method facilitates analytical inquiries into the sonic presentation of voices in popular music. By developing a reproducible methodology for precisely analyzing vocal placement, I align myself with the tradition of challenging the primacy of score-based music analysis (e,g., Cook 2013 and others). The majority of analytical techniques for popular music are designed to address notated parameters such as pitch, harmony, and rhythm and thus begin by reducing the recording to a transcription. Since popular music is generally consumed and distributed via the recorded medium, analytical engagement with this repertoire

[9] See Chapter 6 for a deeper consideration of Morrison's notion of Blacksound (2019) as it relates to vocal placement in North American popular music.

also requires tools that accurately measure, describe, and compare audio-based parameters such as stereo placement, echo, and reverberation. I position this project within an evolving subfield of music studies that uses audio feature extraction and digital methods to analyze recorded music (Devaney 2016; DeMan *et al.* 2017; Hardman forthcoming).

Second, this dissertation explores how vocal placement contributes to gendered meanings in recorded popular music. As explored in Chapter 1, I situate this dissertation within a tradition of feminist music theory. Building upon studies that have established methodologies for analyzing linkages between vocal timbre and gender (Heidemann 2014, 2016; Eidsheim 2019; Malawey 2020), I argue that vocal placement presents another parameter through which gendered meanings are created in music. Through this work, I examine how stereotyped notions of femininities and masculinities are sonically constructed through vocal placement. Additionally, I aim to dismantle those binaries by shedding light on the gendering of voices in popular music, and naming these practices as reductive.

Chapter Outlines

In Chapter 1, I establish a theoretical framework by surveying the subfield of feminist music theory. I position the dissertation within this body of work, which ties the analysis of musical material with considerations of gender. I identify three main components of feminist music theory: (1) a focus on expanding the analytical canon; (2) an emphasis on the creation of analytical tools and methods that allow for new modes of engagement with musical material; and (3) explorations of the relationship between identity and musical analysis. I show how these three components unfold in the dissertation, as I (1) analyze recent popular music; (2) outline a methodology for analyzing vocal placement in virtual space; and (3) study the relationship between vocal placement and gender. The first chapter also serves as a personal reflection on the field of feminist music theory and on my own positionality as an analyst. I contend that more work in feminist music theory could benefit from adopting a framework that considers how race, sexuality, class, and other systems of oppression intersect with gender. Additionally, I propose some ways in which feminist music theory could assume a more inclusive view of gender. Through this discussion, I contextualize my analytical project on vocal placement while pointing toward new avenues of research.

Chapter 2 outlines a methodology for analyzing vocal placement within the recorded virtual space. After Allan Moore and Ruth Dockwray (2010), I depict the virtual space as an empty room in which sound sources are placed. I locate the voice in this empty room according to five parameters: (1) *Width* (the perceived lateral space occupied by the voice); (2) *Pitch Height* (the range of pitches occupied by the voice); (3) *Prominence* (the amplitude of the voice in relationship to other sound sources in the mix); (4) *Environment* (the level of echo and reverberation applied to the voice); and (5) *Layering* (supplementary vocal tracks added to the voice). I provide a measurable way to visually display these parameters within the virtual space. Data on each of the five parameters is obtained through a mixed method of aural analysis and audio feature extraction using source separation algorithm Open-Unmix (Stöter *et al.* 2019), stereo panning visualization software MarPanning (McNally *et al.* 2015), and audio analysis software Sonic Visualiser and its associated VAMP plugins. I provide a complete set of instructions for using the methodology for analyses of recorded music in appendices A and B.

In Chapter 3, I use the methodology outlined in Chapter 2 to analyze vocal placement in two collaborations between Rihanna and Eminem: "Love the Way You Lie" (2010) and "Love the Way You Lie (Part II)" (2010). Additionally, I consider the ways in which vocal placement interacts with vocal timbre, another salient parameter that conveys extra-musical meanings in popular music. Through my analysis, I suggest that Rihanna's vocal performance can be read as representative of a nexus of conflicting emotions in the wake of gendered and domestic violence: anger, fear, loneliness, vulnerability, and doubt. My hearing of the song as rooted in these emotions in based in Rihanna's vocal timbre, and the way that her vocal performance is located within the virtual space. Her vocal placement is wide, reverberant, and often layered, offering a stark contrast with Eminem's narrow, non-reverberated, and focused vocal placement. While Rihanna's vocal placement conveys various emotional states, Eminem's vocal placement expresses anger, frustration, and violence. Finally, I discuss how Rihanna's vocal performance could be seen as a way to avoid gendered and racialized stereotypes that face victims of domestic violence. The analyses in this chapter showcase how the methodology for analyzing vocal placement can be used in close readings of specific songs.

Chapter 4 departs from the close readings of Chapter 3 to study vocal placement in the more general context of twenty-first-century Anglo-American popular music. I briefly survey the history of *Billboard's* ranking algorithms and discuss the gendered templates and personas available to popular artists. Further, I apply the methodology outlined in Chapter 2 to the newly assembled CS Corpus. I provide a descriptive statistical analysis of the resulting vocal placement data to compare how men's and women's voices are sonically presented in recent popular music. My analysis of the *Billboard* chart content using this method provides a new and accurate snapshot of a highly gendered music industry. Throughout the corpus, four of the five vocal placement parameters (width, pitch height, environment, and layering) are used by producers and engineers in contrasting ways when they are applied to men's and women's voices. Women's voices, for instance, are more likely to be mixed as wide and reverberant than those of men. My statistical analysis also considers how formal structure and vocal delivery interact with these vocal placement trends.

In Chapter 5, I conduct a clustering analysis of the vocal placement data in the CS corpus. Using the *k*-means algorithm, which groups similar data points together, I partition the different vocal placements heard in the corpus into four *vocal placement profiles.*[10] These profiles, which are umbrella categories that encompass vocal placements similar to one another, allow me to make general statements about vocal placement trends in the corpus. I show how profiles 1 and 2—which are generally narrow, less reverberant, and less layered—more often characterize men's voices. Profiles 3 and 4—which are wider, more reverberant, and more layered—tend to characterize women's voices. Finally, I examine how different vocal placement profiles tend to be paired together in musical collaborations. Chapters 4 and 5 showcase how the methodology outlined in Chapter 2 can be used for distant readings of vocal placement in a corpus of recorded songs.

Finally, Chapter 6 considers the analyses of vocal placement in Chapters 3, 4, and 5 through the lens of gender. I suggest that Anglo-American popular music can be understood as a gendered soundscape (Järviluoma *et al.* 2012) through which notions of gender are created, maintained, and distributed for broader consumption. Chapter 4 and 5 show that women's voices, often characterized by wide and reverberated vocal placements, are frequently paired with narrow and focused men's voices. The two collaborations between Eminem and Rihanna outlined in Chapter 3, for instance, are examples of this kind of contrasting vocal placement configuration. I argue that these diverging configurations reinforce a gender binary that sonically differentiates men's and women's voices. While this gender binary is socially constructed, and

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[10] The *k*-means algorithm partitions *n* number of observations into *k* clusters. See Müller & Guido (2017, 168).

does not reflect the identities of many individuals, my corpus study shows that it nonetheless shapes the sound of many, if not most, popular music collaborations. In this study, I demonstrate how popular music continually reinscribes this gender binary through vocal placement by presenting men's voices as direct and relatable, and women's voices as ornamental. Finally, I discuss how vocal placements can create sonic stereotypes that evoke notions of "femininity" and "masculinity", independently of the identity of the artist. Through this discussion, I encourage analysts to consider how vocal placement contributes to the formation of gender identity through sound.

Chapter 1 Feminist Music Theory

The goals of this chapter are twofold. First, the chapter sets the theoretical underpinnings for the analytical methodology and case studies outlined in the dissertation. I situate my work in a tradition of feminist music theory, and this chapter allows me to clarify some of the assumptions and objectives that undergird both the methodology for analyzing vocal placement and the subsequent analyses. In section 1.1, I identify three main trends that have characterized the feminist music theory of the past three decades: (1) a focus on expanding the analytical canon; (2) a commitment to the development of new analytical tools; and (3) an emphasis on the relationship between musical analysis and identity. In addition to surveying recent feminist music theoretical literature, I situate my dissertation work within these three trends. Second, the remainder of the chapter consists of a reflection on the subfield of feminist music theory. In section 1.2, I discuss aspects of feminist music theory that could be modified or improved. I contend that much of this analytical literature focuses on the musical lives of white and cisgender women. Then, I reflect on ways through which the subfield of feminist music theory could adopt a more intersectional perspective that also centers an inclusive view of gender.[1] In section 1.3, by drawing on Danielle Sofer's recent critique (2020) of the ways in which studies of gender and sexuality in music theory can further the exclusion of non-male, people of color, and LGBTQIA+[2] individuals in the field of music theory, I reflect on my own positionality as an analyst.

[1] Refer to section 1.2 for a discussion of the term "intersectionality".
[2] The LGBTQIA+ acronym stands for lesbian, gay, bisexual, transgender, queer, intersex, and asexual. Since the list is not inclusive of all non-straight and non-cisgender identities, the + serves as an umbrella under which other terms may be added.

1.1 An Overview of Feminist Music Theory

I situate this dissertation within a tradition of feminist music theory. Broadly construed, this subfield examines issues of gender and sexuality as they relate to musical analysis. Susan McClary's book *Feminine Endings* (1991) is considered a foundational text in feminist music theory, because it was one of the first works to address in depth how gender and sexuality can be used as a lens through which one can examine musical works.[3] In the early 1990s, the journal *Perspectives of New Music* was also instrumental in establishing feminism as a mode of music-analytical inquiry. Contributions by Maus (1993), Cusick (1994a, 1994b), Guck (1994), Kielian-Gilbert (1994), and McClary (1994) consider analytical biases, critique analytical language and discourses, and propose new modes of analysis to examine the ways in which music theory can be enriched by feminist perspectives. The 2001 publication of Ellie Hisama's book *Gendering Musical Modernism* also marks a significant moment in the development of feminist music theory. In addition to providing in-depth studies of the music of three women modernist composers, Hisama explores how musical material can be related to identity. The work of Lori Burns, who addresses the intersections of popular music, gender, and sexuality, has brought feminist music theory to the subfield of popular music analysis. In recent years, authors such as Kate Heidemann (2014, 2016), Lucie Vágnerová (2016), Marc Hannaford (2017), Rachel Lumsden (2017, 2020), Vivian Luong (2017, 2019), Maeve Sterbenz (2017), Amy Cimini (2018), and Danielle Sofer (2020) have continued to explore the way gender, sexuality, and music theory interrelate with one another.

[3] The genealogy established here is meant as a cursory overview of feminist music theory and does not purport to cite all scholars who have contributed to the subfield. Notably, it does not address of the work of several musicologists who have, in the past three decades, established a rich discourse on music, gender, and sexuality. See Wilbourne (2017) for a comprehensive bibliography of gender and sexuality studies in musicology.

I understand feminist music theory as being characterized by three trends (Figure 1.1). First, feminist music theorists are often dedicated to expanding or questioning the analytical canon. Second, they tend to develop new analytical tools and methods meant to elucidate under-discussed aspects of musical material. Finally, feminist music theorists focus on identity, and, more recently, they have begun to at look the intersection of identity—gender, sexuality, race, ethnicity, disability, nationality, class—and musical analysis.[4] I aim to integrate and forefront these three features into my scholarship, and I therefore describe them below to outline the goals and theoretical underpinnings of the dissertation.

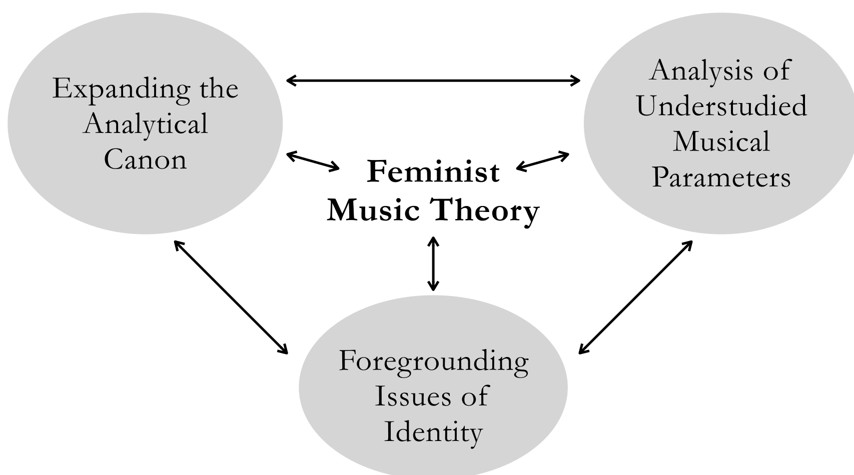

Figure 1.1 Three trends in feminist music theory

1.1.1 Expanding the analytical canon

One of the aims of feminist music theory is the recognition of music composed and performed by women. This recognition has taken the form of published academic work, conferences, and symposia on women performing and composing in Western Art Music

[4] Not all feminist music theories pursue these three goals; moreover, several scholars who pursue these goals may not label themselves as feminist music theorists.

traditions, contemporary music, and popular music. Philip Ewell argues that this privileging of certain composers and theories is part of music theory's white racial frame, a system that elevates the music of white—and generally male—composers at the expense of composers of color and women, while simultaneously obscuring this focus on whiteness and maleness through myths of universality and meritocracy (Ewell 2020). Analyses of music by women in the past thirty years can be read as a push to expand—or dismantle—the music-theoretical analytical canon that privileges the compositions and theories of white men, primarily situated in Austro-German and North American Western Art Music traditions.[5]

The work of music theorist Ellie Hisama has been instrumental in decentering music theory's focus on musical repertory by white men. In the past three decades, she has published at length on the music of women composers and composers of color, many of whom are women. Her 2001 book *Gendering Musical Modernism,* for instance, provides in-depth analyses of the music of American composers Ruth Crawford, Miriam Gideon, and Marion Bauer, through which Hisama ties pitch-related musical parameters to narratives that relate specific biographical events in the life of these three 20th-century composers (Hisama 2001). Hisama has also published on the music of singer-songwriter Joan Armatrading (1999), minimalist composer Julius Eastman (2015), installation artist and filmmaker Isaac Julien (2018), and jazz pianist Geri Allen (2020), highlighting these musicians' artistic contributions to their respective scenes while exploring the ways in which their work has been overlooked in musicological and music-theoretical narratives on popular music, jazz, and contemporary music. Hisama's writings are

[5] Writing in 1993, Fred Maus refers to music theory's mainstream tools and methods as "Schenker and Sets" (Maus 1993, 267). This expression refers to the theories of Heinrich Schenker along with American-style Schenkerian theory, as well as music theories derived from Milton Babbitt and Allen Forte. See Duinker and Léveillé Gauvin (2017) for a more recent survey of the most frequently discussed composers—all white men—in flagship music theory journals.

complemented by an extensive track record in organizing conferences and events on women in music. The 2021 *Unsung Stories* Symposium, for instance, co-organized with composer Zosha Di Castri, highlighted the work of women composers and musicians throughout the history of Columbia University's Computer Music Center. In 2020, she also co-directed *Feed the Fire,* a one-day symposium in honor of Geri Allen. I will return to Hisama's feminist methodologies later in this chapter but highlight here her important contributions in celebrating music outside of music theory's white and male canon.

In addition to Hisama's work, a significant body of music-theoretical scholarship focuses on the works of women composers and musicians.[6] The two *Analytical Essays on Music by Women Composers* collections, edited by Laurel Parsons and Brenda Ravenscroft, feature close analytical readings of music composed by women. The first book, *Concert Music 1960 –2000,* features essays on Ursula Mamlok, Chen Yi, and Kaija Saariaho (2016). The second, *Secular & Sacred Music to 1900,* addresses compositions by Hildegard of Bingen, Élisabeth Jacquet de La Guerre, and Josephine Lang (2018). In addition to these two edited collections, scholarship by Julie Pedneault-Deslauriers on Clara Wieck-Schumann (2017), Susan McClary on Janika Vandervelde (1991), Suzanne Cusick on Fanny Hensel (1994a), and Nancy Rao on Ruth Crawford (1997, 2007), along with a special issue on Chen Yi in *Music Theory Online* (Bain *et al.* 2020), provides a significant body of scholarship on the music of women composing in Western Art Music contexts. Judy Lochhead's book *Reconceiving Structure in Contemporary Music* (2016), additionally, contains in-depth analysis of music by four women composers (Kaijia Saariaho, Sofia Gubaidulina, Stacy Garrop, and Anna Clyne). Lori Burns has published

[6] In addition to published music-theoretical scholarship on music by women, some pedagogical resources aiming to popularize music by women in North American music theory classes are available (e.g., Straus 1993, Murdock *et al.* 2018)

several music analytical studies on women in popular music, including Billie Holiday and Bessie Smith (2005), Tori Amos (Burns and Woods, 2004), PJ Harvey and Björk (Burns *et al.* 2008), Pink and Rihanna (2017), and k. d. lang (1997, 2000). Noriko Manabe has published extensively on protest music, including on the chants at the 2017 Women's March (2019).[7] Finally, Carmel Raz's two video articles on Anne Young (2018a, 2018b) and Rachel Lumsden's article on Oliveria Prescott (2020) have highlighted women's contributions to the history of music theory.[8]

1.1.2 Analysis of understudied musical parameters

In the graduate student-led coalition Project Spectrum's keynote address at the 2020 meeting of the Music Theory of New York State, Alissandra Reed underscored the importance of developing new analytical tools to expand the purview of music theory:

> If you have only ever written about the music of White men, I have to say, I don't blame you, since that is what our field was created to do, and that is what most of its tools were designed for. But it cannot be what sustains our field going forward. It simply can't. We need new tools [...] and the way we make this happen is by making deliberate decisions about what will constitute music theory research at the moment we sit down to do it. (Reed, 2020)

The tools of Western music theory, in other words, are designed for and shaped by the music of white men. The development of Roman numeral analysis, Schenkerian analysis, set theory, formal analysis, and other methodologies commonly taught in North American undergraduate and graduate programs were developed for describing the features of music composed primarily by white men. It therefore follows that a central goal of feminist music theory has been the

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[7] Manabe's analytical work has been instrumental in expanding the music theoretical canon. See for instance her article in *Music Theory Online*'s special issue on Kendrick Lamar (2019) and her publications on Japanese hip-hop (2015).

[8] This list of publications is not exhaustive, and the work of several other feminist music theorists will be outlined later in this chapter.

development of alternative ways of analyzing and theorizing music. In addition to its analytical attention to music outside the analytical canon, feminist music theory is often marked by a focus on the development of new analytical tools and on the study of under-discussed musical parameters.

Several of these new analytical tools center on the body and its role in music theory. In her influential 1994 article "Feminist Theory, Music Theory, and the Mind/Body Problem," Suzanne Cusick calls for a feminist mode of music analysis that considers the role of the composer's, analyst's, and performer's bodies. Her focus on the body is meant as an alternative to music theory's "mind/mind perspective," an analytical practice that "describe the practices of the mind (the composer's choices) for the sake of informing practices of other minds (who will assign meaning to the resulting sounds)" (Cusick 1994a, 16). This mind/mind practice, which is coded as masculine and allows the analyst to present their work as objective knowledge, eschews any serious considerations of the bodies responsible for the music. For Cusick, putting bodies back in the music analytical equation, so to speak, is a feminist act. A consideration of the gestures, sensations, and impressions that arise in musical performance can highlight the ways in which women composers, for instance, may literally perform gender throughout the gestures demanded by their compositions.

Cusick's call for an embodied music theory has served as a starting point for further theorization on the linkages between music and the body. Some studies, while not explicitly stating feminist aims, have further explored the way musical analysis and listening are based in musical performance. Arnie Cox, for instance, proposes a *mimetic hypothesis* that models how music is internalized in the bodies and minds of listeners through a process of covert imitation (Cox 2011, 2016). Kate Heidemann's work on vocal timbre builds on the work Cusick and Cox to propose a body-based method for analyzing vocal timbre (2014, 2016). To describe and analyze the singing voice, she argues, analysts can attend to their sympathetic reactions to vocal performances. In her dissertation work, Heidemann analyzes recorded vocal performances by Aretha Franklin, Gladys Knight, Loretta Lynn, and Dolly Parton, explaining how their voices are markers of gendered subjectivities that intersect with class, race, and nationality (Heidemann 2014). This work squarely fits within a tradition of feminist music theory, as Heidemann uses a new methodology to analyze an under-discussed musical parameter that she relates to the performance of gender.

The work of Victoria Malawey also fits within the embodied feminist music-theoretical tradition. In her 2020 book *A Blaze of Light in Every Word,* Victoria Malawey builds on her previous work on vocality (2007, 2010, 2014) to propose a conceptual framework for analyzing the recorded singing voice. Her goal throughout the book is twofold. First, her analytical model allows her to describe the affective and physiological aspects of recorded performances in detail. Second, she uses the model to highlight the different ways that vocal delivery can evoke "cultural, gender, social, and racial identities" (Malawey 2020, 29). Through this work on the voice, Malawey provides a music theory that focuses on the body and the way it produces sound. Heidemann's and Malawey's work answer Cusick's call for a feminist music theory by providing analysts with tools for describing and engaging with the bodily aspect of music making to decenter the mind/mind game of music analysis.

While I have focused here on analytical methods that engage with voice and embodiment, many authors have recently developed methods for analyzing other under-studied musical parameters such as gesture and timbre. Additional recent music-theoretical studies proposing analytical methods for under-studied musical parameters include Megan Lavengood's (2020) and

Kristi Hardman's (forthcoming) scholarship on vocal and instrumental timbre. A subfield of music theory also theorizes gesture, embodiment, and performance in instrument-specific contexts (Duguay 2019; Momii 2020; Rockwell 2009; De Souza 2017, 2018). While not all these analytical methods have an explicit feminist aim, they all contribute to the feminist project of expanding the purview of music-theoretical inquiry by providing tools for analyzing under-studied musical parameters like balance or instrumental gesture.

1.1.3 Foregrounding issues of identity

Finally, feminist theory links musical analysis and aspects of identity. In her reflection on feminist music theory, Hisama writes that identity informs her own analytical practice:

> Situating compositions within their historical and social contexts, I perform close readings that recognize the impact of the composer's gender, politics, and social views on the "music itself"; relate each piece to specific incidents in the composer's life that occurred at roughly the time of composition; and link narratives in the pieces to the composer's identity as projected in her writings and in reflections by contemporaries. (Hisama 2000, 1288)

Hisama first points out that the identity of a *composer* or *musician* can inform an analysis. Their life and identity can be used as a lens through which an analyst may approach a piece of music. In *Gendering Musical Modernism,* for instance, Hisama ties events in composer Ruth Crawford's life to musical narratives in Crawford's compositions (2001). This approach, in which an analyst considers the composer's or musician's identity while crafting their analysis, is an especially common feature of feminist music theory. Maeve Sterbenz, for instance, examines the link between identity and movement-music interactions in Tyler, The Creator's music videos for *Yonkers.* Sterbenz reads the rapper's body language in light of "racist and sexist systems of oppression that often demand brutishness and arrogance of black masculinity" (Sterbenz 2017). Mary Lee Greitzer is also inspired by musicians' lives for her analysis of vocal performances by

Tori Amos and Lydia Lunch. By carefully analyzing their vocal performances in "Me and a Gun" and "Daddy Dearest," respectively, she illustrates how both artists use vocal timbre to communicate their responses to sexual trauma (Greitzer 2013). Other articles that tie an artists' identity—gender and sexuality, in particular—with musical material include Lumsden (2017), Hannaford (2017), Burns (2008), Burns and Lafrance (2017), and Hubbs (2015). Such studies are not built on the essentialist premise that some music contains "feminine" or "masculine" aspects because of the bodies their composers or performers inhabit. Rather, they seek to propose a particular way of hearing a musical work that considers the composer's or musician's lives as it is shaped by gender.

Additionally, Hisama writes that the identity of the *analyst* can have an impact on the process of analysis: "My analyses, moreover, do not speak with a disembodied authority; they are marked by my own identity" (Hisama 2000, 1288). She speaks of how her identity as a woman of Asian descent informs her analytical approach toward a John Zorn album, adorned with violent, racist, and misogynist images (Hisama 1993, 2004). The approach outlined here by Hisama shifts the analytical focus from the composer to explore how one's identity affects their musical analysis. In such cases, feminist music theory analyzes the analysts' own identity.[9] Early work on the ways in which the analysts' identity shapes their relationship with music include Cusick's essay on lesbian aesthetics in musicology (1994b), Marion Guck's work on music loving (1996), and Fred Maus's study of masculine discourses in music theory (1993). In her

[9] An article by Sumanth Gopinath (2009), while not explicitly related to issues of gender, nonetheless exemplifies a discussion of the relationship between identity, research, and the way this research is received. Gopinath writes candidly about his experience taking comprehensive examinations during his Ph.D. in music theory at Yale University in 2000. He relates his experience writing a Marxist-feminist analysis of a Brahms lied, and the subsequent backlash he faced from his examination committee. Gopinath uses his experience as a springboard for discussing academic precarity, notions of diversity in the academy, and how scholars' "ethno-racial identity and research seem to be related in complex, not always easy-to-discern ways" (Gopinath 2009, 69).

dissertation, Vivian Luong experiments with auto-ethnography in conducting a Schenkerian analysis of J. S. Bach's prelude in B-flat minor, BWV 891 (Luong 2019). She documents the emotions that arise as she produces a Schenkerian sketch of the piece, along with the material conditions under which she is analyzing. She describes the childhood memories that arise when she touches the piano keyboard, her breathing patterns, the pages she printed out and the way they lie on the music stand, her ruler, paper, and manuscript paper, and her posture as she hunches over her voice-leading graph. This discussion allows her to explicitly tie her lived experience with her analytical practice. For Luong, this auto-ethnography is a feminist mode of analysis that allows her to explore an ethics of analysis that centers music loving. By analyzing the relationship between their own identity and music analysis, feminist music theorists therefore do away with the myth of objectivity to instead center how individual experience impacts knowledge formation.

1.1.4 Feminist music theory throughout the dissertation

The dissertation contributes to the three trends highlighted above.

Expanding the Analytical Canon

First, one of my overarching goals throughout this dissertation is to contribute to scholarship on music by women by highlighting and analyzing commercial popular music after 2000. Analyses of North American popular music are frequent in music theory, with several recent works on rock, indie, hip-hop, and R&B, among other genres.[10] The dissertation also complements work by Asaf Peres (2016) and Alyssa Barna (2019, 2020), who focus on "Top 40"

[10] The past decade has seen a sharp increase in music-theoretical publications on hip-hop, which are often published by white men and rarely address the music of women artists. Notable exceptions include Manabe's previously cited works, Hanisha Kulothparan's analyses of flow in Nicki Minaj's music (2021), and Jinny Park's article on rhyming and identity in Korean hip-hop (2021).

music in the twenty-first century. In Chapters 2, 3, and 5, the music of Rihanna, one of the best-selling popular musicians of the twenty-first century, serves as a recurring motif. By paying close analytical attention to her vocal placement and vocal timbre, I hope to contribute to the beginning of a music-analytical discourse on an artist that has been virtually ignored in academic music theory.[11]

Analysis of Understudied Musical Parameters

Second, I provide a new analytical tool for engaging with recorded music. Vocal placement, which is an underdiscussed musical parameter, is crucial to the formation of meaning in recorded music. My proposed method facilitates analytical inquiries into the sonic depiction of voices in popular music. As noted above, most analytical techniques for popular music are designed to address notated parameters such as pitch, harmony, and rhythm. Since popular music is generally consumed and distributed via the recorded medium, however, analytical engagement with this repertoire requires tools that accurately measure audio-based parameters such as stereo placement, echo, and reverberation. Through the methodology, I challenge the primacy of score-based music analysis. I envision this methodology as a tool for feminist music theory that will enable analysts to explore new modes of engagement with recorded music.

The methodology proposed in Chapter 2 allows me to examine how vocal placement contributes to gendered meanings in recorded popular music. My decision to study virtual space and its relationship to gender builds on the work of several authors addressing the gendered implications of other aspects of vocal mediation. In music studies, specifically, recent work has focused on the pitch-based modifications applied to voices. Catherine Provenzano argues that the

[11] In addition to work by Lori Burns (2017) and Johanna Devaney (2020), I am not aware of any published studies by music theorists that provide in-depth analyses of Rihanna's music. As will be shown in Chapter 3, a significant amount of literature on Rihanna exists in other academic fields but is rarely cited in music-analytical contexts.

widespread use of pitch correction in recorded music is tantamount to a type of control, in which mostly male producers control the excesses of the emotional female voice (Provenzano 2019). The use of Auto-Tune is also addressed in work by Dickinson (2001), Young (2015), and Brøvig-Hanssen and Danielsen (2016). As I discuss in Chapter 2, other authors propose ways to link virtual space with a singer's identity. This dissertation posits that vocal placement, a central parameter in popular music, allows for a feminist music theory that examines how gender is sonically depicted in popular music.

Additionally, the dissertation expands the purview of feminist music theory by exploring modes of analysis that contrast with the tradition of close readings of individual pieces. In Chapters 4 and 5, I depart from the study of individual musical works to propose a corpus study of vocal placement in sung collaborations on the *Billboard* charts. The dissertation therefore exemplifies how corpus studies can be used as a tool for feminist music analysis. I blend feminist music analysis with practices from data science that allow me to generalize about a larger set of data. This juxtaposition is unusual, since feminist music theory usually relies on close analytical readings of musical works. Through the corpus study, I aim to show how positivist methods such as the ones used in this dissertation can be used as a tool for highlighting sonic trends that relate to gender identity.[12]

Foregrounding Issues of Identity

Third, the dissertation explores the relationship between identity and music. I situate Chapter 3, which addresses Rihanna's vocal performances in "Love the Way You Lie" and "Love the Way You Lie (Part II)," within this trend of feminist music theory. I propose a hearing

[12] Refer to the conclusion to this dissertation for a reflection on the politics of analytical tools that take an extractive and categorizing approach to musical material.

of Rihanna's vocal timbre and vocal placement that captures complex and contrasting responses to gendered violence. While the dissertation does not contain auto-ethnographic vignettes like the ones offered by Gopinath and Luong, the goal of examining my positionality as an analyst was a central concern in my writing process.[13] Chapter 3 focuses on my own response to Rihanna's vocal performances, and on the ways in which my own identity may inform my experience of the piece. By providing analyses that explicitly center my own musical experience, I aim to avoid the myth of objectivity that can surround music-theoretical studies. Finally, in both the current Chapter and in the Conclusion, I reflect in more detail on my own positionality within the field of music theory.[14]

1.2 Feminist Music Theory, Intersectionality, and the Gender Binary

Most of the feminist music theory cited in the above discussion focuses on the music, theories, and thoughts of white and cisgender women. In this section, I reflect on the ways in which feminist music theory could be developed to be more intersectional, resulting in a field of study that does not exclusively center on white women and their perspectives. Legal scholar Kimberlé Crenshaw coined the term *intersectionality* in reference to analytical frameworks that consider the new forms of oppression caused by interlocking systems of dominance (Crenshaw

[13] I experienced a considerable amount of difficulty when writing about my own listening experience. The discomfort I felt was shaped by my training in music theory, which has accustomed me to taking on an objective tone and providing definite "facts" about music. Vivian Luong (2019) and Mary Lee Greitzer (2013) also write about the discomfort they experienced in making apparent their affective response to music. Luong (2019, 81) writes of the "pang of recognition" she felt upon reading Mary Lee Greitzer's assertion that her expectation to provide a unifying, seemingly objective analytical narrative is "shaped […] by the norms of music-analytical discourse as I've internalized them" (Greitzer 2013, 108).

[14] See section 1.3 for a reflection on citational ethics, education, and my positionality as a white woman engaging in music analysis. See the Conclusion of the dissertation for further discussions on whiteness, feminism, and musical analysis.

1989, 1991).[15] An intersectional perspective accounts for the way women of color's lived experiences, for instance, are shaped by both race *and* gender.[16] These structures overlap to create new forms of oppression that are more than the sum of their parts, that cannot be reduced to race *or* gender. Some of the feminist music theoretical literature outlined above adopts an intersectional perspective. The work of Ellie Hisama, Maeve Sterbenz, and Danielle Sofer, to name only a few, explicitly centers the ways in which gender and race intersect to affect musicians', composers', and analysts' lived experience.

In discussions of music composed and/or performed by white women, race is often left undiscussed, reinforcing white womanhood as a hegemonic identity that is depicted as neutral or unmarked (Rowe 2008; Deliovsky 2008, 2010; Butler 2013). In the section that follows, I explore some of the reasons responsible for this focus on white womanhood, and outline some of the ways in which feminist music theory could take on a more explicitly intersectional perspectives that centers the music, analyses, and compositions of women of color. In doing so, I do not intend to disregard the music theorists who *do* adopt intersectional analytical frameworks, but I instead aim to point toward new avenues of research that could be further explored as the field of feminist music theory develops. In the previous discussion, I have exclusively focused on issues of race and gender, but other systems of oppression such as sexuality, class, disability, and nationality can and should also be considered.[17]

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[15] As anthropologists Alyssa A.L. James and Brendane Tynes note, the term "intersectional" is sometimes used colloquially to refer to individuals with more than one marginalized identity. They point out that this use of the term incorrectly conveys Crenshaw's theorization. Intersectionality is not an identity, but an analytical framework that considers the ways in which structures of oppression converge (zorasdaughters, 2021).

[16] As will be explained below, the term "gender" is used throughout this dissertation to refer to socially constructed categories such as "man" and "woman." While gender and sexuality are often discussed together, they should not be conflated.

[17] Further studies on music and disability would be crucial in expanding the purview of feminist music theory. The subfield of music and disability also focuses on identity and embodiment, often providing close readings of

Despite the significant advances in furthering gender equality in music analysis made by the scholarship above, it is important to name and interrogate the whiteness of feminist music theory. While an in-depth exploration of the ways in which feminist music theory can replicate and further entrench music theory's white racial frame is outside the purview of this dissertation, I offer here a few preliminary thoughts with the hopes of exploring the issue in more depth in future work. First, most of the authors and composers named above are white. In line with the white majority comprising the members of the Society for Music Theory, most of the women studying and teaching music theory in Canadian and American institutions—often with the goal of making the field a more equitable place in terms of gender—are white.[18] As a result, the perspectives of white women—such as myself—are overrepresented in feminist music-theoretical inquiry. Since the field of North American music theory privileges Western art music theory and practice, many individuals who enter the field are solely trained to analyze music in this tradition. Music theorists wishing to expand the analytical canon may therefore focus their work on the music of (virtually always) white women composing in genres they are already equipped to discuss—Clara Wieck-Schumann, Fanny Hensel, Josephine Lang, and others. Of course, I believe it is extremely important to analyze and highlight the musical contributions of composers like Wieck-Schumann, Hensel, or Lang. I do think, however, that a feminist music theorist project should examine race and gender—among other systems of oppression—as they

individual pieces with the goal of highlighting narratives relating to composers and performers. Music-theoretical work lying at the intersection of feminism, gender studies, and disability include Iverson (2016) and Kielian-Gilbert (2016).

[18] The 2019 Annual Report on Membership Demographics of The Society for Music Theory indicates that its members are mostly men (63.9%), followed by women, (33.2%), trans/transgender members (0.3%), and members who selected another identity (0.3%). 83.7% of the Society's members are white, 7% are Asian/Pacific Islanders, 3.9% prefer not to disclose their race, 2.7% are Hispanic, 1.5% are Mixed Race, 1% are Black, 0.3% indicate an unknown Race/Ethnicity, and 0.1% are Native American. Strikingly, the Society does not report data that considers both gender *and* race. While this lack of transparency prevents me from making a precise statement about the percentage of non-male SMT members who are white, the statistics on gender and race/ethnicity suggest that non-male members of color are starkly underrepresented (Brown, 2019).

intersect. Music theories by and about women of color exist, within and beyond music theory journals and publications, but they are often not cited. A telling example is outlined by Loren Kajikawa, who points to the exclusion and erasure of Black feminist scholar Tricia Rose and her analytical work on hip-hop within music-theoretical discourses on rap flow.[19] Exclusionary citational practices that uphold the works of white men and women often ensure that music theoretical studies, even if they center the music of women of color, continue to center white analytical perspectives.[20] As a result, music theory—including feminist music theory—can take on a veneer of progress while replicating the dynamics of the white racial frame (Ewell 2020).

In addition to ensuring that the work of women of color is given due credit, the field of music theory should also further examine its own whiteness. Feminist music theorists studying music composed and performed by white women, for instance, can take the opportunity to critically examine the construction of white womanhood as an identity. Music theoretical studies of Wieck-Schumann, Hensel, or Lang, for instance, instead of ignoring issues of race, could explore how notions of whiteness and womanhood have shaped the lives of these composers. An intersectional feminist music theory, which would (1) give due credit to the perspectives of women of color and (2) critically study whiteness rather than not mentioning it—all while ensuring that the field can both invite and retain scholars of color, women, trans-feminine, and

[19] Loren Kajikawa argues that the recent increase in hip-hop music scholarship in North American music theory paradoxically reinforces the field's white racial frame. This occurs because (1) music theory's focus on "the music itself" allows analysts to ignore the social, political, and historical factors relevant to hip-hop politics; (2) music theorists establish a citational chain that privileges the analytical work of white men while excluding the voices of Black hip-hop scholars; and (3) North-American M.A. and Ph.D. programs in music theory privilege students with expertise in Western Classical Music, ensuring that "earning the privilege to write about Black music as a music theorist or musicologist paradoxically requires possessing greater familiarity with the music and ideas of white men" (Kajikawa 2020, 51).

[20] Consider for instance a recent article on collaborative rap flow in flagship journal *Music Theory Online* (Komaniecki 2017). The article analyzes the music of Nicki Minaj, among others, but cites (1) no women; and (2) a majority of white men.

LGBTQIA+ scholars—could be instrumental in dismantling the music theory's analytical and musical canon.

In addition to centering discussions of race, feminist music theory could further engage with social constructions of sex, gender, and the way they intersect with music analysis. Feminist music theory has generally focused on binary understandings of sex and gender, often exemplifying a feminism that takes for granted the categories of man and woman. Additionally, the works cited in the first section of this dissertation feature a near-constant focus on the music of cisgender musicians and composers. I summarize here key notions on sex and gender, with the goal of suggesting potential avenues for expanding feminist music theory.

First, there are important differences between the concepts of *sex* and *gender* and a variety of ways in which people make those distinctions. One approach asserts that sex should refer to biological differences (i.e., male and female) while gender should refer to social and cultural differences (i.e., men and women) (West and Zimmerman 1987, Muehlenhard and Peterson 2011). The notion of gender outlined here includes concepts such as birth-assigned gender category (i.e., I was categorized as female—and as a woman—at birth), current gender identity (i.e., I identify as a woman), and social presentation (i.e., I dress, speak, and act in a way that makes others read me as a woman). Sharp distinctions between maleness and femaleness, as well as between manhood and womanhood, are widespread and occupy a prevalent role in the way gender is viewed both in popular culture and various academic fields (Hyde *et al.* 2019). The view that sex and gender are both binary frameworks, however, is inaccurate and does not encapsulate the lived reality of several individuals. First, the male/female notion of sex does not account for biological variations in the human body, for which sex is a spectrum rather than a binary. A dimorphic view of sex erases intersex people, who are frequently encouraged to take hormones or undergo surgery to better "fit" into the male/female binary.[21] Activists, writers, and scholars have written about intersex identity, but a binary notion of sex too often remains assumed (Fausto-Sterling 1993, 2000; Hird 2000; Reis 2007; Dreger and Herndon 2009; Holmes 2016). From this binary notion of sex arises the binary notion of gender (man/woman), which is frequently assumed to directly correlate to someone's sex. Research nonetheless shows that the binary view of gender inaccurately reflects the way gender operates as a spectrum, network, or constellation of identities (Haynes and McKenna 2001; Bornstein 2016; Hyde *et al.* 2019).[22] A more precise view of gender encompasses a range of identities such as transgender, agender, non-binary, genderqueer, two-spirit, and genderfluid. Trans* categories of gender, as Laurel Westbrook argues, can trouble and make us rethink this assumed link between sex and assigned gender identity (Westbrook 2016, 33).[23]

Feminist music-theoretical work could further analyze music by trans, genderqueer, and nonbinary musicians, while also further exploring the ways in which trans and queer methodologies may create a music-analytical practice that does not exclusively rely on binary conceptions of gender identity. Such an analytical practice can for instance be found in the work of Victoria Malawey (2020), whose recent book considers among other topics the physicality of the voice of trans and non-binary singers of Anglophone popular music. Other authors have also

[21] An approximate 1 to 2% of the population with "statistically atypical genitals or internal reproductive structures." (Hyde *et al.* 2015, 172.)

[22] The notion of a gender spectrum can be problematized because it implies that gender identities only exist in relationship to—and at a certain distance from—the "man" and "woman" poles of a spectrum. Joelle Ruby Ryan writes that "The desire is to reclaim trans* as a way that is not reducible to transsexuals or medically transitioning people firmly locatable within the binary gender system. Under the wide spectrum of gender-diverse, gender-expansive, and gender-variant people […] We need to be inclusive of non-binary gender identities and not only of those who are legible within the binary" (Ryan 2016, 133).

[23] The term Trans* is used here by Westbrook as an umbrella term for various trans identities. In reference to search engine convention, the asterisk serves as a wildcard that expands the boundaries of the term to refer to identities such as—but not limited to—genderqueer, non-binary, agender, transmasculine, transfeminine, transgender, and genderfluid. The term has sometimes been criticized for being redundant, since "trans" and "transgender" are already umbrella terms (Garvin 2019; SJWiki 2017).

considered the intersection of voice, gender, and technology in the work of trans singers (Bell 2016, Blanchard 2018). Music theorists could also draw on the significant body of literature on queer and trans musicology (Brett *et al.* 2006; Whiteley and Rycenga 2006; Peraino and Cusick 2013; Baitz 2018; Välimäki 2019; Maus and Whiteley 2020; Moon 2020).

Throughout this dissertation, I use the term "gender," along with the terms "man" and "woman," to refer to the socially constructed categories of gender and the individuals who identify with them. I study the *Billboard* charts as a soundscape in which women's and men's voices are presented in particular ways. Despite my focus on the binary of man/woman, I do not mean to imply that gender is binary. Rather, I argue that popular understandings of gender as a binary are upheld and distributed through commercial music hits that attain status on the *Billboard* charts. I understand the identity categories of "man" and "woman" as produced socio-culturally, and that this binary is reified through the sound of popular music. Vocal placement in popular music is one of the mechanisms through which this binary is sonically constructed. While outside the current purview of this dissertation, the methodology outlined here could be used to explore the ways in which many artists play with, deconstruct, and refute the gender binary so often upheld in popular music contexts.[24]

[24] For intersectionality and gender inclusivity to be at the forefront of feminist music theoretical inquiry, the very definition of music theory may need to be re-examined and expanded. What counts as music theory? Does it have to be published in one of the flagship music theory journals? Does it have to be written by a Ph.D. holding music theorist associated with higher education in North America or Europe? Several scholars have recently addressed these questions and critiqued the exclusionary nature of North American music theory. Toru Momii (2021), for instance, discusses the institutional power structures that privilege the work of Euroamerican white men as primary producers of music theoretical knowledge, calling for an intercultural analysis that not only studies non-Western music but also takes seriously the intellectual contributions from non-Western musicians and theorists. Clifton Boyd (2020) proposes the notion of "vernacular music theory" to account for music theoretical traditions created outside of academic circles. Finally, Marc Hannaford (2021) draws on critical race theory, Black studies, and postcolonial studies to outline the concept of "fugitive music theory," which refers to a network of Black music theorists and theories that reassess the contexts and activities that count as musical analysis. Intersectional feminist music analyses could draw on this work and others to rethink and redo the field of music theory.

1.3 Doing Feminist Music Theory: A Personal Reflection

In "Specters of Sex" (2020), Danielle Sofer surveys the development of sexual discourses in music theory that occurred in the past thirty years. Despite the clear development of a sexually-oriented music theory that purports to be conscious of racialized, gendered, and sexualized difference, Sofer wonders why the field of music theory has been unable to compel many of its members who are minoritized in terms of gender, race, and sexuality to "stick around" (Sofer 2020, 33). In other words, the growth of a music-theoretical discourse focused on issues of gender, race, and sexuality—encompassing the feminist music theory outlined above—has failed to result in an academic field that truly welcomes gendered, racial, and sexualized difference. Sofer argues that music-theoretical discourses on gender and sexuality can in fact erase the perspectives of several minoritized members of academic societies such as the Society for Music Theory, while purporting to be mindful of their lived experiences.[25] Throughout the article, they encourage analysts to engage in music-theoretical work that productively considers the perspectives of women, trans-feminine people, and other members of the LGBTQIA+ community.

[25] Sofer identifies several reasons for this failure. First, they critically examine work by Maus (1993) and Lee (2020) that, under the guise of theorizing a queer music-theoretical and analytical experience, nonetheless center the perspective of (white) cisgender men without theorizing how women, trans-feminine people, and other members of the LGBTQIA+ community may fit within this theory. These works therefore contribute to furthering dynamics of exclusion by ignoring perspectives outside of their authors' lived experiences. Second, Sofer explains how some theories of musical "embodiment"—music theories that aim to theorize from the body—become engaged only in a *metaphorical* embodiment that continues to ignore the real bodies of individuals who are marginalized within music theory. The bodies under discussion are implicitly assumed to by white, male, heterosexual, and cisgender, often serving to professionally elevate the author without requiring them to question their own positionality and the way it informs their analyses. Finally, they critique work that aims to "diversify" the field of music theory by analyzing music by women, women of color, and people of color only as sound without centering the perspectives (i.e., academic work) of marginalized scholars. This type of work considers its public to be a majoritarian audience, rather than the minoritized perspectives it apparently seeks to center.

First, Sofer compels scholars to examine their own citational practice to amplify scholarly and musical work by individuals who are marginalized within music studies. Second, they encourage scholars to reflect on their own positionality to consider how their own identity shapes analysis. Finally, they encourage theorists to rethink their intended audience. Music theories are technologies, they argue, and techniques have users. Music theories often implicitly assume a white, cisgender, and heterosexual man as its user. If women, for instance, remain *objects of studies* as opposed to *users* of musical theories, the problem of exclusion persists. Sofer writes: “If instead we explicitly name women—who may also be black scholars, scholars from Asia or the Global South, and/or members of the LGBTQIA+ community—as part of the users of our theories, our music-theoretical objectives may very well change” (Sofer 2020, 56). Through their survey of recent music-theoretical work that center issues of sexuality, Sofer encourages music theorists to engage in a more ethical type of study that centers the knowledge and musical experience of individuals whose perspectives have been routinely ignored.

Encouraged by Sofer’s invitation to reflect on my own analytical practice, the remaining portion of this chapter offers a personal reflection on my experience writing this dissertation. By providing this reflection, I aim to make clear my own positionality and the way it impacts the analyses outlined in subsequent chapters. The issue of citational practice raised by Sofer, for instance, was an ever-present focus as I wrote. As a music theory graduate student at North American institutions, I was trained to understand and cite a specific—and often limited—group of music theorists. This group of theorists consists almost exclusively of white men and of a few white women. Sara Ahmed writes about the way in which these chains of citations are perpetuated: “you become a theorist by citing other theorists that cite other theorists” (Ahmed 2017, 8). Bodies of work, authors, and modes of analysis are given legitimacy through repeated citation, in turn granting legitimacy to the author who does the citing. Throughout this dissertation, I consciously aim to craft chains of citation that depart from those that solely focus on the thoughts and ideas of white men. I am inspired by Ahmed's assertion that "citation is how we acknowledge our debt to those who came before; those who helped us find our way when the way was obscured because we deviated from the paths we were told to follow" (Ahmed 2017, 15–16). The current chapter, for instance, establishes a genealogy of feminist music theorists. By citing these authors, I aim to acknowledge the feminist scholars who enabled my current work by making its central questions legible to the field of music theory. In other sections of the dissertation, I build on the work of scholars who operate outside the established boundaries of music theory (i.e., authors that do not exclusively, or at all, publish in the Society for Music Theory's flagship journals or have doctoral degrees in music theory). I draw for instance from texts in musicology, gender studies, and music information retrieval.

Sofer's exhortation to consider the users of music theory is instrumental to the way I approach aspects of this dissertation. First, the methodology for analyzing vocal placement in virtual space outlined in Chapter 2 relies solely on free and open-access tools. Analysts interested in using the methodology are therefore not required to purchase software. Second, when outlining the framework and methodology for analyzing vocal placement in virtual space, I define every technical term related to my computational analysis. When I began familiarizing myself with source separation and other aspects of audio feature extraction, I experienced a steep learning curve due to the significant number of technical terms in the academic literature. To make the text more accessible for readers who do not have technical training in music information retrieval, I wrote the text with sufficient explanation so that a music scholar at any stage of study wishing to analyze vocal placement could understand and apply my methodology.

Additionally, my decision to adopt a listener-centric approach for the analysis of vocal placement—one that does not directly consider the recording, mixing, and producing process—relates to my desire to create accessible analytical tools. The analyst needs no access to a recording studio or materials that are rare, difficult, or expensive to obtain. My decision to analyze from the listener's perspective is consciously made to even the playing field and create feminist solidarity by making the analytical method more readily available.

Finally, Sofer's article also invites me to reflect on my own experience and positionality as I engage in music analysis. I approach the music-theoretical work in this dissertation, for instance, from a particular perspective shaped by my education. Trained as a pianist, I completed a B.Mus. and M.A. in the study of music in the Western art canon. As a doctoral student in music theory, I was trained to analyze music in a goal-oriented manner, using defined tools and methods to extracts tangible results and conclusions from musical material. This analytical mode is showcased, for instance, in the methodology I outline in Chapter 2 and the corpus study described in Chapters 4 and 5. Moreover, my approach to the post-2000 popular music analyzed throughout the dissertation is shaped by my relationship to this music. I enjoy, listen to, and teach this repertoire every day. My perspective, however, is ultimately limited to the one of a listener/analyst. I do not have significant experience performing, composing, or producing the type of music under study in this dissertation. As such, my approach to these songs is listening-based and therefore different from that of a recording artist, producer, or mixing engineer. The analyses outlined throughout the dissertation are meant as documentation of my own listening experience. I do not purport to be describing a universal way to listen to the songs under study, nor am I trying to prescribe specific hearings. In Chapter 3, for instance, I aim to provide an embodied analysis of "Love the Way you Lie" that explicitly considers my own experience as opposed to the experience of an unnamed, seemingly "objective" listener. Throughout the dissertation, I aim to make visible my own perceptions, biases, and thoughts, to examine how my identity as a listener shapes the meaning of the songs I analyze.

In *The Race of Sound* (2019), Nina Sun Eidsheim studies how listeners rely on pre-existing expectations and stereotypes to make assumptions about a vocalist's race. She encourages her readers to examine their listening practices so that they will be better attuned to the biases, expectations, and assumptions they make about the way others do or should sound. Throughout the dissertation, I aim to bring attention to the biases that shape my music analytical practice. More specifically, the way I approach music is shaped by my positionality as a white woman. The meanings I perceive when I listen to music and analyze it arise from my own identity, ideas, and received cultural narratives about race and gender.[26] The analytical lens through which I write about music, in other words, is shaped by my own race and gender. To the extent to which it is possible, I aim to make these biases transparent. At different moments in the dissertation, I therefore bring attention to my own identity and the ways in which it may shape particular hearings, statements, or analyses.[27]

In this chapter, I have outlined a brief genealogy of feminist music theory and have identified three trends that characterize the subfield: (1) a desire to expand the music-analytical canon; (2) a focus on the creation of new analytical tools and methods; and (3) a consideration of the ways in which musical analysis interacts with the identity of the composer, musician, and/or analyst. This dissertation follows these three trends by (1) analyzing recent popular music, often

[26] Kate Heidemann writes that since white middle-class listeners (such as myself) are often the target audience in the entertainment industry and popular media, the way they perceive meaning influences cultural narratives about identity (Heidemann 2014, 30).
[27] In the Conclusion to the dissertation, I further explore the racial power dynamics at play in my musical analyses.

performed by women; (2) proposing a new analytical method for the study of vocal placement in virtual space; and (3) providing close and distant readings of vocal placement as it relates to gender. This chapter has also provided a reflection on the ways in which the subfield of feminist music theory as a whole could draw on existing work—both within and outside the boundaries of feminist music theory—on the intersections of race, gender, and other systems of oppression. Additionally, I have proposed that feminist music theory should depart from the binary notions of gender and sex it often adopts. Finally, I have reflected on my own experience conducting musical analyses with feminist aims, especially as it relates to (1) citational practice; (2) intended audience; and (3) my own positionality as an analyst. Through these discussions, I aim to make clear the theoretical underpinnings and assumptions that undergird the remainder of this dissertation.

Chapters 2 through 5 will explore the way vocal placement operates in recent American popular music. I will return to the topic of feminist music theory in Chapter 6, which will revisit the analyses presented in this dissertation through the lens of gender.

Chapter 2 Vocal Placement in Virtual Space

Put on your headphones and listen to Eminem's "The Monster." [1] Rihanna, the featured artist, opens the song with a chorus:

> *I'm friends with the monster that's under my bed*
> *Get along with the voices inside of my head*
> *You're trying to save me, stop holding your breath*
> *And you think I'm crazy, yeah, you think I'm crazy*

Her voice immediately assumes a wide physical presence as it fills the space created around you by your headphones. Only supported by an understated synthesizer, Rihanna seems to sing in a large room across which every word is reverberated. Listen to the way echoes of "head" and "bed" are disseminated within this space: a first echo emerges from your left headphone, before bouncing toward the right. As the synthesizer crescendos, the first chorus ends with Rihanna's utterance of the word "crazy." Even before its echo fully tapers off, Eminem enters with the first verse. The reverberant space evoked by Rihanna's voice abruptly disappears. Accompanied by both the synthesizer and percussion, Eminem's voice is centered, focused, and distinctly non-reverberated. Within the song's first thirty seconds, you have been sonically introduced to Rihanna and Eminem. The singer's voice reverberates across a wide landscape, while the rapper's voice remains consistently focused.

Upon listening to "The Monster," you are perceiving a virtual space—an imaginary physical location evoked by the manipulation of reverberation, stereo placement, and other sonic parameters. Various cues in the recording contribute to your impression of a place in which you,

[1] Released in 2013 on *The Marshall Mathers LP 2,* the track is the fourth collaboration between Eminem and Rihanna, following "Love the Way You Lie" Parts 1 and 2 (2010) and "Numb" (2012).

Rihanna, and Eminem are located. According to Eric Clarke, "listeners at home hearing the size of a recorded space or position of a voice are detecting the attributes of a *virtual space*—a space specified by the same perceptual attributes as a real space, but which is not physically present at the time" (Clarke 2013, 95, emphasis mine). The virtual spaces described by Clarke are an important parameter through which listeners experience recorded music. These spaces shape the ways listeners perceive and relate to the recorded sound sources. A specific performance—once manipulated by various technologies in a recording studio—might be positioned in a virtual space that evokes a large concert hall, an intimate setting, or an otherworldly space. The placement of sound sources within this space is one of the musical parameters through which listeners ascribe cultural meanings to popular music.

It is important to note that virtual spaces do not represent real spaces but are the product of a series of technical decisions to represent voices and sounds in a particular way. Before reaching your ears, Rihanna and Eminem's original performances in the recording studio have been mediated by several effects—added reverberation, panning, EQ, compression. In other words, the virtual space heard in "The Monster" may or may not reflect the physical location in which Eminem and Rihanna were recorded. Virtual spaces are not accidental: they are carefully crafted, malleable, and as integral a part of the creative product as pitch, rhythm, and form. Zagorski-Thomas writes that a sound engineer can "guide us toward hearing in a particular way," asserting that record production can be studied as a set of techniques "that seek to manipulate the way we listen" (2014, 72). Manipulated versions of Rihanna and Eminem's voices are presented to our ears after a series of creative decisions made in the studio. When analyzing recorded popular music, we should therefore set out to describe the social resonances of such creative decisions.

Consider the following questions:

(1) How can we describe the virtual space evoked by Rihanna and Eminem's voices in "The Monster"?

(2) How can we compare the ways in which Rihanna and Eminem's voices unfold within this virtual space over the duration of the song?

This chapter provides tools for answering such questions. In what follows, I propose a methodology for analyzing *vocal placement*—the apparent location of a voice within a recording's virtual space. The methodology is intended for analysts who have access to a final mix only; that is, when information about specific artistic decisions that happened in the studio are unavailable. I begin with a review of existing approaches to the analysis of virtual space. I then outline a methodology in which virtual spaces are depicted as three-dimensional spaces containing individual sound sources (after Moore & Dockwray 2010). I posit that five parameters contribute to vocal placement within this virtual space: (1) Width; (2) Pitch Height; (3) Prominence; (4) Environment; and (5) Layering.

Vocal placement is determined by extracting information about these parameters from a recorded voice. After outlining a visual system for notating vocal placement in virtual space, I showcase the methodology by comparing vocal placement in Eminem and Rihanna's four collaborations: (1) "Love the Way You Lie" (released in 2010 on Eminem's album *Recovery*): (2) "Love the Way You Lie (Part II)" (released in 2010 on Rihanna's album *Loud*); (3) "Numb" (released in 2012 on Rihanna's album *Unapologetic*); and (4) "The Monster" (released in 2013 on Eminem's album *The Marshall Mathers LP 2*).

2.1 Literature Review

Over the past two decades, several studies have outlined analytical approaches to virtual space. Rather than focusing solely on the voice, they address virtual space more generally by also considering additional recorded sound sources and instruments. These studies provide valuable ways to discuss parameters specific to recorded music along with harmony, rhythm, pitch, and so-called "secondary parameters" such as tempo, timbre, and texture. Music analysis is often score-based (Cook 2013), and these approaches therefore contribute to an evolving subfield of music studies that focus on the recording as an object of study (Devaney 2016; DeMan *et al.* 2017; Hardman forthcoming).[2] The following section reviews the analytical approaches that have been proposed to analyze virtual space. I highlight the aims and methods of these studies, and then explain how I build on them to outline my own methodology for analyzing vocal placement in virtual space.

Peter Doyle's (2005) study of American popular music from 1900 to 1960 is one of the first analytical ventures into virtual space. Through an in-depth study of monoaural recordings, Doyle asserts that the application of echo and reverberation can reinforce the lyrical aspects of a song. A song's theme, he argues, can be expressed through its sonic material. Consider for instance the groundbreaking use of slap-back echo in Elvis Presley's 1956 major-label debut "Heartbreak Hotel." The echo sonically positions Presley in a wide, empty space, compounding the feeling of loneliness conveyed by the lyrics (Doyle 2005).

Aside from Doyle's foray into monoaural recordings, most studies on virtual space analyze stereophonic sound. A key example of this is Moore & Dockwray's sound-box (2010).

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[2] Refer to Chapter 1 for an overview of other music analytical tools that focus on non-score-based musical parameters.

Their sound-box stands as the most intuitive display of virtual space. In essence, the sound-box looks like an empty room. It represents the virtual space experienced by a listener upon listening to a recorded piece of music. An analyst can display the location of various sound sources—instruments, voices, and sound-effects—within this space. Consider for instance the sound-box illustration of Jimi Hendrix's "Purple Haze" (Figure 2.1). The image shows three parameters:

(1) The *lateral placement* of a sound within the stereo field (left-right axis). Hendrix's voice—depicted as floating vocal folds—originates from the right side of the space. Drums, guitar, and bass are located at the center of the mix.

(2) The *proximity* of a sound (front-back axis). As the loudest sound of the track, Hendrix's voice hovers toward the front. The remaining instruments, which are quieter, are relegated to the back.

(3) The *height* of a sound according to frequency (high-low axis). Notice how the bass guitar, with its low range, floats right above the floor. Hendrix's high-pitched voice, conversely, is closer to the ceiling.

The sound-box can also express a fourth, and final, parameter, which is absent from "Purple Haze":

(4) The *movement* of sounds through time. A guitar moving from the left to the right channel, for instance, could be depicted by an arrow or an animation.

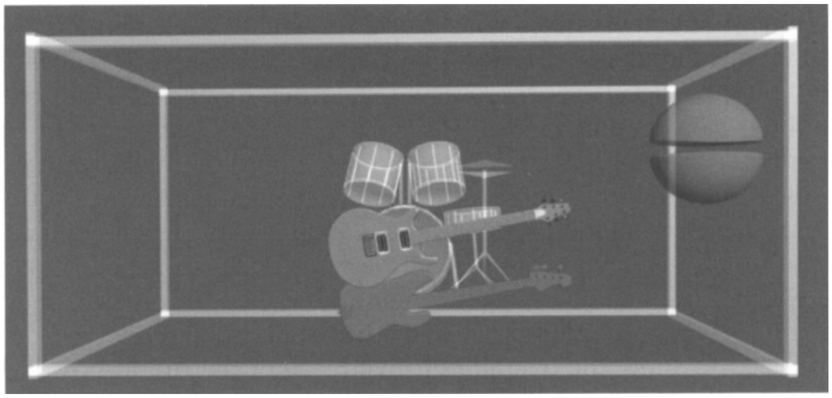

Figure 2.1 Moore & Dockwray's sound-box representation of "Purple Haze" (The Jimi Hendrix Experience, 1967) (Moore & Dockwray 2010, 192).

Moore & Dockwray use the sound-box to track the development of stereo placement in commercial recordings. They provide a taxonomy of mixes used in pop-rock, easy listening, and psychedelic tracks from 1966 to 1972. Their study highlights how the "diagonal mix"—in which the vocals, bass, and snare drum are positioned in a diagonal configuration in relationship to the vertical axis—became normalized in the 1970s.

In his 2000 dissertation, Serge Lacasse proposes another approach to the visual representation of recorded space. Focusing exclusively on the voice, he coins the term "vocal staging" in reference to "any deliberate practice whose aim is to enhance a vocal sound, alter its timbre, or present it in a given spatial and/or temporal configuration." These practices include manipulations in (1) *environment* (echo, reverberation); (2) *stereo image* (lateral location in space); and (3) *distance* (changes in intensity). Phasing, saturation, flanging, and distortion also contribute to vocal staging. Lacasse displays vocal staging through maps showing any enhancements, manipulations, and effects applied to the voice as it evolves through time (Figure 2.2). In a 2010 article, Lelio Camilleri proposes an alternative way to visually represent virtual space. He considers three features of a recording: (1) *localized space* (the depth and position of a sound within the stereo field); (2) *spectral space* (the timbral saturation of a sound, or, the extent to which a sound fills up the spectral space with close frequency bands); and (3) *morphological space* (the interaction between localized space and spectral space). Camilleri illustrates the first feature, localized space, through two-dimensional diagrams called "Stereo Windows" (Figure 2.2). The methods designed by Lacasse and Camilleri allow a great degree of specificity in showing the individual elements of virtual space as they evolve through time. Their proposed visual representations, however, flatten the virtual space to a two-dimensional plane that does not capture the listening experience as intuitively as the sound-box representation.

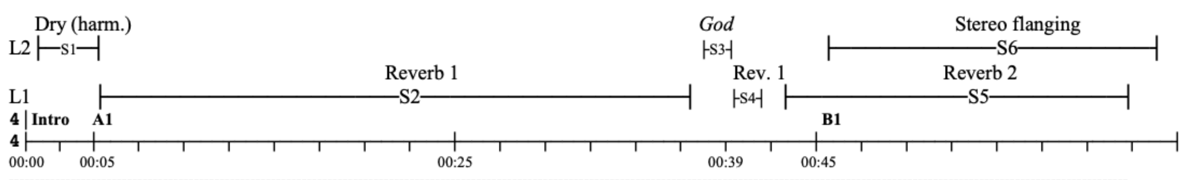

Figure 2.2 Excerpt of Lacasse's representation of vocal staging in "Front Row" (Alanis Morrissette, 1998) (Lacasse 2000, 224).

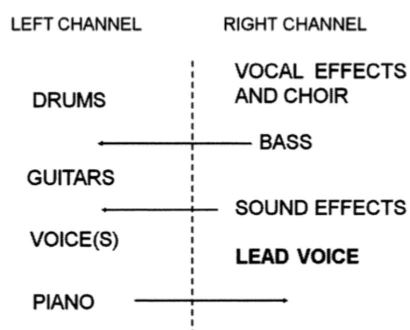

Figure 2.3 Camilleri's representation of the stereo field in "Lovely Rita" (The Beatles, 1967) (Camilleri 2010, 208).

Rather than solely focusing on providing visualizations of recorded spaces, some analysts examine instead the ways in which virtual space intersects with other musical parameters. Zinser

(2019, 2020), for instance, explores how virtual spaces contribute to texture and form in recent popular music. Other authors study the impact of virtual space on a song's theme, atmosphere, or lyrical content. Such analyses often take the form of close readings of individual pieces, and fall within the purview of feminist music theory as they explicitly link musical parameters to gender. Moore, Schmidt & Dockwray (2009), for instance, identify four zones in which a track can unfold: intimate, personal, social, and public.[3] This framework allows them to explore how different spaces convey meaning. In "Standing in the Way of Control," Beth Ditto's "overdriven voice"—loud, aggressive, and prominent—rejects the regulated femininity afforded to white Western women.[4] Kate Heidemann's (2014) study on vocal timbre also touches upon virtual space. In addition to discussing the mechanics of vocal performance, she shows how a sound's stereo placement can create gendered meanings. Heidemann shows for instance that the recorded performance of Loretta Lynn's "Fist City" uses panning to emulate instrument placement on a real stage. This evokes a working-class performance venue with little to no amplification and mixing equipment, where Lynn sings about gender roles in a way that evokes a "rugged working-class model of femininity" (Heidemann 2014, 31). This dissertation takes a similar approach, as I examine the relationship between vocal placement and common depictions of masculinity and femininity. Chapter 3 departs from the practice of close readings of individual pieces to show how vocal placement and gender operate in *Billboard* charts collaborations after 2008.

[3] The four zones are determined by (1) the perceived distance between performer and listener; (2) the location of the voice in the sound environment; and (3) the articulation of the singing persona based on lyrics and vocal delivery.
[4] Nicola Dibben builds on Moore, Schmidt & Dockwray's four zones to examine the relationship between listener and singer. The latter is often centered in the mix, and Dibben attributes this norm to a music industry predicated on celebrity. Ultimately, she concludes that the aural proximity afforded by intimate virtual spaces invites a focus on the private lives of the artist (Dibben 2013).

Through a variety of approaches, the authors discussed above advocate for virtual space to be taken seriously as a musical parameter. From these studies emerge two limitations that warrant further discussion: the lack of (1) consensus about the sonic parameters that constitute virtual space and (2) a reliable way to compare the virtual spaces of different recordings.

Issue 1: Which sonic parameters contribute to the creation of virtual space?

At first glance, the works reviewed above seem to discuss the same phenomenon—virtual space. Each author, however, constructs their methodology around different elements of a recording. As a result, there is no consensus on the sonic parameters that constitute virtual space. These discrepancies are illustrated in Table 1.1. Notice, for example, how Camilleri is the sole analyst interested in timbral saturation while Moore & Dockwray's sound-box is the only methodology that addresses frequency or pitch. Conversely, the sound-box does not account for the microphone technique central to Doyle's approach as well as Moore & Dockwray's previous article on the hermeneutics of recorded space. This lack of overlap between methodologies can potentially create difficulties for an analyst because there is no consensus on the parameters responsible for the creation of virtual space.

Table 2.1 Comparison of six methods for analyzing virtual space.

	Lateral placement	Distance/ depth	Frequency	Time	Saturation	Echo	Reverberation	Microphone technique
Doyle (2005)				X		X	X	X
Camilleri (2010)	X	X		X	X			
Lacasse (2000)	X	X		X		X	X	X
M & D (2011)	X	X	X	X		X	X	
M, S & D (2009)	X	X	X	X				X
Heidemann (2014)	X			X				

A subtler issue arises when two or more authors discuss the same parameter, but with divergent definitions and conceptualizations. The notion of "distance"—occasionally called "depth"—is especially relevant here. Camilleri, Lacasse, and Moore & Dockwray all use these terms to refer to the perceived distance between a sound source and a listener. For Camilleri, this sense of depth is created through reverberation. The more reverberant the virtual space, the more depth is perceived by the listener. Camilleri is not referring to the distance between sound source and listener, but to the size of the space in which these sound sources unfold.[5] For Lacasse, distance refers to the position of a sound along the depth axis of the virtual space. Unlike Camilleri, he does not consider reverberation the primary factor in creating distance. Rather, he argues that the illusion of distance is created by a combination of timbral parameters, reverberation, loudness, and the microphone technique. Finally, for Moore & Dockwray, a listener perceives the distance of a sound via a combination of volume and reverberation. Three different studies on the creation of virtual space, then, offer three different definitions of the same term. These inconsistencies raise several questions: What, exactly, is distance? Does it refer to the size and dimensions of the virtual space, the perceived gap between listener and sound source, or the perceived placement of the listener within the virtual space? What sonic parameters participate in its creation?

Issue 2: How can virtual spaces be compared?

Suppose that you want to compare the virtual space in "The Monster" with the virtual space created in "Love the Way You Lie" (2010), another collaboration between Eminem and Rihanna. Which space is more reverberant? Is Eminem's voice more salient in the first or second

[5] Camilleri acknowledges that the impression of depth relates to "the spectral content (timbre) of sound, [which] plays a relevant role in the overall perception of space" and "the combination of spectral content of sounds and their disposition" (Camilleri 2010, 202). His analyses, however, focus on depth as reverberation.

song? How similar are the voice's locations on the stereo stage? In order to answer these questions, you would need to precisely quantify each space's characteristics (i.e., "The voice is panned at 30% to the right").

Current methodologies, however, do not provide a precise way to describe virtual spaces. As a result, different virtual spaces cannot accurately be compared. Consider the following analytical statements:

(1) "The brass is more prominent and brought forward in the mix" (Moore & Dockwray 2010, 189, on "Congratulations" [1968] by Cliff Richard).

(2) "Interestingly, the 'God' setting consists of a very high level of reverberation with a quite long reverberation time, typical of very large environments such as concert halls, caves, or cathedrals" (Lacasse 2000, 227, on "Front Row" [1998] by Alanis Morissette).

Both claims are based on close listening of the tracks. Moore & Dockwray hear the brass as more prominent than other instruments. Lacasse hears reverberation and associates it with spacious environments. Such personal readings are especially useful when making claims about a single track: Moore & Dockwray are interested in the diagonal mix in "Congratulations," and Lacasse ties the reverberation in "Front Row" to word painting. These claims, however, are not supported by any explicit methodology, procedure, or instructions on how to listen for and describe virtual spaces. Without such guidance, a reader can't necessarily know for certain that they are attuned to the same musical parameters that the author is describing. A lack of a clear methodology or procedure also becomes problematic when attempting to compare two or more tracks. Consider the following questions: Is the brass more prominent in "Congratulations" than in Tower of Power's "What Is Hip" (1973)? Does "Front Row" evoke the widest space in Morissette's album *Supposed Former Infatuation Junkie*? Both questions require us to compare two or more virtual spaces. This cannot be achieved, however, without a clear way to measure parameters like "prominence" and "reverberation." An analyst might be able to hear varying degrees of reverberation, for instance, but would need a precise scale on which to locate the different degrees.

Moore, Schmidt & Dockwray's 2009 classification of potential distances between the singer and listener is a useful step toward such a scale. They identify four proxemic zones, after Hall (1963), in which a piece of recorded music can unfold: (1) *intimate* (very close to the listener); (2) *personal* (close to the listener); (3) *social* (medium distance from the listener); and (4) *public* (sizeable distance from the listener). Upon listening to a track, an analyst can instinctively tell if the singer is located at a close or sizeable distance. A detailed comparison of two tracks, however, would require a precise way to measure distance.

As a response to the two limitations described above, my method for analyzing vocal placement within virtual space will feature: (1) a clear definition of the sonic parameters contributing to the perception of space; and (2) a reproducible, step-by-step methodology allowing for consistent and replicable descriptions of various virtual spaces. In addition to supporting close readings of individual pieces, this analytical tool will enable reliable comparisons of virtual spaces by presenting a series of sliding scales on which specific sonic parameters can be located.

2.2 Methodology

Borrowing Dockwray's and Moore's visual representation of the soundbox, I depict the virtual space as an empty three-dimensional room in which sound sources are located. The analyses outlined throughout this dissertation assume the existence of a listener who is positioned in front of the virtual space, at the location indicated by an X (Figure 2.4). The listener—myself, in this case, as I listen to the recorded performances via stereo speakers—perceives this virtual space as though it were a stage on which a virtual performance was unfolding.[6] Five parameters contribute to vocal placement within the virtual space: (1) *Width*; (2) *Pitch Height*; (3) *Prominence*; (4) *Environment*; and (5) *Layering*. For each of the five parameters, I provide a definition, instructions for displaying the parameter in the virtual space, a set of terms to be used in describing the voice's location in accordance with this parameter, and an explanation of the parameter's significance to vocal placement within virtual space.[7] As shown in Table 2.2, some of these parameters are measured automatically through audio feature extraction, while others are measured through aural analysis. Each parameter is expressed according to its own scale.

Table 2.2 Overview of methodology for analyzing vocal placement in virtual space

Parameter	Analytical method	Scale
Width	Aural analysis and audio feature extraction	5-point scale (W1, W2, W3, W4, W5)
Pitch Height	Audio feature extraction	Expressed as a frequency range (ex. C3–G4)
Prominence	Audio feature extraction	Expressed as a percentage
Environment	Aural analysis	5-point scale (E1, E2, E3, E4, E5)
Layering	Aural analysis	5-point scale (L1, L2, L3, L4, L5)

6 Alternatively, one could conceive of a situation in which the listener mentally positions themselves as one of the sound sources in the virtual space, such as the main vocals. In this case, the listener may experience the recorded performance as though they were on the virtual stage.

7 Appendices A and B provide detailed instructions for analyzing a voice's placement in virtual space according to these five parameters. The method relies on a combination of aural analysis and audio feature extraction. I have omitted technical details from the present chapter to facilitate reading, but the reader is invited to consult the Appendices to gain a deeper understanding of the five parameters outlined in the following section.

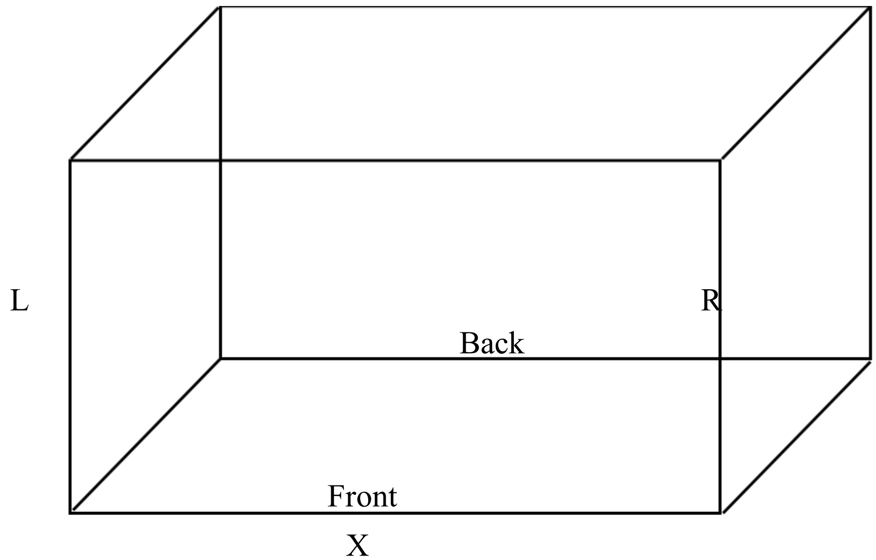

Figure 2.4 The virtual space. The X indicates the position I assume for the analyses. I situate myself as a listener who is facing the virtual space as though it were a staged performance.

2.2.1 Panning

Before introducing the five parameters that contribute to vocal placement in virtual space, I introduce the additional concept of *Panning.* This parameter refers to the position of a sound source in the stereo field of the virtual space. Given that most voices in recent popular music are positioned to the center of the virtual space, rather than toward the right or the left, panning will not be discussed at length as a standalone parameter throughout this dissertation. I nonetheless introduce the concept here because it is directly linked to the width parameter.

Definition

In virtual space, panning is the position of a sound source in the stereo field.

Visual Representation

The horizontal axis of the virtual space represents the stereo field. A voice's position in the stereo field is indicated by its location on the horizontal axis (Figure 2.5).

Relevant Terms

The position of a voice on the horizontal axis is described by the spectrum left/right.

The left pole refers to sounds emerging from the left channel only, while the right pole refers to sounds originating from the right channel. A sound may be located anywhere along the spectrum. Left-oriented sounds appear toward the left of the virtual space, and right-oriented sounds appear toward the right.

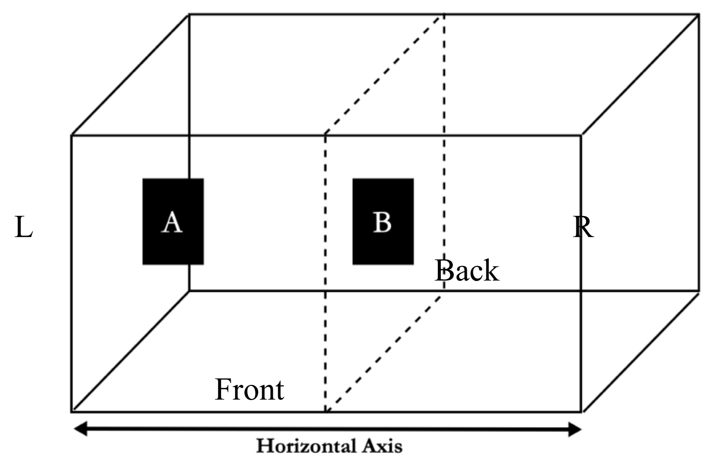

Figure 2.5 Displaying panning on the horizontal axis. The dotted line represents the center of the horizontal axis. Voice A is located to the left of the virtual space, and Voice B is centered in the virtual space.

Justification

The position of a voice on the horizontal axis is a salient aspect of virtual space that emulates real-life perception of sound. Humans perceive the lateral location of a sound through (1) interaural intensity difference; and (2) interaural time-arrival difference (Huber 2018, 70). In other words, the intensity and time-arrival of a sound is perceived differently by both ears. Imagine, for instance, a car horn sounding to your left. Both of your ears will capture the sound, but with slight differences. The left ear will hear the horn first at a louder intensity. The right ear will hear a slightly delayed sound, at a lower volume. This difference in perception allows you to identify the horn's location. The same principles apply to two-channel (stereo) recordings. An engineer may pan a sound to the extreme right by placing it in the right channel only. A subtler pan to the right may be obtained by putting the sound in both channels, but with a louder signal on the right side. When a sound is panned in one direction, there is proportionally more energy in the channel that it is panned toward. A sound appears in the center of the virtual space when identically replicated in both channels.

The lateral placement afforded by stereo sound is unanimously accepted as an essential parameter of virtual space: all analytical methods discussed in the previous section address the left-right axis. Sound engineering manuals also highlight the importance of panning by praising crisp, clear mixes that place different sound sources across the virtual image. Owsinski's *The Mixing Engineer's Handbook* (2017), for instance, warns against mixes that lack definition and depth because all sound sources are panned in the same location. Instruments and voices can gain better clarity by being panned at different locations on the lateral axis. In general, commercial popular music recording practice places lead vocals at the center of the virtual space. This central panning ensures a "greater psychoacoustic impact" in which the voice is the most salient aspect of a recording (Zak 2001, 155). For example, consider the central location of Estelle's voice from 0:34–1:02 in "American Boy" (2008). Upon listening to the song with a pair of headphones, you may have the impression that Estelle is located directly in front of you, or even imagine that her voice originates from the same location as your head.[8] This occurs because her voice emerges from both the left and right channel at the same time and amplitude.

[8] When listening to the song excerpts, try (1) listening with a pair of headphones; (2) listening with speakers; (3) listening to both channels separately, and (4) listening in mono. These different situations will help create familiarity with how lateral placement is obtained in stereo sound.

In some cases, the voice is disseminated through the stereo image rather than occupying a central position in the virtual space. Consider the following scenarios:

(1) From 0:05–0:32 in "American Boy," Estelle's voice is occasionally layered with background vocals—also sung by Estelle. These additional vocal tracks are panned to the sides of the virtual space. This vocal placement emulates that of several singers standing at different locations on a stage; it also prevents background vocals from obscuring the lead. When the background vocals appear, Estelle's voice occupies a wider space on the left-right axis. When the "vocalists" withdraw, her solo voice resumes its narrow position in the virtual space.

(2) Syd Barrett's voice from 0:04–0:15 in Pink Floyd's "The Gnome" (1967) is located to the left of the virtual space. The voice is layered with a slightly delayed copy of itself. The copy is panned to the right. Rather than being centered, the voice seems to emerge from both sides of the virtual space. This uncanny effect—made possible by contemporary innovations in analog recording—is used throughout Pink Floyd's debut album *The Piper at the Gates of Dawn*.[9]

(3) From 0:08–0:38 in "We Found Love" (2011), Rihanna's voice is panned to the center. Reverberated copies of her voice, however, are panned throughout the virtual space.[10] As a result, her voice is diffused along the entirety of the left-right axis. This emulates a real-

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[9] The effect was created through Artificial Double-Tracking (ADT), an analog method in which two tape recorders capture a sound signal at a slight delay from one another. The technique was developed at Abbey Road Studios in 1966 by sound engineer Ken Townsend, and the technique is featured prominently on Beatles albums from *Revolver* (1966) onwards (Lacasse 2000, 131). Also recorded at Abbey Road Studios, *The Piper at the Gates of Dawn* features extensive uses of ADT in which the two vocal tracks are panned to either end of the stereo field.

[10] When adding artificial reverberation to a voice, a sound engineer may (1) pan the reverberation in the same place as the voice; or (2) pan the reverberation throughout the virtual space. While the latter option may create an undesirable muddy sound, it also emulates a real-life enclosed space in which reverberated sounds are reflected on various surfaces.

> life situation: if Rihanna were singing in the middle of a reverberant room, the reverberated images of her voice would be reflected on the ceiling, floor, and walls.

As highlighted by these examples, it is not sufficient to simply state where the voice is panned in the stereo field to capture our experience of the voice in the virtual space. We must also characterize the voice's width within this field.

2.2.2 Width

Definition

The width of a sound is the breadth it occupies in the stereo stage.

Visual Representation

The width of a sound is shown in the virtual space through the size of the image: localized sounds look narrow, while diffuse sounds are wider (Figure 2.6). I identify five possible categories of width (Figure 2.7).

Relevant Terms

Sounds occupying a narrow space can be described as localized, while wider sounds width can be described as diffuse.

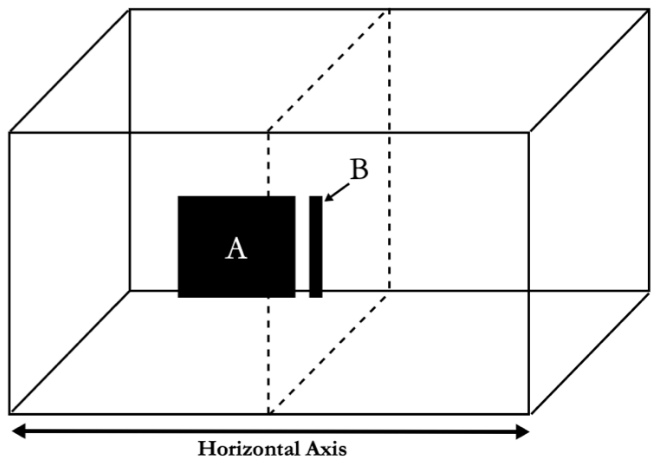

Figure 2.6 Displaying width on the horizontal axis. Voice A is wider (and therefore more diffuse) than Voice B. Voice B is narrower (and therefore more localized) than Voice A. Voice A is in the W2 width category, and Voice B is in the W1 width category.

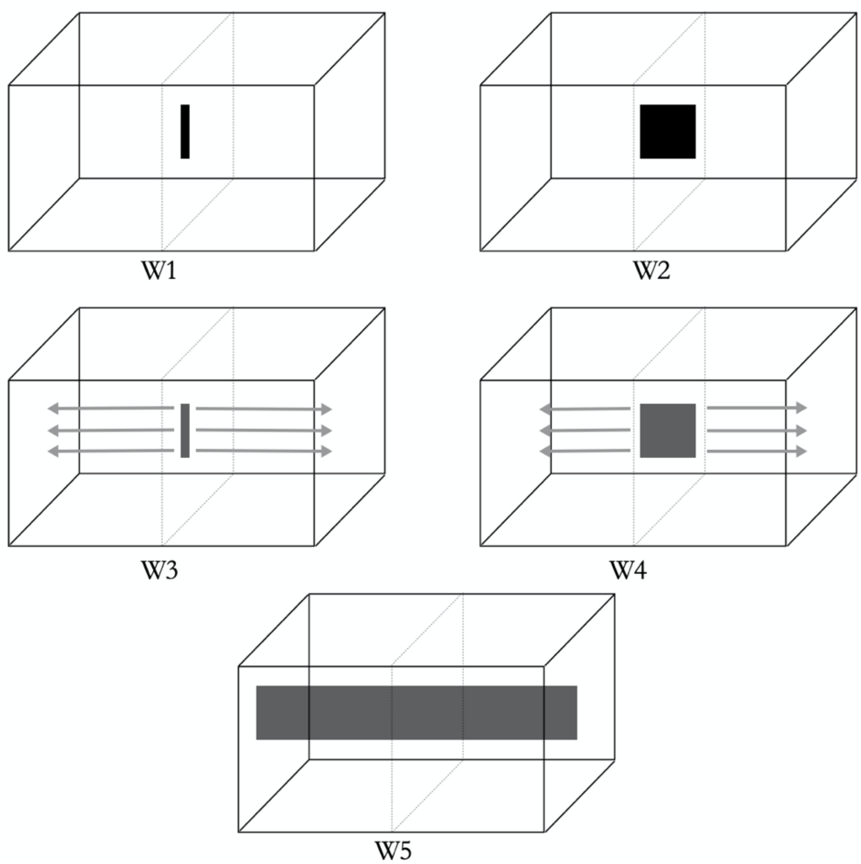

Figure 2.7 Displaying five levels of width in the virtual space.

2.2.3 Pitch height

Definition

In virtual space, pitch height is the vertical distribution of a sound source according to its frequency.

Visual Representation

The vertical axis represents the frequency range of a virtual space. A voice's position in the frequency range is indicated by its location on the vertical axis. The "floor" of the virtual space corresponds to C0, while its "ceiling" corresponds to C7 (Figure 2.8)

Relevant Terms

The position of a voice on the vertical axis can be described according to a high/low pitch range, ranging from C0 (16.35 Hz) to C7 (2093 Hz). C7 indicates a sound at the very top of the frequency range, while C0 refers to a sound at the very bottom. High sounds are therefore located toward the top of the virtual space, while low sounds are located toward the bottom

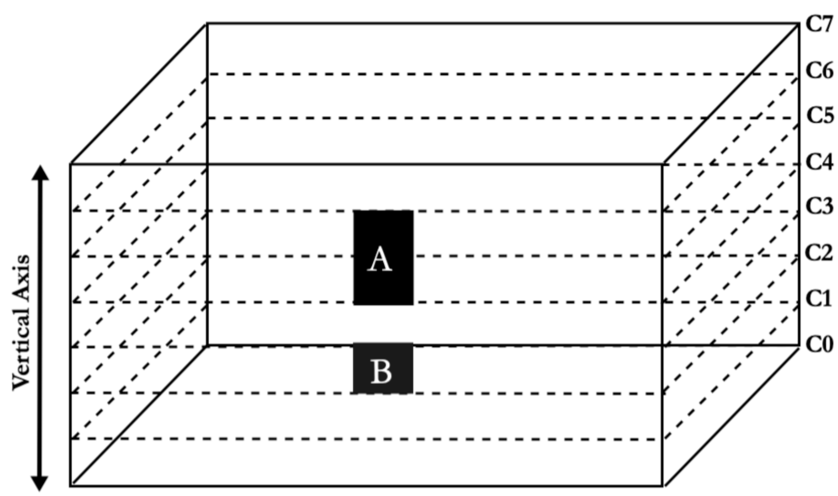

Figure 2.8 Displaying vocal placement on the vertical axis. Voice A is higher than Voice B. Voice A has a range of C4–C6, and Voice B has a range of C2–C3.

Justification

I equate the vertical axis with pitch for four reasons:

(1) Humans have a perceptual tendency to hear increases of pitch and increases in height (Shepard 1999);

(2) Equating the vertical axis of the virtual space to pitch height invokes traditional metaphors of pitch organization in Western music notation, in which frequencies are organized on a vertical scale from lowest to highest.[11] Moore & Dockwray's sound-box follows suit, along with several sound engineering manuals (Gibson 2005, Huber 2017, Owsinski 2017).

(3) While humans can discriminate sound based on its horizontal location, the height—in actual location, not pitch—of a sound is more difficult to perceive (Huber 2017). As such, the vertical location of a sound is next to irrelevant to our listening experience. Since we can discriminate between pitch height much better, it follows that the virtual space's vertical axis should represent pitch.

(4) The fourth reason is mainly practical: without a vertical axis showing pitch, the virtual space would be flattened to two dimensions, and therefore made more difficult to represent visually.

[11] For a thorough discussion of metaphorical and literal height in staff notation and musical performance, see Cox 2016, 91–104.

2.2.4 Prominence

Definition

In virtual space, prominence is the perceived depth of a sound source according to its amplitude. Prominence is measured by determining the relative RMS amplitude of the voice in relationship to the full mix. It is expressed as a percentage that represents the portion of a track's RMS amplitude that is occupied by the voice. Refer to Appendix A for detailed instructions on obtaining this measurement.

Visual Representation

The depth axis represents the amplitude of sound objects in the virtual space. A voice's amplitude in relationship to other sound sources is indicated by its location on the depth axis. The "back wall" of the virtual space corresponds to 0% prominence while the "front wall" corresponds to 100% prominence. The image of the voice should be located on this axis according to its prominence (Figure 2.9).

Relevant Terms

The position of a voice on the depth axis can be described according to a scale of prominent to blended. The term prominent refers to high-amplitude, salient sound. The term blended refers to low-amplitude sounds that seem to merge with other sources. Prominent sounds are located toward the front of the virtual space, while blended sounds are located toward the back.

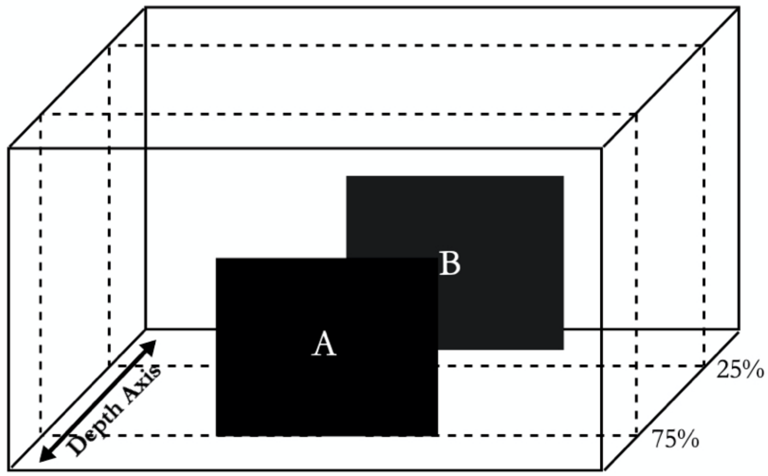

Figure 2.9 Displaying prominence in the virtual space. Voice A is more prominent than Voice B, and Voice B is more blended than Voice A. Voice A occupies 75% of the song's amplitude, and Voice B occupies 25% of the song's amplitude.

To better understand prominence, listen to Jamie Foxx's voice in 0:00–0:07 of Kayne West's "Gold Digger" (2005). As the only sound source in the mix, it is the most prominent. When Kanye West's voice enters, 0:08–0:21, Foxx's voice lowers in amplitude and is therefore relegated to the background of the virtual space. In the verse of "Something Just Like This" (2017), 0:44–1:01, Chris Martin's voice is blended with the accompaniment. While the voice stands out because of its dry environment and centered panning, it is not brought forward through dynamics.

Justification

My decision to tie the depth axis with amplitude warrants some discussion. As described in the previous section, different authors define the depth axis along various parameters. Camilleri conceptualizes it in terms of reverberation, Moore & Dockwray in terms of volume, and Lacasse through a combination of parameters. The front-back axis is discussed differently in several sound engineering manuals. In the *Mixing Engineer's Handbook*, it is described as the "depth" that can be achieved through reverberation and delay (Owsinski 2017, 156). *The Art of*

Mixing shows volume as the responsible parameter for front-back location (Gibson 2005, 24). Gibson admits that the ear "need(s) other cues, such as delays and reverb, to help gauge the distance (of a sound). Nonetheless, he chooses to center volume as the primary parameter of distance for the sake of a simpler framework. *Modern Recording Techniques* center the importance of reverberation, which can be used by the engineer to "place the sound source at either the front or the rear of the artificially created soundscape" (Huber 2018, 74).

We are therefore confronted with a thorny mix of different definitions of distance. A discussion of the different sonic parameters responsible for the perception of distance is therefore in order. In what follows, I (1) review the parameters that contribute to real-life perception of distance; (2) describe the difficulties of gauging distance in recorded music; and (3) explain why I associate the depth axis of the virtual space with prominence rather than with distance.

In *Understanding and Crafting the Mix*, William Moylan (2015) discusses the parameters that contribute to real-life perception of distance: (1) timbral detail and (2) the ratio of direct sound to reflected sound. First, he writes that humans primarily determine distance through timbral detail: the better we perceive a sound's partials, the closer we are. With increasing distance, our ears have more difficulty perceiving high-frequency partials from a sound since they typically have lower-amplitudes. Moylan then moves on to reverberation, writing that "as the [sound] source moves from the listener, the percentage of direct sound decreases while the percentage of reflected sound increases" (2015, 30). To picture this effect in action, imagine that you're in an enclosed, reverberant space. Someone located near you sings a melody. You hear the direct sound—the person's voice—clearly, along with its reverberated images—the echoes of the voice—bouncing across the room. Now, imagine that this person walks to the opposite side of the room, further away from you, and sings the same melody. The direct sound is now murkier, but the reverberation is more pronounced. These variations in the relationship between a sound and its reverberation allow you to perceive distance.

Perception of distance in recorded music

Moylan (2015) describes the parameters that are not responsible for the perception of distance in recorded music: (1) loudness, (2) the amount of reverberation, and (3) microphone technique. First, while a sound loses amplitude as distance increases, loudness does not directly relate to distance. A soft sound may be close, and a loud sound may be far. Second, the amount of reverberation does not contribute to distance perception. A reverberant sound may be close while a dry sound may be far. As discussed above, it is rather the quality of the reverberation—the amplitude of the direct sound in relationship to the reverberated images—that contributes to the perception of distance. Finally, the perceived distance between a microphone and a sound source does not contribute to the perception of distance; microphone technique only accounts for the level of timbral detail captured.

When editing and mixing a song, engineers can modify sound sources to alter our perception of distance. Albin Zak (2001) explains how effects of distance can be manipulated by a mixing engineer through loudness, frequency spectrum, equalization, compression, and stereo placement:

> [W]hen we think of prominence, the first thing that usually comes to mind is loudness, but on a record, loudness is only one of many factors that influence such impressions. In the area of timbre, for instance, the frequency spectrum can be configured so that certain sounds take on prominence simply by inhabiting a space where there is little competition from other sounds. Also, equalization can sharpen a sound's presence without raising its overall amplitude. […] And because sounds at or near the center of the stereo field have greater psychoacoustic impact, a sound's stereo placement can affect its prominence. (Zak 2001, 155)

The parameters outlined by Moylan and Zak are useful from a mixing engineering perspective, because varying a recorded sound along these parameters can contribute to the illusion of distance. Most of these parameters, however, cannot be analyzed directly from a finished mix. Consider, for instance, the role of timbral detail in distance perception. Upon hearing a guitar sound in a recorded mix, we are unable to immediately pinpoint its apparent distance. To do so, we would need to hear the guitar several times at a variety of distances to gauge how distance affects its timbral level. Reverberation provides no additional help in locating the guitar sound: there is no way for us to determine how distance affects the ratio of direct to reverberant sound if we only have the finished recording. In virtual space, then, the sonic parameters that would normally affect our perception of distance are of no help. The lack of information on the way distance affects the sound we hear prevent us from identifying its distance in a reliable way.[12]

As an alternative to distance, I posit that the prominence of a sound determines its location on the depth axis. Prominence refers to the perceived depth of a sound based on its amplitude, not its distance. This is analogous to Moore & Dockwray's sound-box, in which the front-back axis is defined by volume. Thinking of depth in terms of prominence rather than distance, however, represents a shift in framework. We cannot hear the distance of a given sound object based on a recording only, but we can easily hear its prominence. Rather than being defined through a mixture of sonic parameters, the depth axis is now under the purview of amplitude only. This allows us to discuss reverberation under different terms that better encapsulate its role in a mix.

[12] It would be possible to study a mixing engineer's manipulation of distance, but only with access to the DAW files in addition to the completed mix. One could then compare the pre-processed recording to the final product.

2.2.5 Environment

Definition

The environment is the space in which a sound object reverberates. In a virtual space, each sound object—a voice, a guitar, percussion, etc.—can have its own environment. Virtual spaces are therefore a compound of smaller-scale environments, each containing their own sound object.

Visual Representation

The voice's environment is shown through opacity. Figure 2.10 displays five different possible environment categories: Level E1 has no reverberation, and Level E5 is extremely reverberant. As reverberation increases, opacity decreases. Refer to Appendix B for a detailed explanation of how these environment categories are estimated.

Relevant Terms

The environment of a voice can be described according to the spectrum flat/reverberant.

The flat pole indicates a reverberation or echo-free environment. The reverberant pole refers to high-reverberation environments (Figure 2.11).

Figure 2.10 Five categories of environment

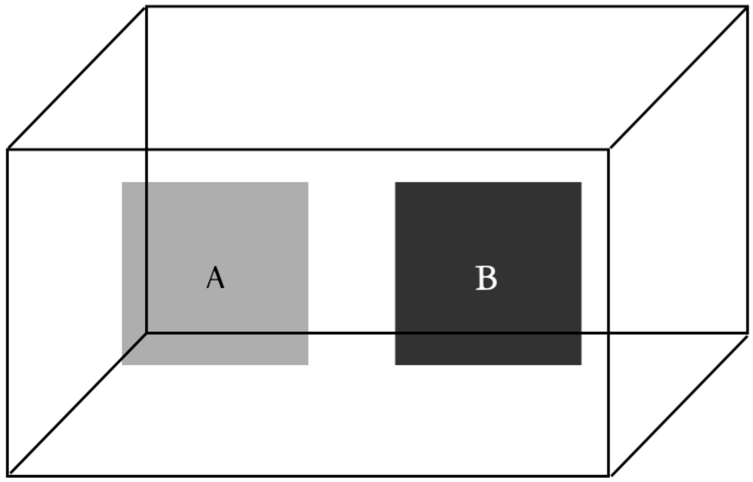

Figure 2.11 Displaying flat and reverberant environments in the virtual space. Voice A is situated in a more reverberant environment than Voice B. Voice A has an E4 level of reverberation, and Voice B has an E3 level of reverberation.

Justification

Amongst the many sonic parameters that contribute to the creation of virtual space, reverberation is the most complex. Even a cursory listening of any commercially produced recorded song reveals that voices—and other sound sources—are manipulated with different types of reverberation that evoke spaces of varying sizes and characteristics. Remember, for instance, the way Rihanna's voice is treated at the beginning of "The Monster" (2013). Her singing voice is reverberated throughout the virtual space, evoking a large space.

Reverberation—the persistence of a sound after it is produced—occurs when a sound signal is reflected off a variety of surfaces.[13] As such, reverberation is not a characteristic of the

[13] Reverberation differs from echo in that the reflections occur before approximately 50ms. Echoed repetitions of a sound are easily detectable by ear, with a minimum reflection time of 50ms.

sound source itself but a characteristic of a sound's environment. Every conceivable space has its distinctive reverberation profile, with a unique configuration of walls, floors, surfaces, and materials that absorb or reflect sound. Moreover, reverberation is frequency dependent: in the same room, an A4 and an A5 played on an oboe may decay differently.

In commercially produced recorded music, there are at least three levels of reverberation to consider. The first level consists of the properties of the environment in which the sound was recorded. Imagine, for instance, that you record your singing voice in an empty room. The microphone will capture both the sound of your voice and its reaction to the room.[14] A second level of reverberation might be added to your recorded voice by a mixing engineer. A very short reverberation time—under 30ms, for instance—could give the recording a more present sound (Huber 2015, 74). Every sound source in a mix can exist in its own reverberant environment: the guitar accompanying your voice could be mixed with a contrasting reverberation profile. Finally, an additional layer of reverberation may be applied to the entire mix.

Virtual spaces are therefore a compound of varied sound sources placed in different environments—each with its own reverberation profile. As a result, virtual spaces can often only exist abstractly. Listen, for instance, to the first verse of "MotorSport" (2018), 0:07–0:22. Quavo's voice is placed in the center of the virtual space, and there is no audible reverberation applied to his voice. Offset and Takeoff—the two other members of Migos—support him with background vocals that are reverberated. Listeners hear both the reverberant and non-reverberant voices simultaneously, which implies an abstract environment in which this would be possible. We can think of the virtual space as a large-scale environment containing smaller-scale environments in which individual sound sources exist. Moylan makes a distinction between the

[14] The aspects of reverberation captured by this recording would depend on the microphone's position.

“individual environments”—the reverberant qualities of the space in which a single sound source is located—and the “perceived performance environment”—the entire virtual space, which is a composite of several individual environments that may have subsequently be processed as a group (Moylan 2009). Gibson illustrates these nested environments by displaying a smaller image of a room within the larger-scale virtual space (Figure 2.12).

While some authors (Camilleri 2010, Moore & Dockwray 2010) have linked reverberation with depth or distance, my model does not equate reverberation with a sound’s position in the virtual space. Location is instead determined through the lateral, vertical, and depth axis, which respectively correspond to panning, pitch height, and prominence. These three parameters operate independently of reverberation: A reverberant sound could be placed toward the front or back of a virtual space, for instance, depending on its amplitude.

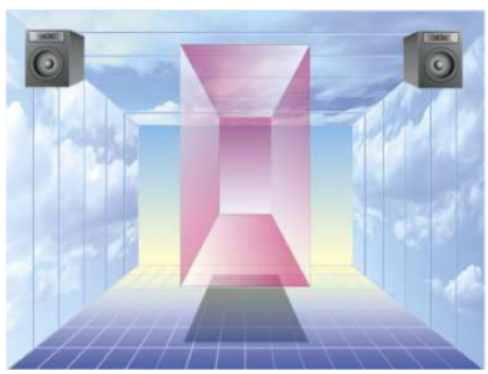

Figure 2.12 Nested environments (Gibson 2005)

2.2.6 Layering

Definition

In virtual space, layering refers to the additional vocal tracks that are dubbed over a single voice. The layering parameter only considers copies of the singer’s own voice and does not take into consideration added background vocals provided by one or more additional singers. Layering categorizations do not take into consideration added background vocals provided by one or more additional singers.

Visual Representation

Layering is illustrated through repetitions of the sound object in the virtual space. Figure 2.13 displays five categories of layering. Refer to Appendix A for a detailed explanation of how these different layering categories are determined by aural analysis.

Relevant Terms

The vocal doubling of a voice can be described according to the spectrum singular/layered (Figure 2.14).

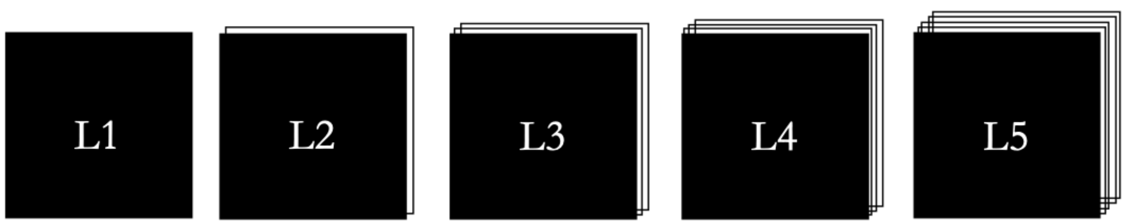

Figure 2.13 Five categories of layering

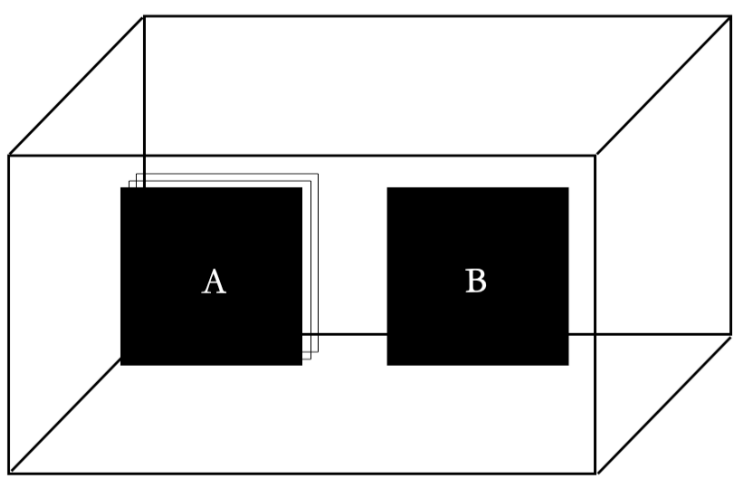

Figure 2.14 Displaying single and layered sound sources in the virtual space. Voice A is layered and Voice B is singular. Voice A is in the L3 category of layering, and Voice B is in the L1 category of layering.

In the verse of "We Found Love" (2011), for instance, Rihanna's voice is singular. While highly reverberated, her singing voice is not layered by other vocal tracks, such as in 0:08–0:38. In some instances, the layering can be especially subtle. Cardi B's voice in "I Like It" (2018) might at first appear to stand alone, but careful listening reveals the existence of other vocal tracks layered at a lower amplitude, as heard in 0:14–0:26.

Justification

Doublings are an instance of what Lacasse (2001) calls "vocal staging," that is, any effect meant to modify the recorded voice. While vocal doublings do not directly affect the perception of the virtual space, they nonetheless represent an important feature of the voice's behavior in a track. Singular and layered voices interact with virtual space in different ways. A singular voice may be associated with impressions of familiarity, intimacy, and closeness. Singular vocals also tend to occupy a narrow position in the stereo space—unless they are accompanied by reverberation that is subsequently panned across the virtual space. Layered vocals carry certain artificial connotations: it would be impossible to hear different versions of Cardi B's voice singing in harmony without the aid of technology. Layered vocals occupy a wider space in the horizontal axis if the tracks are panned in slightly different locations.

2.2.7 Summary

In the previous sections, I have introduced five parameters relevant to the analysis of virtual space. Each parameter is associated with one or two spectra along which the voice may operate: left/right, localized/diffuse, high/low, prominent/blended, flat/reverberant, and singular/layered. The position of the voice in the virtual space can intuitively be shown though visual models. The visual conventions I have put forward efficiently convey the overall position occupied by the voice according to the five parameters. Note that each of the five dimensions is completely independent from the others. The voice's position on the horizontal axis, for instance, has no bearings on its behavior along the remaining dimensions of the virtual space.

2.3 Analytical Examples: Four Collaborations Between Rihanna and Eminem

In the following section, I discuss the vocal placement of Eminem's and Rihanna's voices in their four collaborations: (1) "Love the Way You Lie" (released in 2010 on Eminem's album *Recovery*); (2) "Love the Way You Lie (Part II)" (released in 2010 on Rihanna's album *Loud*); (3) "Numb" (released in 2012 on Rihanna's album *Unapologetic*); and (4) "The Monster" released in 2013 on Eminem's album *The Marshall Mathers LP 2*). Eminem's and Rihanna's voices share a virtual space in each track. Their voices—in addition to being differentiated by their timbre—evolve throughout the space in contrasting ways. Eminem's voice tends to be flat and localized, while Rihanna's is reverberant and diffuse.

The methodology outlined throughout this chapter allows me to describe in more detail their vocal placements in the virtual space. Measuring the width, pitch height, prominence, environment, and layering of Rihanna's and Eminem's voices provides a clear picture of contrasting ways in which their voices operate in the recording. At the beginning of the chapter, I ended a short discussion of the "The Monster" with two questions. I revisit them here through my analysis of the four tracks to illustrate how the methodology can precisely locate the placement of a voice within the virtual space.

2.3.1 How can we describe the virtual space evoked by Rihanna and Eminem's voices?

The methodology outlined in this chapter captures essential features of a voice's placement within virtual space. Figures 2.15 to 2.18 display the vocal placement of Rihanna and Eminem within each of their four collaborations. Table 2.3 summarizes the data from Figures 2.15 to 2.18.

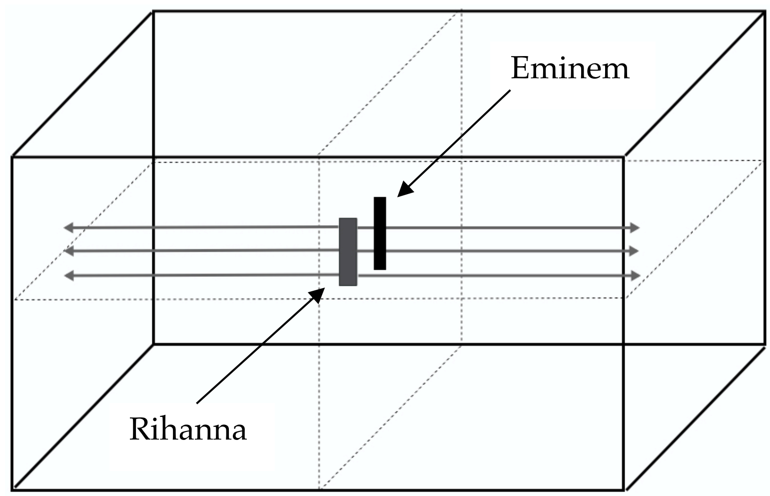

Figure 2.15 Vocal placement in "Love the Way You Lie," Part I (2010), 0:00–1:00.

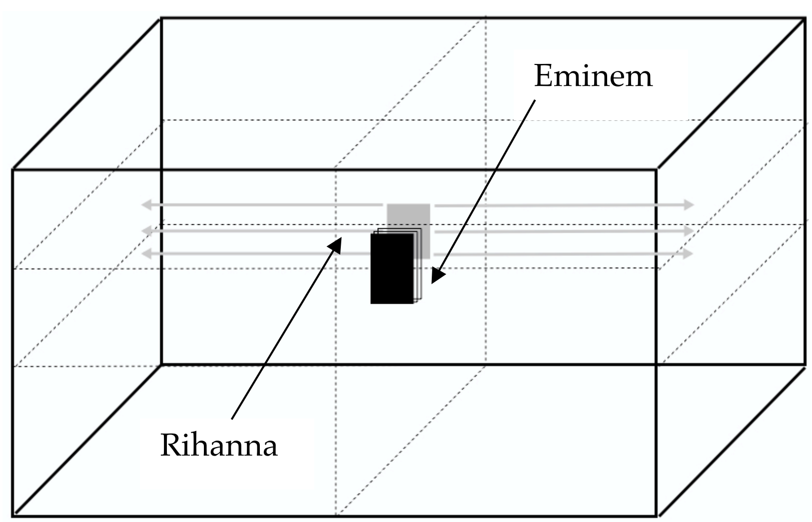

Figure 2.16 Vocal placement in "Love the Way You Lie (Part II)" (2010), 0:00–1:20; 3:06–4:03.

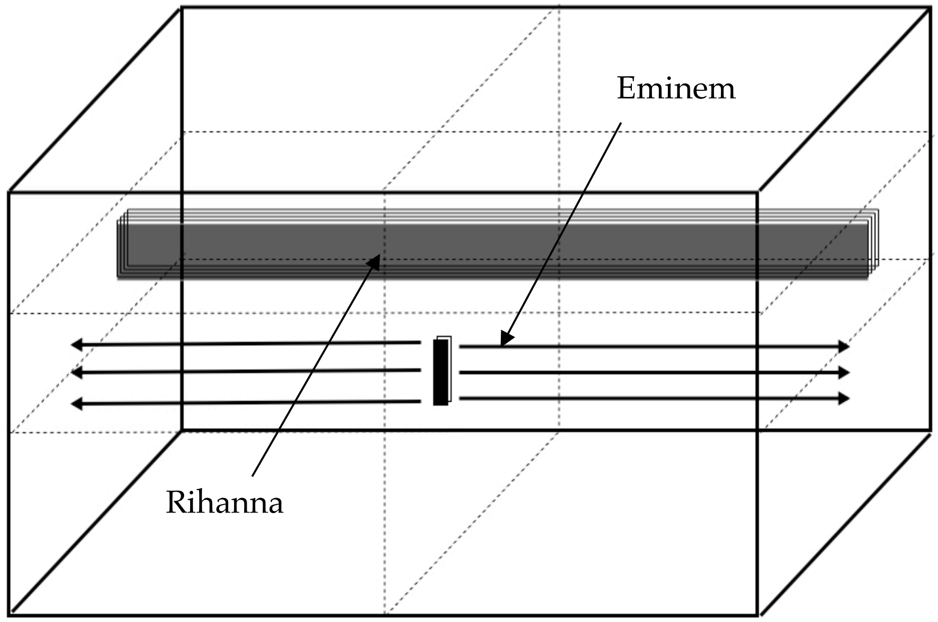

Figure 2.17 Vocal placement in “Numb” (2012), 0:40–1:20; 2:21–2:49.

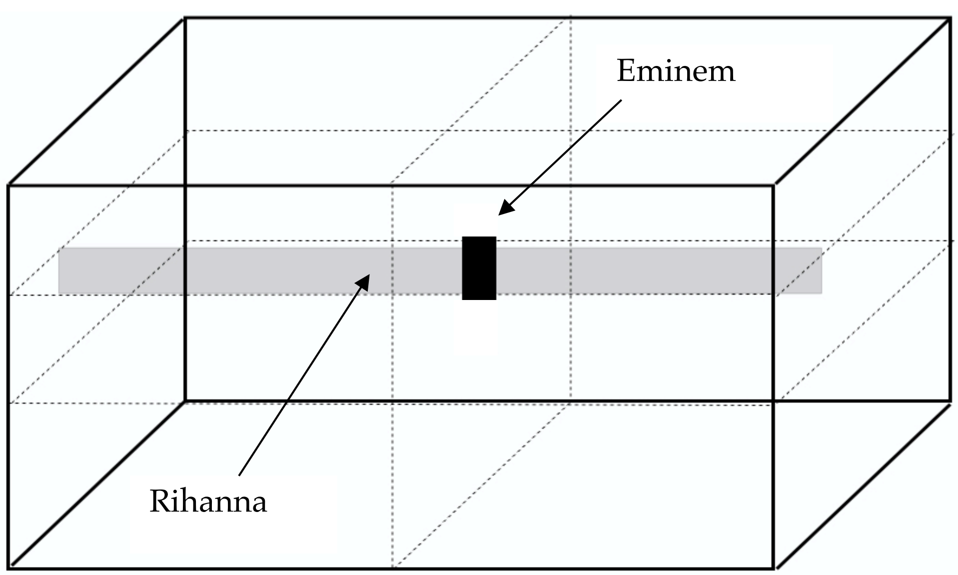

Figure 2.18 Vocal placement in “The Monster” (2013), 0:00–0:52.

Table 2.3 Vocal placement in Eminem and Rihanna's four collaborations

Song	Section	Time	Width	Pitch Height	Prominence	Environment	Layering
Love I (E ft. R)	Rihanna First chorus	0:00–0:25	W3	Bb3–D5	85%	E2	L1
	Eminem Verse 1	0:26–1:10	W1	≈F#3–E4	67%	E1	L1
Love II (R ft. E)	Rihanna First verse	0:00–0:44	W4	Bb3–C5	92%	E5	L1
	Rihanna First chorus	0:45–1:20	W4	G3–D5	47%	E2	L3
	Eminem Verse 3	3:06–4:03	W2	≈D3–F#6	53%	E1	L3
Numb (R ft. E)	Rihanna Chorus	0:40–1:20	W5	Ab3–Gb4	38%	E2	L5
	Eminem Verse 3	2:21–2:49	W3	≈C#3–C#4	62%	E1	L2
Monster (E ft. R)	Rihanna First chorus	0:00–0:18	W4	C#4–B4	89%	E5	L1
	Eminem Verse 1	0:19–0:52	W1	≈F#3–F#4	62%	E1	L1

2.3.2 How can we compare the way Rihanna's and Eminem's voices unfold within the virtual space?

Once an analyst has access to visual representations of the vocal placement, it becomes easy to compare the ways in which two or more singers are sonically presented. Eminem and Rihanna's four collaborations are especially adequate objects of study for comparing vocal placement between two artists. First, both artists appear twice as the main artist and twice as a guest. Table 2.4 shows how this division of labor is reflected in the song's formal structure. As an invited guest, Rihanna provides the chorus; Eminem's role as a featured artist is to rap the third verse.[15] Moreover, each track has been recorded, mixed, and produced at a variety of

[15] Both formal outlines are typical for songs featuring a rapper and a singer. The link between featured artist, vocal delivery, gender, and song structure is further discussed in Chapters 4 and 5.

studios, by different personnel (Table 2.5), lowering the possibility that vocal placement is based on a single engineer's idiosyncratic artistic choices rather than on larger-scale conventions regarding mixing norms within American popular music.[16] Finally, the two versions of "Love the Way You Lie" are especially suited for comparison as they engage in direct dialogue with one another. The songs share the same chorus, and are conceived as mirror images of one another, with Eminem and Rihanna acting respectively as narrators.[17] To compare vocal placement in each song, I discuss each sonic parameter separately. The reader is invited to consult Table 2.3 for a summary of the relevant data.

Table 2.4 Formal structure of Rihanna and Eminem's four collaborations

Song	Chorus	Verse 1	Chorus	Verse 2	Chorus	Bridge	Verse 3	Chorus
Numb (R ft. E)		Rihanna	Rihanna	Rihanna	Rihanna		Eminem	Rihanna
Love II (R ft. E)		Rihanna	Rihanna	Rihanna	Rihanna	Rihanna	Eminem	Rihanna
Love I (E ft. R)	Rihanna	Eminem	Rihanna	Eminem	Rihanna		Eminem	Rihanna
Monster (E ft. R)	Rihanna	Eminem	Rihanna	Eminem	Rihanna		Eminem	Rihanna

[16] For instance, the rapped verses for "Love the Way You Lie" were recorded at Eminem's own Effigy Studios. Rihanna recorded her chorus while on tour, in Dublin's Sun Studios. Mixing engineer Mike Strange explains that he "kept the vocal balance made by Rihanna's people, and simply had Rihanna's vocals come up on the desk in stereo" (Herrera 2010).

[17] Chapter 3 examines the two versions of "Love The Way You Lie" in more detail, with a focus on the narratives of domestic violence that arise from the lyrics, vocal delivery, and vocal placement heard in both songs.

Table 2.5 Personnel of Rihanna and Eminem's four collaborations.

Song	Year	Album	Recorded at	Recording	Mixing	Production
Love I (E ft. R)	2010	*Recovery*	Effigy Studios (Ferndale, MI, USA); Sun Studios (Dublin, Ireland)	Marcos Tovar	Alex da Kid, Mike Strange, Eminem	Alex da Kid, Makeba Riddick
Love II (R ft. E)	2010	*Loud*	Westlake Recording Studios (Los Angeles, CA, USA); Effigy Studios (Ferndale, MI, USA)	Alex da Kid, Kuk Harrell, Josh Gudwin, Bobby Campbell	Manny Marroquin, Erik Madrid, Christian Plata	Alex da Kid
Numb (R ft. E)	2012	*Unapologetic*	Westlake Recording Studios (Los Angeles, CA, USA); Metropolis Studios (London, UK)	Marcos Tovar, Kuk Harrell, Xavier Stephenson	Manny Maroquin	Oak Felder "Ronald Flippa" Colson Andrew "Pop" Wansel
Monster (E ft. R)	2013	*The Marshall Mathers LP 2*	Effigy Studios (Ferndale, MI, USA) Record One (Los Angeles, CA, USA)	Tony Campana, Joe Strange, Mike Strange	Dr. Dre, Mauricio Iragorri, RJ Colston	Aaron "Aalias" Kleinstub, Bryan "Frequency" Fryzel

Width and Panning: In the four tracks, Eminem' and Rihanna's voices are consistently centered within the virtual space. As acknowledged by Moylan (2015) and Zak (2001), this placement is conventional for recorded popular music. Focusing on the width of both artists' voices reveals an interesting trend: Rihanna's voice is always presented as significantly more diffuse than Eminem's, with width ratings of W3, W4, and W5. Eminem's voice, conversely, always occupies a narrower position than Rihanna in the virtual space. Despite minute variations in the width of his voice from song to song, his voice consistently sounds more localized with width ratings of W1, W2, and W3. Rihanna's voice is presented in more reverberant spaces, which accounts for its more diffuse presence within the virtual space. Her singing voice is centered, but the delayed images of her voice are panned toward the sides of the stereo image.

Pitch Height: Rihanna's voice is generally located higher in the virtual space, spanning a range of G3 to D5. across the four tracks. Eminem's rapping voice covers an approximate pitch range of C#3 to F#4.

Prominence: In all songs, apart from "Numb," Rihanna's voice is more prominent than Eminem's. Her voice often appears alone in the virtual space, only supported by a low-amplitude piano or synthesizer. Her voice therefore takes on a prominent role in comparison to the other sound sources heard in the mix.[18]

Environment: Rihanna's voice is always presented in a more reverberant environment than Eminem's. The distinction between their voices is made especially evident in "The Monster" and "Love the Way You Lie," in which Rihanna's vocal environment E5 contrasts with Eminem's flat E1.

Layering: There are few instances of clear and persistent layering in the four songs under study. In "Numb," Rihanna's voice is heavily layered (L5) with harmonies. In "Love the Way You Lie (Part II)" and "Numb," Eminem's voice is subtly ornamented with added layers.

[18] In subsequent choruses, her voice takes on a lower prominence as other accompanying instruments join the mix.

2.4 Conclusion

This chapter has outlined a methodology for precisely locating a voice's placement within the virtual space created in a recording. The method results in visual representations of a voice's width, pitch height, prominence, environment, and layering. The approach may be of use to any analyst wishing to precisely describe vocal placements in recordings. Because each parameter is measured according to a pre-defined scale, the methodology can also be used for comparing two or more vocal placements within the same recording or across different tracks. Finally, while the methodology currently focuses on vocal placement, it could be easily adapted to study the placement of any recorded sound source. Through this methodology, I hope to provide a reliable way to engage with one of the most crucial parameters of recorded popular music.

The analytical examples above have addressed the exact ways in which the vocal placements of Rihanna and Eminem differ throughout their four collaborations. The stark contrast between Rihanna's wide vocal placement and Eminem's narrow position within the virtual space raise the following questions: *why* might Rihanna and Eminem's voices evoke such different spatial characteristics? What do these specific sonic cues convey about their identities and artistic personas? Chapter 3 delves into these questions by providing in-depth analyses of the vocal placement in both versions of "Love the Way You Lie." I show how the methodology outlined in this chapter can help precisely describe how voices create gendered narratives through the way they evolve in virtual space over the duration of a song.

Chapter 3 Vocal Placement and Gender in "Love the Way You Lie" (Eminem feat. Rihanna)

The 2010 single "Love the Way You Lie" (Eminem feat. Rihanna) achieved high commercial success when it was released, remaining at the number one position on the *Billboard* Hot 100 charts from July 31 to September 11, 2010. The significance of the song—a pop/rap ballad depicting an abusive relationship—and its public appeal is intricately linked with Eminem's and Rihanna's artistic trajectories, personal lives, and public personae. Several critics responded to the single by tying it to Rihanna's highly mediatized 2009 assault at the hands of then-boyfriend Chris Brown, along with Eminem's reputation for violent and misogynistic lyrics, particularly in relation to his ex-wife, Kim Anne Scott (Montgomery 2010, McAlpine 2010). The apparent biographical connections between the single and its performers' lives lends the collaboration an air of authenticity. The song's success is partially explained by the purported glimpse it provides the listener into Rihanna's and Eminem's personal lives.

When I listen to the song, I always experience simultaneous and conflicting feelings.[1] First, there is the excitement. With its catchy hook and unfolding narrative, "Love the Way You Lie" (hereafter LTWYL) is a great pop song. Despite Rihanna's delivery of a memorable chorus melody, it's Eminem's verses that I find most exhilarating. The quality of his voice is so evocative that I can easily put myself in his shoes and sense his anger. I know what it's like to speak and scream like him; I imagine myself delivering the same lyrics. Then, there is

[1] The song was a central component to the soundtrack of my late teens, as it regularly played on various radio stations in the early 2010s. I have also listened to the collaboration several times in the past decade as I followed Rihanna's career, and was surprised to see it recently resurface in a TikTok trend (Acevedo 2021). The song also took on another meaning for me as a component of the corpus study conducted in the second chapter of this dissertation.

anticipation. By the end of the second chorus, I always brace myself for the textural and timbral climax of Eminem's final verse, right before his voice merges with Rihanna's as she launches into one last iteration of the chorus. The building intensity in each of Eminem's three verses creates a particularly enjoyable song-length trajectory that ends with a cathartic release.

Along with the excitement and anticipation, I feel an underlying sense of unease at my enjoyment of a song that so explicitly depicts gendered violence. It feels conflicting to eagerly anticipate a musical climax in which Eminem yells "If she ever tries to fucking leave again, I'm a tie her to the bed and set this house on fire." Moreover, I'm uncomfortably aware that the song romanticizes domestic abuse in its lyrical assertion that Rihanna "loves the way it hurts." The music video released along the single, too, perpetuates harmful stereotypes. Jonel Thaller and Jill Theresa Messing (2013) trace the ways in which the music video perpetuates six common myths about intimate partner violence.[2] One of the more common misperceptions, that most women could get out of a violent relationship if they wanted to, is depicted in the video as the young woman portrayed by Megan Fox willingly returns to her abusive partner after meeting his "loving gaze" (627).[3] These problematic lyrical and visual representations contribute to damaging narratives that hold victims of domestic violence—especially Black women—responsible for the abuse to which they are subjected. Adding to my discomfort is Eminem's history of violently misogynistic songs like "Kim" and "97 Bonnie & Clyde." I wonder how a

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[2] The six myths outlined by Thaller and Messing are "(1) Most women could get out of an unsafe relationship if they wanted to; (2) Some women who are abused secretly want to be treated that way; (3) Some women initiate intimate partner violence by treating their men badly or taking the first swing; (4) Most intimate partner violence occurs when a man has been drinking or has lost control of himself; (5) Much of what is referred to as intimate partner violence is a normal reaction to relationship conflict; and (6) Intimate partner violence is low-class, not something that happens in my neighborhood" (Thaller and Messing 2013, 626).

[3] In a similar vein, Stephanie J. Brommer (2016) argues that the music video construes "sexual passion as a normalized component of abusive relationships" (201). Rather than focusing on the potentially harmful effects of this trope, she draws on focus groups discussions with domestic violence caregivers to show that such representations in music videos "validate the emotions and patterns experienced by real women" (204).

man who had previously sonically depicted the murder of his wife could authentically act as a poster child for domestic violence advocacy, one who seemingly overcame his violent impulses and was thus able show his fans realistic depictions of gendered abuse.[4]

Finally, I'm painfully aware that the song is implicitly tied to a traumatic event in Rihanna's life. As a member of the public, I do not know how Rihanna felt when recording "Love the Way You Lie." I do have access, however, to her statements about the song. She has praised the single as "authentic" and "real," stating that "[Eminem] pretty much just broke down the cycle of domestic violence, and it's something that a lot of people don't have a lot of insight on, so this song is a really, really powerful song, and it touches a lot of people" (Rodriguez 2011). It is difficult to perceive this quote outside the context of Brown's assault. A significant part of my unease, then, stems from the fact that I am actively enjoying a song that depicts a Black woman's pain in the wake of gendered violence. Does the popularity of the song stem from a voyeuristic desire, a wish to witness what is presented as an authentic depiction of intimate partner violence? Am I deriving aesthetic pleasure ("such a great verse!") from an implicit depiction of Rihanna's suffering? Is my enjoyment of the song, as a white woman, perpetuating the dynamics of a popular culture that is predicated on depictions of Black women's suffering? By thinking about the ways in which the song's lyrics further reify harmful narratives on gendered violence, am I positing that Rihanna is "guilty" of participating in the collaboration?

This chapter aims to confront these questions by further examining the narratives of domestic violence at play in "Love the Way You Lie." First, I provide a timeline of events

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[4] Doyle (2010) argues that Eminem's apparent repentance in the single is disingenuous, especially in light of his previous songs on gendered violence. More recently, several users on the social media platform TikTok called for a boycott of Eminem in light of his participation in "Love the Way You Lie" (Blair 2021, Kreps 2021, Rolli 2021, Zidel 2021).

relating to Rihanna's and Eminem's musical releases and personal relationships, in order to contextualize the 2010 release of "Love the Way You Lie" and its subsequent reception. Conspicuously absent from academic literature on "Love the Way You Lie" is an in-depth engagement with the song's musical material. While the music video and lyrics are discussed at length in various sources, considerations of Eminem's and Rihanna's vocal performances—along with associated production techniques—are omitted despite their importance in drawing listeners toward the song in the first place.

Second, I bring the song's musical material and its potential for conveying narratives of domestic violence into focus. These singles are arguably Rihanna's most explicit engagements with narratives of domestic violence, and I aim to show how a close analysis of vocal placement and vocal quality can allow us to hear "Love the Way You Lie" not solely as a song that glorifies gendered abuse, but as a genuine and complex response by Rihanna. In a musical industry predicated on celebrity culture, voices serve as an important entry point into the creation of meaning in popular songs.[5] Rihanna's voice—and the way her voice is presented to listeners through a recording —play a central role in delineating the song's narrative. More specifically, I analyze vocal placement, vocal timbre, and the way they interact throughout the song. Vocal placement is analyzed according to the methodology described in Chapter 2. To analyze vocal timbre, I use Kate Heidemann's analytical methodology (2016). Her method invites analysts to consider different aspects of their embodied experience in order to describe vocal timbre. I document my embodied response to Rihanna's vocal placement and vocal timbre throughout two versions of the single: (1) "Love the Way You Lie" on Eminem's album *Recovery* (2010), the

[5] The voice is a central parameter in popular music. Nina Sun Eidsheim writes that "the timbre of a sung vocal line carries as much meaning as do the meaning of the words uttered in a speech-act" (2008, 194). The salience of the voice relates to its potential for creating an embodied listening experience, as it "invites the listener to experience physical empathy" (Young 2015, 3).

version that has gained the most commercial success;[6] and (2) "Love the Way You Lie (Part II)," which was released on Rihanna's album *Loud* (2010) and conceived as a sequel to the original single. Throughout this chapter, both versions of the song are respectively referred to as "LTWYL" and "LTWYL II".

Finally, I show that a serious engagement with the song's musical material—more specifically, Rihanna's vocal performance—allows for an alternate reading of the song that centers Rihanna's perspective without reducing her experience to a harmful victim-blaming narrative. In the last section of the chapter, I draw on Katherine McKittrick and Alexander G. Weheliye's (2017) notion of heartbreak and Donna M. Weir-Soley's (2015) study of Rihanna's experience of traumatic bonding to show how one can read Rihanna's vocal performance as a refusal to subscribe to (1) racialized and gendered archetypes that surround Black women who face gendered violence; and (2) a neoliberal narrative of overcoming and transcendence in the face of abuse. I hear Rihanna's vocal performance as a nexus of conflicting emotions that eludes harmful and reductive narratives of domestic violence. Rihanna's voice allows me to lean into the ambiguous and difficult feelings that can arise in situations of intimate partner violence, opening up a space for more realistic and reparative narratives in popular musical depictions of gendered violence.

Through this chapter, I aim to show how the methodology detailed in Chapter 2 can be used to support close readings of recorded songs. As described in Chapter 1, this approach is informed by two aspects of feminist music theory: (1) a focus on developing new analytical tools (in this case, a methodology for describing vocal placement); and (2) close readings that consider aspects of identity (in this case, events of Rihanna's life). Additionally, my analyses of LTWYL

[6] Among several other accolades, the single was nominated for five Grammy awards in 2010. It sold 12 million copies in the US, and 1.5 million copies in the UK.

and LTWYL II show how the vocal placement methodology can be used in tandem with analytical approaches to vocal timbre. Vocal timbre in musical performance, especially as it relates to issues of gender and sexuality, is a frequent object of analytical inquiry (Greitzer 2013; Heidemann 2014, 2016; Malawey 2020). I show how analyses of vocal timbre can be enriched by discussions of vocal placement—that is, by a consideration of how vocal timbre is packaged for consumption and spatially presented for listeners.

3.1 Chris Brown, Eminem, and Rihanna: A Timeline of Events

The following timeline summarizes the events relevant to Eminem and Rihanna's collaboration on LTWYL and LTWYL II. The timeline surveys the link between incidences of the topic of domestic abuse in Eminem's musical output, Rihanna and Brown's relationship, and release dates of related collaborations between the three artists.

⇒ <u>February 23, 1999:</u> Rapper Marshall Bruce Mathers III (Eminem) releases *The Slim Shady LP,* his second studio album. "'97 Bonnie & Clyde," the seventh track on the album, depicts a fictional scenario in which Eminem talks to his infant daughter Hailie as he disposes of the murdered body of his wife Kim by dumping her into a lake.[7]

⇒ <u>May 23, 2000:</u> Eminem releases *The Marshall Mathers LP,* which contains the track "Kim." Conceived as a prequel to "'97 Bonnie & Clyde," the song depicts the imagined murder of Kim. Eminem performs as himself, occasionally adopting a high-pitched voice to impersonate his wife.

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[7] In September 2001, American singer-songwriter Tori Amos released *Strange Little Girls*, an album containing twelve covers of songs written and performed by men. Amos's rendition of "'97 Bonnie & Clyde" assumes the murdered wife's perspective; she changes the tone and delivery of Eminem's version while retaining his original lyrics. Burns & Woods (2004) and Lacasse & Mimnagh (2005) both provide in-depth analyses of Amos's vocal performance in this cover.

⇒ February 8, 2009: Singers Chris Brown and Robin Rihanna Fenty (Rihanna), a couple since 2007, attend a pre-Grammy Awards party in Los Angeles. While driving home, the couple begins arguing about a series of texts Brown received from an ex-girlfriend. Brown physically assaults Rihanna, repeatedly punching her, slamming her head into the car window, and threatening her with more violence and death. Rihanna manages to escape the vehicle and screams for help, prompting a resident of the area to contact the police.

⇒ February 2009: Shortly after the assault, the police department involved in the case leaks pictures of Rihanna's visibly bruised face to the media. Gossip site TMZ.com is the first to distribute the images, shortly followed by other news sources. Discussions and speculation about the assault proliferate on various celebrity blogs and social media. Some media sources blame Rihanna by implying that she was responsible for instigating Brown's violence (Rothman *et al.* 2012).

⇒ March 5, 2009: Brown is charged with felony assault and is later sentenced to five years of probation and a restraining order.

⇒ June 25, 2010: Release of LTWLY by Eminem featuring Rihanna, as the second single of Eminem's album *Recovery*. The song depicts a physically abusive intimate relationship from the perspective of two unnamed protagonists. Eminem raps the verses from the point of view of an abusive man, while Rihanna sings the choruses as the woman. In the music video released with the song, actors Dominic Monahan and Megan Fox appear alongside Eminem and Rihanna, performing various romanticized scenes of domestic violence.

- ⇒ November 12, 2010: Release of Rihanna's fifth studio album, *Loud,* which contains the song LTWYL II. Envisioned as a sequel to LTWYL, the song centers the woman's perspective as Rihanna provides most of the vocals. Eminem only performs the bridge section.
- ⇒ February 20, 2012: Double release of musical collaborations between Brown and Rihanna**.** Online release of "Birthday Cake" by Rihanna, with Brown as a featured artist. The song is a remix of a short track on Rihanna's sixth studio album, *Talk That Talk* (released on November 18, 2011). Online release of "Turn Up the Music" by Chris Brown, with Rihanna as a featured artist. The song is a remix of the lead single of Brown's fifth studio album, *Fortune* (Released on July 3, 2012).
- ⇒ January 2013: In an interview with *Rolling Stone* (2013), Rihanna states that she has resumed her romantic relationship with Brown.
- ⇒ May 2013: On Australian radio show *The Kyle and Jackie Show,* Brown declares that Rihanna and himself have ended their relationship (Ravitz 2013).

3.2 Vocal Placement and Vocal Quality in "Love the Way You Lie"

In this section, I tease out the salient aspects of Rihanna's vocal performance in LTWYL and LTWYL II. First, I analyze the *vocal quality* of Rihanna's vocal performances. Vocal quality encompasses any audible aspect of the vocal performance—that is, the physical and tangible way in which Rihanna make use of her voice. Malawey writes that this blend of parameters "imparts the feelings, emotions, and meanings that listeners ascribe to the recordings and performances they consume" (2020, 94). I situate my analysis within the trend of embodied feminist music theory, as outlined in Chapter 1. I do so by adopting Kate Heidemann's analytical method for vocal timbre. Her methodology draws on Arnie Cox's "mimetic hypothesis," which posits that listeners experience music through overt (visible, conscious) or covert (invisible, subconscious) motor imitation (Cox 2011, 2016). Heidemann argues that listeners attribute extra-musical meanings to vocal performance by implicitly or explicitly positioning themselves as though they were the ones singing. Heidemann's approach to the analysis of vocal timbre relies on four questions: (1) How do the vocal folds seem to be vibrating? (2) What is the apparent position of the vocal tract? (3) Where do sympathetic vibrations occur in the body? (4) What is the apparent degree of breath support and muscular anchoring? Analysts can answer these questions by being attuned to their own embodied reaction to the vocal performance.

Second, I study *vocal placement* to examine how Rihanna's vocal performance is sonically presented to the listener. As outlined in the previous chapter, vocal placement refers to the apparent position of a singer's voice within the virtual space—the sense of physical space created around a listener as they hear a recorded song on headphones or stereo speakers. I use the methodology outlined in Chapter 2 to precisely show the location of Rihanna's voice in the virtual space throughout both versions of LTWYL. The vocal placements affect the performance space I imagine and influence the way I physically relate to Rihanna's voice.[8] I focus on the ways in which Rihanna's vocal quality is complemented by her vocal placement—that is, the way in which her vocal performance is conveyed to the listener through its spatialization in virtual space.

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[8] Other scholars have offered analyses that tie a song's perceived virtual space with notions of meaning and identity. Brøvig-Hanssen and Danielsen (2016), for instance, consider the ways in which of echo and reverberation create the impression of an otherworldly space in Kate Bush's "Get Out of My House" (1982). In her extensive study of vocal timbre in popular music, Heidemann counts virtual space as one of the parameters through which singers can express gendered and racialized subjectivities (Heidemann 2014). Moore, Schmidt, and Dockwray (2011) provide a typology of virtual spaces—intimate, personal, social, and public—based on Hall's (1963) proxemic zones. See also Doyle (2005), Dibben (2013), Greitzer (2013), Malawey (2020), and Kraugerud (2020). The methodology for analyzing vocal placement within virtual space used in this chapter builds on these studies by proposing a precise way to quantify and depict the ways in which voices operate within recorded spaces.

Through a close examination of Rihanna's vocal quality and vocal placement, and by documenting my own embodied reaction to her performance, I highlight the intricate web of emotions evoked by her performance. Through this analysis, I engage with the song in a way that complements the feelings of enjoyment and discomfort evoked at the opening of this chapter. I show that we can read LTWLY and LTWYL II as characterizing a nexus of conflicting emotions: anger, affection, loneliness, frustration, bonding, and resignation. In the last section of the chapter, I will show how through this vocal performance, we can hear Rihanna's voice as a refusal to subscribe to harmful and reductive narratives of domestic violence.

LTWYL and LTWYL II share the same chorus, as Rihanna sings the melody and lyrics shown in Figure 3.1 While there are minute rhythmic variations between both versions of the chorus, the lyrics, melody, and harmonization remains the same. Despite these similarities, the two versions of the chorus contrast with one another. Rihanna's vocal quality, and the way her voice is conveyed through the recording's virtual space, differs from one version of the song to the next; despite their shared chorus, both songs therefore create contrasting listening experiences.

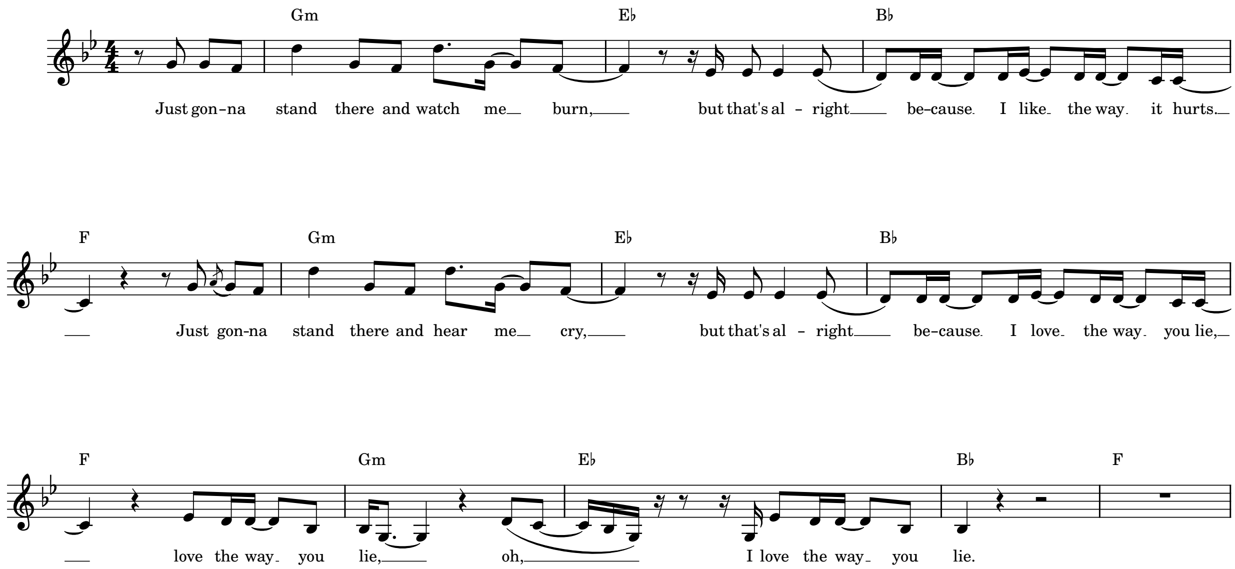

Figure 3.1 “Love the Way You Lie (Part II),” Chorus, 0:45—1:20. Transcription of the vocal melody.

3.2.1 “Love the Way You Lie”

Just gonna stand there and watch me burn
Well that's alright, because I like the way it hurts
Just gonna stand there and hear me cry
Well that's alright, because I love the way you lie
I love the way you lie

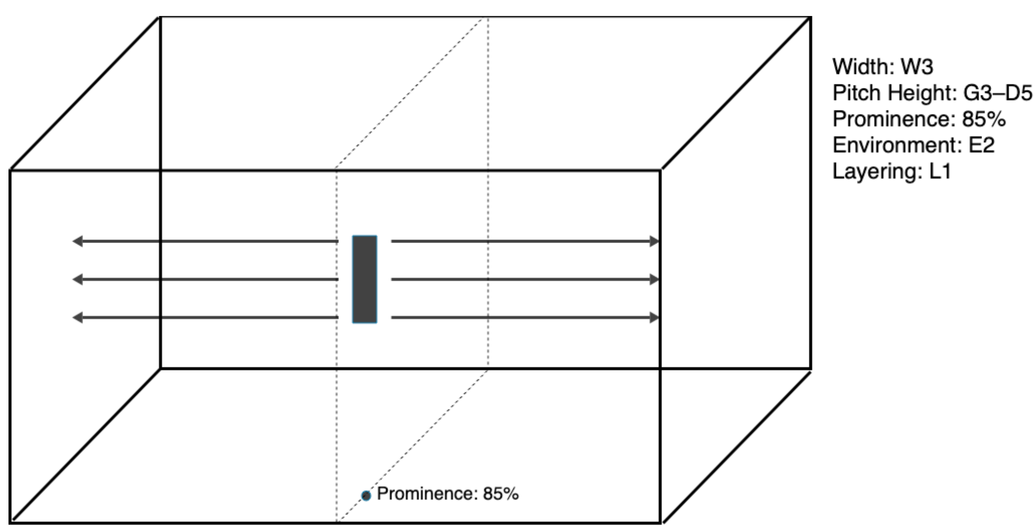

Figure 3.2 Rihanna’s vocal placement and lyrics in “Love the Way You Lie,” Chorus, 0:00–0:25.

"Just gonna stand there and watch me burn?" *(0:00)* As I listen, the words **stand** and **watch** in the first phrase capture my attention. Sharing the pitch of D5, both verbs mark the highest registral point heard thus far. The **stand/watch** pair is also emphasized by Rihanna's use of head voice.[9] This switch in vocal register grants the words a subdued quality that contrasts with the surrounding chest voice.[10] Since Rihanna is able to belt the pitch D5—as can be heard, for instance, in the song "Higher" from her *ANTI* album (2016)—I read her decision to perform these two words in her head voice as a release in tension that creates a sense of vulnerability and fragility. Read on their own, the lyrics are accusatory—the two verbs, highlighting the inaction of the abuser, are a reproach. If the lyrics were spoken, they would take the form of a question. How dare he just stand there and watch me burn? If belted, these lyrics might evoke a sense of anger. Due to Rihanna's vocal performance, however, I hear them as more subdued and resigned ("Yet again, he will stand there and watch me burn"). This resignation is reflected not only through the pitch contour, which sets his actions (standing and watching) at a higher frequency, but in the way she vocally performs the words.

The intimacy of the vocal placement also contributes to this sense of vulnerability. Figure 3.2 displays Rihanna's vocal placement and lyrics in the first chorus of LTWYL. As shown by its position on the depth axis, Rihanna's voice is rather prominent (85%).[11] Through its high amplitude in relationship to other sound sources in the virtual space (the piano, in this case), she

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[9] The head voice has a light tone and is produced by thinly stretched vocal folds. It typically occurs within a high pitch range and features sympathetic vibrations in the head (Malawey 2020, 46).

[10] The chest voice has a rich and overtone heavy timbre. It typically occurs within a low to mid pitch range and features sympathetic vibrations in the chest (Malawey 2020, 42). Belting occurs when a singer extends their use of chest voice to a higher pitch range. Vocal Coach Kim Chandler refers to belting as "a heavy vocal setting above the main passaggio," which is equivalent to "singing at the intensity of yelling or calling" (Chandler 2014, 39).

[11] As discussed in Chapter 2, "Prominence" refers to the perceived depth of a sound source in the virtual space. The prominence of a voice is expressed as a percentage, that represents the portion of a track's amplitude that is occupied by the voice. The "back wall" of the virtual space corresponds to 0% prominence while the "front wall" corresponds to 100% prominence. More prominent voices are therefore positioned closer to the "front wall" of the virtual space.

sounds as though she is positioned toward the front of the virtual space. Additionally, her voice is presented as a singular vocal track (L1)—her voice is not audibly double-tracked, nor is it accompanied by additional layers of harmony of background vocals. The stripped-down vocals, minimal instrumentation, and mild reverberation give me the sense that I'm hearing a live performance by Rihanna, who is alone in a large hall. To me, the single vocal track creates a sound reminiscent of a live performance in an intimate setting; more abstractly, it creates a sense of loneliness as Rihanna is sonically presented as existing in a sparsely populated virtual space.

"Well that's alright, because I like the way it hurts" *(0:06)* Rihanna incorporates a subtle growl sound in her performance of the word **hurts.** A form of text-painting, her lingering on the **r** and incorporation of vocal fry on the **u** emphasizes the physicality of the verb, an acknowledgement of her response to the physical and emotional pain. As Weir-Soley notes in her analysis of the music video for LTWLY, this moment in the song features Rihanna curling her upper lip in a "sneer" (Weir-Soley 2015, 150). In addition to her growl and facial expression, she digs her nails into her face, conveying a state "where intimate pain meets erotic pleasure" (Fleetwood 2012, 426). This moment in the song expresses an ambiguous state in which the sexual pleasure co-mingles with physical pain.

"Just gonna stand there and hear me cry?" *(00:12)* The opening phrase of the chorus is modified for the verb pair **stand** and **hear**, further acknowledging the pain caused by his inaction. Rihanna's performance of the word **cry** evokes the action of crying itself—the word is blurted out, with less control and precision than the previous notes in the chorus. Within the virtual space, the last word of each musical phrase is reverberated and reaches toward the right and left of the stereo field (E2).[12] This feature of her vocal placement is depicted through the

[12] This slight amount of reverberation is shown via the transparency of Rihanna's voice in the virtual space.

arrows shown emerging from her voice in Figure 3.2. Her voice, for instance, is reverberated across the space on the lyric's "burn" and "cry." This occasional use of reverberation has several effects. First, and perhaps more practically, it serves as a sonic filler for the rests that follow the reverberated words. Second, the reverberation emphasizes the actions to which Rihanna is subjected: burning and crying. The word "cry" physically reaches out toward the corner of the virtual space, emulating a cry for help and acknowledging the vulnerability and fear felt by Rihanna. Third, the reverberation contributes to the impression of a large and empty space in which Rihanna is located; it also creates a stark sense of contrast with Eminem's voice, which enters shortly after.

"Well that's alright, because I love the way you lie" *(00:17)* All of the song's choruses—except for the first one—are followed by a short post-chorus section in which Rihanna repeats the ending phrase of the chorus: "I love the way you lie." As is common of post-choruses, the instrumental texture drops in intensity. Any sense of ambivalence, anger, or pain that we may have heard in the chorus disappears, as Rihanna takes on a gentle, and almost cajoling voice: her slightly breathy tone reveals the diminished muscular support she uses to perform this particular line. Upon listening to this section of the song, I feel a softening in my body as I emulate the muscular release enacted by Rihanna. I hear this performance choice, and understand my own bodily response, as symptomatic of a kind of resignation. While Rihanna acknowledges the pain and hurt that the relationship causes her, the gentle repetition of **I love the way you lie** reminds us of the difficult bonding she feels toward him.

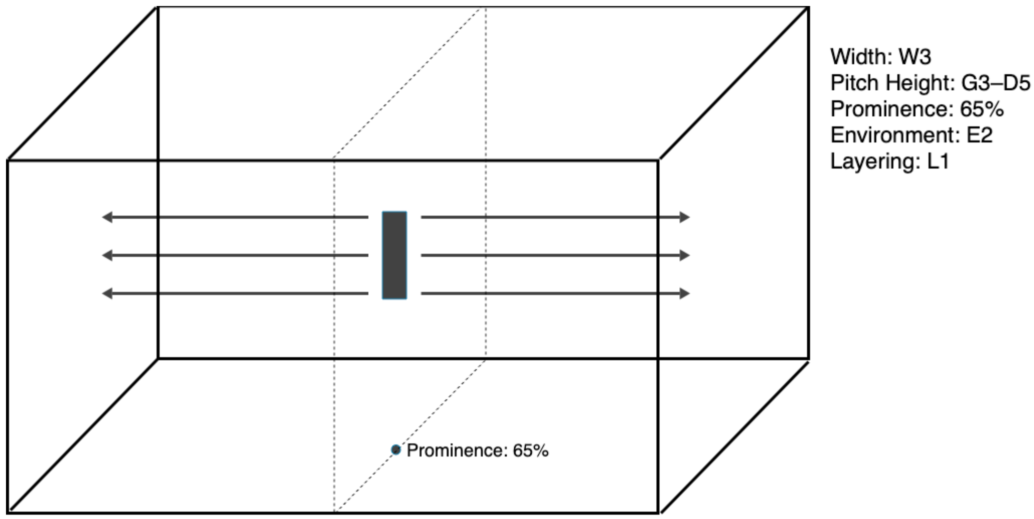

Figure 3.3 Rihanna's vocal placement in "Love the Way You Lie," Chorus, 1:10–1:43.

The opening chorus is the only instance in the song in which Rihanna's voice, stripped down and isolated, is heard so clearly. The same recording of Rihanna's vocal performance is reused for the three subsequent choruses, but the way it fits within the virtual space is re-worked (Figure 3.3). First, the heavier instrumentation causes her voice to recede in the background (prominence of 64%) and obscures the subtle use of reverberation at phrase endings. Moreover, added vocal harmonies lend Rihanna's voice a more textured aspect (L3), while also moving away from the live performance experience of the first chorus.

The fact that a single vocal performance by Rihanna was reworked to fill four different choruses—while a very common practice—has rich implications. Her voice takes on an almost decorative quality because it becomes a simple sonic material to be repeated, re-mixed, and re-manipulated at every chorus. While Eminem is responsible for advancing the song's narrative, performing a series of contrasting verses, Rihanna's voice becomes a static object, a fixed musical performance repeated throughout the song. On the one hand, we can read this sonic objectification of Rihanna's voice as one further way in which women are stripped of individuality and identity. This reading of Rihanna's repeated vocals resonates with the work process through which the single was recorded and mixed. LTWLY was mixed by Mike Strange, who has said the following of Rihanna's vocals:

> Rihanna recorded her vocals while on the road. They consist of seven stereo vocal tracks, and basically we left these exactly as they were given to us. We added a bit of SSL EQ and compression, and some reverb, but not much. In fact, I kept the vocal balance made by Rihanna's people, and simply had Rihanna's vocals come up on the desk in stereo. Often when we work with another vocalist, we figure that they have done what they want, and so we prefer to leave it. (Tingen 2010)

In the construction of the single, Rihanna's voice becomes a disembodied sound, a musical material to be used as an ornamental chorus for Eminem. Having recorded only one instance of the chorus, she is somewhat disengaged from the performance. At the beginning of the song, Rihanna's voice evoked a sense of vulnerability and loneliness through its bare vocal placement and call for help on the word "cry". As her vocal performance is re-contextualized in a busier virtual space in subsequent choruses, her performance becomes colder and less evocative.[13] I understand this contradiction between two emotional states as exemplifying the conflicting feelings that she is exploring through her vocal performance.

[13] As discussed in the final part of this chapter, Weheliye and McKittrick's read Rihanna's cold delivery as emotional disengagement. Similarly, we could hear the repeated vocal performance in LTWYL choruses as a refusal by Rihanna to perform emotional labor.

3.2.2 "Love the Way You Lie (Part II)"

On the first page of our story
The future seemed so bright
Then this thing turned out so evil
I don't know why I'm still surprised
Even angels have their wicked schemes
And you take that to new extremes
But you'll always be my hero
Even though you've lost your mind

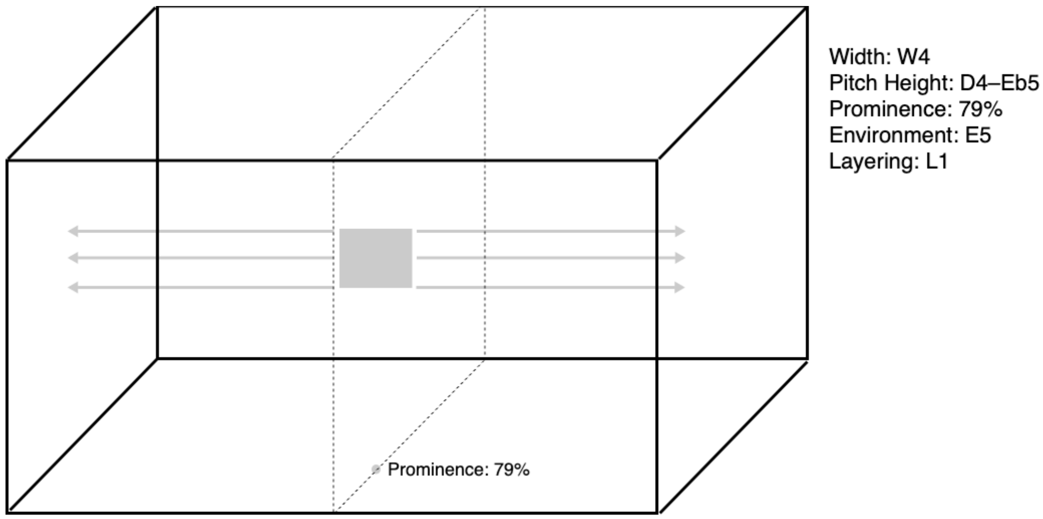

Figure 3.4 Rihanna's vocal placement and lyrics in "Love the Way You Lie (Part II)," Verse and Pre-Chorus (0:00–0:45).

Despite sharing the same melody, the chorus in LTWYL II features a very different vocal performance from Rihanna. This chorus is now preceded by a verse: **"On the first page of our story, the future seemed so bright"** *(0:00)* In this initial phrase, Rihanna's voice sounds soothing. "On the first day," specifically, sounds especially caring and loving because she almost coos the words. There is a small amount of vocal fry, and she is not using a lot of resonance on the vowels in "f**i**rst" and "d**a**y". Given that this particular phrase is addressed to the abuser, but we don't know the specifics of their relationship yet, this opening of the song makes it seem like a kind of love ballad. We can perhaps think of this opening as an instance in which Rihanna is reflecting about how she originally felt in the relationship.

"Then this thing turned out so evil, don't know why I'm still surprised" *(0:12)* This is the first sign that something is awry. A sense of anger seeps through Rihanna's voice—when she sings the word **evil**, I hear it as full of restrained energy.[14] Her voice has more muscular support on that word; her throat opens up and there is a bit of vibrato as the vowels resonate in her face. The reverberated images of her voice that spread across the virtual space (E5) contribute to the sense of space created by Rihanna's vocal performance.

"Even angels have their wicked schemes, and you take that to new extremes" *(0:23)* The sense of energy ignited with the word **evil** continues to build up. As Rihanna's voice climbs in its register, I experience an embodied sense of rising tension as I imagine the increase in energy necessary for performing this phrase. First, I physically emulate the energy and muscular support that Rihanna exerts to sing in this higher register in her chest voice. Second, when she breaks into her head voice on **-gels have, schemes, take that,** and **extremes,** her voice now resonates in her head rather than her chest. The two sensations of increase—one metaphorical, as I experience a rise in energy, and one literal, as I emulate an ascent in resonance from chest to head—evoke a rising a sense of anger and frustration.

This increase in energy is also reflected in the vocal placement of the verse (Figure 3.4). In this version, Rihanna's voice is consistently accompanied by two delayed copies of itself (E5). Listen, for instance, to how two lower-amplitude copies of Rihanna's voice shoot through the virtual space, first reaching the left, then the right sides of the stereo stage. This use of delay is a common technique used by Manny Maroquin, the engineer who mixed Rihanna's vocals in this version of the song. While this type of delay is common in a lot of recorded popular music, as it adds textural and rhythmic interest to what would otherwise be a single vocal layer, I hear this

[14] She adopts a similar vocal delivery on the word **battles,** found at the corresponding moment in the second verse.

particular stylistic choice as rife with extra-musical connotations. Rihanna no longer sounds isolated and crying out for help in the middle of the virtual space. Her voice takes on an imposing presence, moving freely across the stereo stage as its delayed copies unfold.

“But you’ll always be my hero, even though you’ve lost your mind” *(0:35)* The sense of energy established in the previous line suddenly disappears as Rihanna returns to the loving tone of the beginning. Having heard the anger bubbling under the surface, I can no longer hear this tone as earnest. The gentle tone and breathy voice now sound ironic as Rihanna acknowledges the cycle in which she feels trapped. Robin James (2020) touches upon a similar sense of irony when analyzing Rihanna’s vocal performance in “Love on the Brain.” Rihanna’s singing, James argues, does not express the literal meaning of the lyrics but rather the singer’s frustration at their content.

Just gonna stand there and watch me burn
But that's alright because I like the way it hurts
Just gonna stand there and hear me cry
But that's alright because I love the way you lie
I love the way you lie, oh, I love the way you lie

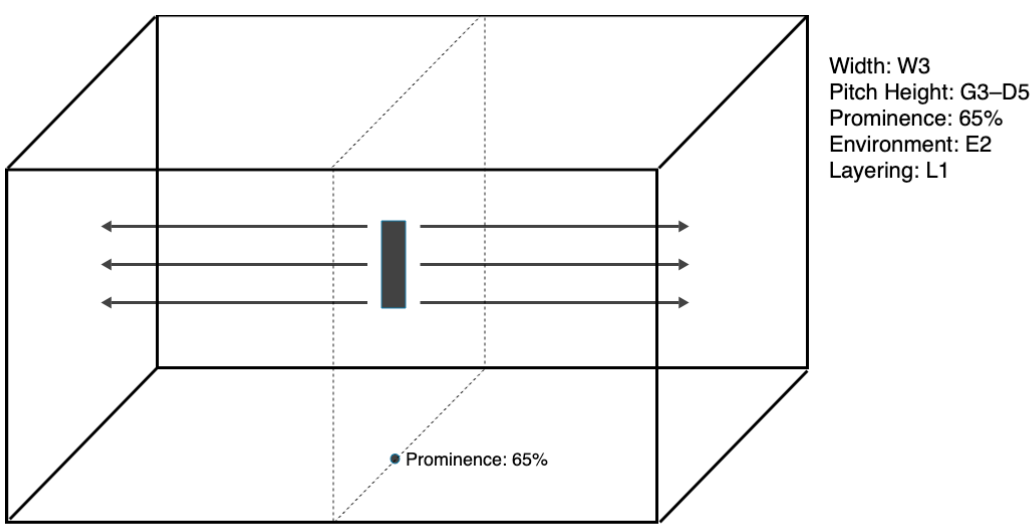

Figure 3.5 Rihanna’s vocal placement and lyrics in “Love the Way You Lie (Part II),” Chorus (0:45–1:20).

The chorus of LTWYL II is characterized by a sense of restrained vocal energy. **"Just gonna stand there and watch me burn?"** *(0:45)* In this iteration of the chorus, Rihanna delivers the words **stand** and **watch** in a vocal register that blends with the surrounding phrase, infusing both words with a powerful anger.[15] As I sense a rise in the tension of my vocal folds, **stand** and **watch** now strike me as an accusation. He just stands there and watches me burn. Rihanna's contempt and rage is especially evident in her delivery of **burn.** She lingers on the **b** as though she's gathering energy to spit out the word "…**bbbburn.**" I can picture the scornful face needed to emulate her performance of the word. I hear in Rihanna's voice an expression of loathing toward her partner's complacency, as though she can barely bring herself to admit the extent of his inaction.

Accompanied by percussion, piano, and synthesizer, her voice is significantly less prominent (58%) on the depth axis of the virtual space than it was in LTWYL and in the verse and pre-chorus of LTWYL II. Less salient in the virtual space, her voice is now accompanied by a thicker instrumental texture. I no longer have the impression that she is performing alone, and the sense of intimacy created in the opening chorus of LTWYL has disappeared. Instead, Rihanna's voice is staged among various other sound sources, and she performs in her chest voice so that her voice can better carry. The sense of vulnerability evoked by the intimate vocal placement of LTWYL is replaced by feelings of disgust and anger.

"Well, that's alright, because I like the way it hurts" *(0:51)* The descending vocal melody and the way Rihanna blurts the vowels in "l**i**ke," "w**a**y" and "h**u**rts" contributes to the sense of disgust I heard in the previous phrase. Rihanna is in a rush to get rid of the phrase, as

[15] Rihanna perhaps delivers **stand** and **burn** in her "mix" voice, which refers to a blended register between chest and head voice. Chandler defines the "mix" voice as "the continuation of a 'chest'-like tone above the passaggio but with more 'Twang' and 'Cry' added" (Chandler 2014, 39). This performance of the phrase contrasts with that of LTWYL, where Rihanna performed with a clear demarcation between her chest and head voice.

her sense of revulsion turns inwards: she loathes the fact that she supposedly "enjoys the way it hurts"; she loathes the way that others will say she wanted it.[16]

"Just gonna stand there and hear me cry?" *(0:57)* Rihanna's performance of these words strikes me as highly expressive of an ambivalent emotional state. In the second chorus, which begins at 2:10, **hear** is delayed by half a beat (from its usual position in the other choruses). At this point in the song, I have already heard this melodic pattern three times and expect the **hear** on the third beat of the measure. The half-beat delay causes me to precipitously adjust my breathing pattern. This pause in the vocal melody (indicated by an arrow in Figure 3.6) evokes a sob, a break that Rihanna takes as she composes herself through tears in order to keep singing.

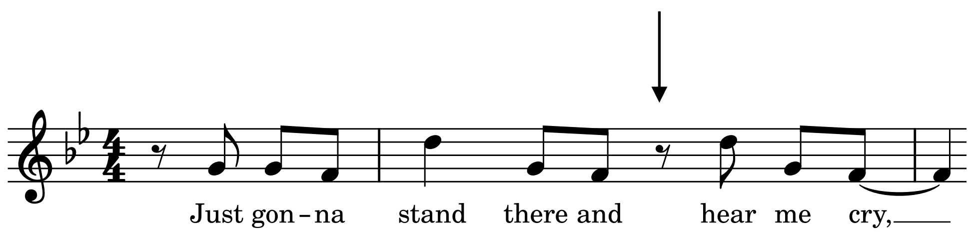

Figure 3.6 Pause before the lyric "hear me cry" in "Love the Way You Lie (Part II)," Chorus, 2:21.

"Well, that's alright, because I love the way you lie" *(1:03)* The word **lie** at the end of the chorus is marked by lots of vibrato, assertion, and controlled energy. When listening to it and placing my own body the same way that Rihanna would when performing this, I get a sense of controlled energy—she ends the chorus on a powerful note, as she denounces his lies. She could sing much louder or with less control but her contained vocal performance evokes a powerful and confident woman. This sense of poise strikes me as another facet of the complex blend of

[16] See Badour & Adams (2015) and Akça (2018) and for discussions of disgust and self-disgust as a response to trauma.

contradictory emotions—sadness, disgust, contempt, rage, resignation, and care—expressed throughout Rihanna's vocal performance in LTWYL II. As I will discuss in the next section of this chapter, these emotions represent a realistic response to domestic violence that eschews harmful tropes that often surround survivors of abuse.

Throughout her performance in the song, her voice is never layered by other vocals or added harmonies (L1). It remains alone in the virtual space, taking on a commanding aura as it travels across the stereo stage. While I can read this vocal placement as more assertive or angry than in LTWYL, I can also hear these delayed copies as evocative of solitude. Rihanna's words repeat over and over again, with no resolution or answer. She is alone with obsessive thoughts which unfold around her in ever-expanding concentric circles. In this performance of LTWYL II, Rihanna's vocal placement evokes emotions—assertion, anger, obsession—that complement the sense of vulnerability and loneliness I hear in LTWYL. Both performances of the single make me hear and feel different facets of the complex emotions that can arise because of gendered violence.

As described at the end of Chapter 2, Eminem's vocal placements in LTWYL and LTWYL II offers a stark contrast with those of Rihanna. Through both singles, his vocal placement is much narrower than Rihanna's, with a consistent width value of W1. His voice is occasionally layered (L2) and always positioned in a non-reverberant environment (E1). When I listen to his voice in both versions of the single, certain images, impressions, and experiences come to mind. His voice occupies a narrow and definite space in the center of the virtual space. If I close my eyes and focus on what's coming out of my headphones, I can imagine Eminem as though he were placed directly in front of me on a stage. His narrow and centralized vocal placement positions him as the primary subject of the song. In LTWYL, the centrality of

Eminem's voice is also compounded by the fact that he advances the narrative by delivering all the verses. Rihanna's voice, conversely, takes on a more decorative function as it repeats the same chorus lyrics while being reverberated across the stereo stage. In LTWYL II, the roles are reversed as Rihanna takes on the verses. Eminem only appears in the song's third verse, but his narrow and focused voice still brings attention to his persona by providing a stark contrast with Rihanna's vocal placement.

Eminem's narrow vocal placements in LTWYL and LTWYL II complement his vocal timbre. Throughout both singles, he adopts his signature nasal, occasionally shouted rap. As both songs reach their climax at the end of their respective third verse, his voice sounds increasingly hoarse and frantic. Eminem's vocal delivery contributes to a sense of claustrophobia: from his constricted vocal placement, he seems to struggle to be heard against the accompanying instruments. His vocal placement and vocal timbre both convey the anger, frustration, and violence expressed in the lyrics. The vocal placement also evokes an explosive self-loathing, a sense of frustration with his own inability to control his anger and his own unwillingness to change. Overall, Rihanna's voice is presented as more multi-dimensional, malleable, and expressive than Eminem's. Her vocal quality and vocal placement evoke a much larger range of emotional states. Despite the decorative function of her voice, I hear her voice as freer. Dynamic and active, her vocal placements contrast with Eminem's as they occupy more room within the virtual space.

3.3 Narratives of Domestic Violence Surrounding "Love the Way You Lie"

This section ties the above analysis of Rihanna's vocal timbre and vocal placement to narratives of domestic violence that have surrounded LTWYL and LTWYL II. After surveying the way these narratives have shaped the reception Rihanna's and Eminem's collaborations, I offer a reading of the conflicting emotions in her vocal performance as a way through which Rihanna eschews these narratives.

The events described in the timeline earlier in this chapter have been the topic of a significant amount of academic scholarship. This body of work has mostly focused on the ways in which public responses to Brown's assault of Rihanna fit within overarching narratives and depictions of domestic violence in the United States. The assault is often framed in light of Rihanna's subsequent song and video releases. Suzanne Marie Enck and Blake A. McDaniel (2012), for instance, tie the video to larger-scale narratives surrounding Eminem, Rihanna, and Chris Brown. Megan Fox's character, who is depicted as initiating and reciprocating violence, stands in for Rihanna, who has been accused by bloggers and media of provoking Brown's violent outburst. By being held responsible for the assault, Rihanna "comes to stand in for all victims of abuse, especially women of color, who are held accountable for their own abuse" (619). Here, Enck and McDaniel refer to harmful tropes of domestic violence that position victims as guilty and responsible for the abuse. I will explore these tropes in more detail in the next pages. While the video serves to further reify Rihanna's status as "guilty," it concurrently allows Eminem to redeem his public image. Enck and McDaniel view the release of the song on the album *Recovery* as a marketing ploy by Eminem to gain forgiveness for and transcend the past releases of violently misogynistic songs. This strategic move allows him to maintain a Honeymoon phase with the public. [17] Finally, Chris Brown is implicitly absolved of culpability because of Rihanna's alleged incitation to violence. As a result, he is forgiven by a public eager "to place him back into some category of recuperated masculinity" (633).[18]

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[17] The cycle of abuse comprises of four phases: (1) Tension, (2) Explosion, (3) Remorse, and (4) Honeymoon (Walker 1980).
[18] Enck and McDaniel's analysis of Brown focuses on his "fall from grace" and loss of access to hegemonic

Within the literature on LTWLY, several authors focus on the fact that the popular narratives on the assault have been shaped by Rihanna's and Brown's race and gender. Black feminist theory, which has shown how gender, sexuality, race, and class must be analyzed together, is key to understanding the various reactions to Brown's assault of Rihanna.[19] Indeed, Black women's representation as victims of domestic and sexual violence is shaped by long-established stereotypes that are both racialized and gendered. In *Women, Race, and Class,* Angela Davis writes that the institutionalized sexual abuse of enslaved Black women at the hands of white men created a pervasive discourse on Black women's sexuality. This discourse, which outlived the institution of slavery, created the "image of the Black woman as chronically promiscuous" (Davis 1981, 189). Patricia Hill Collins describes how such stereotypes, in tandem with the common portrayal of Black men as rapists, created an understanding of Black women as "sexually deviant" women who were "denied legitimacy as rape victims" (Collins 1998, 918). Through their analyses, Davis and Collins show how Black women's experiences with violence cannot be satisfactorily encapsulated by only considering race *or* gender. To effectively account for the narratives of violence that affect Black women, one must consider how both systems of oppression—race *and* gender—overlap and constitute new forms of oppression.[20] The

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masculinity after the assault. Robin James's analysis of the assault's media reporting adds another layer of complexity by examining the ways in which Black men are criminalized more readily than white men. She writes that "white supremacy—in this example, the media's racist treatment of Brown …—makes it impossible to clearly put people into clear-cut victim and aggressor boxes. Brown, for example, was both Rihanna's aggressor and the racist media's victim" (James 2020, 17).

[19] While I cannot purport to have reviewed the entirety of literature on the intersection of gender, race, and violence (domestic, sexual, state-sanctioned, and their intersections), I invite the reader to refer to Madriz (1997) and Meyers (2004), who survey the media representations of African American women and violence from the 1980s onwards. Crenshaw (1990, 1991), Collins (1990, 1998), and Davis (1981) address the topic at length. In *Margins to Center* (1984), bell hooks ties the violence that arises from male supremacy to the Western philosophy of hierarchical rule, calling for an elimination of this foundation in order to remove violence at the root. See also Potter 2008, Mukhopadhyay 2008, and Maynard 2017.

[20] Legal scholar Kimberlé Crenshaw coined the term "intersectionality" in reference to analytical frameworks that consider the new forms of oppression caused by interlocking systems of dominance (Crenshaw 1989, 1991). Prior to Crenshaw's naming of the concept, several Black feminist theorists have called for analytical methods that consider

mainstream blame of Rihanna is rooted in a long history of images that portray Black women as "guilty" of assault, or "bad victims." More specifically, public reactions to Brown's assault of Rihanna have been shaped by various gendered and racialized stereotypes: The *Sapphire* (Jewell 1993, West 1995), the *Island Woman* (Bierria 2011)*,* and the *strong Black woman* (Morgan 1999, Collins 2004). Through these archetypes, Rihanna was represented by the media as both responsible for and victimized by the abuse.

The *Sapphire* archetype depicts a Black woman—often represented in the midst of a heated argument with a Black man—who is angry, nagging, and opinionated. Jewell notes that the *Sapphire*'s sheer existence is "predicated upon the presence of the corrupt African American male," who is then emasculated through the *Sapphire*'s "sassiness" (Jewell 1993, 45). Alisa Bierria (2011) notes that in online debates about the assault, the onus of the conversation focused on Rihanna's accountability: "What had she done to provoke Brown that night? What is she teaching girls about staying in abusive relationships? Why isn't she prosecuting her abusive boyfriend?" (Bierria 2011, 102).[21] Enck and McDaniel write that accounts of Rihanna that depict her as equally responsible as Brown for the violence, as "position[ing] Rihanna within the

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the intersection of race, class, and gender. In addition to previously cited work by Davis, Collins, and hooks, see The Combahee River Collective Statement (Taylor 2017).

[21] Such public reactions inevitably trickle down to young girls, who internalize these messages. Stephens and Eaton (2017) report a particular reaction from a thirteen-year-old Black girl who stated that "I think it, well, me and my friends we all decided together that it was, it was Rihanna's fault because Chris Brown would have never did that if they weren't together that night or, or like they were in, like if Rihanna would've never said what she said to make Chris Brown want to beat her up or whatever" (Stephens and Eaton 2017, 391).

stereotype of the nagging, antagonistic Sapphire" (Enck and McDaniel 2012, 627). Rihanna is therefore denied the status of "good victim"[22] by being held responsible for the assault.[23]

The archetype of the *Island Woman* has also shaped public discourse surrounding the assault. Rihanna was born in 1988 in Saint Michael, Barbados, and moved to the United States in 2005. Alisa Bierria notes that Rihanna's public image is therefore shaped by discourses of racialized sexism and imperialism. "Within the United States," she writes, "Afro-Caribbean women are constructed through a prism of violent ideologies that are rooted in historical processes of British colonial expansion and the trans-Atlantic slave trade, and reinforced through contemporary U.S. imperial interests and transnational tourist industries in the Caribbean and Latin America" (Bierria 2011, 105). Rihanna—and *Island Women* in general—are constructed as exotic, erotic, and dangerous women, who are to be subjugated and controlled under a system of white heteropatriarchal dominance.[24] This stereotype intersects with the *Sapphire* archetype to portray Rihanna as a dangerous and out-of-control woman who is responsible for and implicitly deserving of the violence inflicted upon her.

Finally, Rihanna is portrayed through the archetype of the *strong Black woman*. This image depicts Black women as resistant to adversity and enduring. In sharing her decision to "retire" from being a *strong Black woman,* Joan Morgan outlines the stereotype and the

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[22] The harmful notion of "good victim" relies on the idea women should behave, dress, and react a certain way in order to be perceived as innocent and ideal victims. As Esther Madriz writes, "the fear that 'something bad can happen to them' teaches women at a very early age what 'their place' is; who is expected to be strong and who weak; who should be protected and who should protect; what women should wear and what type of activities they should or should not engage in. If these clear, gendered rules of behavior are not strictly followed, women get the blame for their own victimization, because good women are supposed to 'know better.'" (Madriz 1997, 41). See Meyers (2004) for more on the notion of the "good victim."
[23] See for instance Gamboa (2012), who lambasts Rihanna for returning with Brown by stating that they both "deserve each other."
[24] For more information on the dynamics of imperialism, colonization, tourism, sexuality, and the objectification of women (not limited to the Caribbean), see Trask (1991); Alexander (1996); O'Brien (2006); Holmes (2016); Amor (2017).

expectations that it puts on her as follows: "…by the sole virtues of my race and my gender I was supposed to be the consummate professional, handle any life crisis, be the dependable rock for every soul who needed me, and, yes, the classic—require less from my lovers than they did from me…" (1999, 87). Hillary Potter (2008) identifies a tension at the heart of this stereotype. It can point to and celebrate, she notes, the strength and resiliency of Black women.[25] When internalized by Black women or otherwise deployed in interpersonal relationships and policies, however, the archetype may erase, overlook, or ignore real challenges, struggles, and calls for help.[26] Popular depictions of the *strong Black woman* imply that Rihanna should "be tough enough to protect herself from any backlash" (Enck and McDaniel 2012, 628) that comes from allegedly provoking Brown.

Kristin Rodier and Michelle Meagher have written about the link between the archetype of the *strong Black woman* and the neoliberal paradigm under which individuals are held responsible both for past abuse and future transcendence and recovery. The case of Rihanna, they argue, exemplifies the difficulties of effectively addressing domestic violence while women are positioned as neoliberal subjects who are compelled to take control and individual action over the violence they face. This subject position is encouraged through "problematic temporal imperatives meant to bolster women's agency" (177) as women are pressured to survive, overcome, and finally transcend abuse. Rodier and Meagher identify signs of this neoliberal framing of domestic violence within the advice dispensed to Rihanna after the assault. In publicly encouraging Rihanna to leave Brown after the assault, talk-show host Oprah Winfrey

[25] As Morgan writes, the *strong Black woman* archetype is "not to be confused with being strong, black, and a woman" (Morgan 1999, 87).
[26] Donovan & West (2014), West *et al.* (2016), Young (2018), and Geyton *et al.* (2020) address the internalization of the *strong Black woman* stereotype.

implicitly puts the task of "moving forward" upon Rihanna.[27] As a *strong Black woman*, Rihanna is responsible for fixing the situation, leaving the relationship, and moving on. This trope is problematic because instead of holding the perpetrators of domestic violence accountable, it puts the responsibility of "overcoming" abuse on the victims. Under this paradigm, there is no focus on the systems that enable violence and patriarchy, nor on the establishment of institutions that could and should protect victims of abuse: the onus is on individual women and on how they react to violence.

In addition to shaping popular and media reception of the assault, these gendered and racialized archetypes have also shaped the reception to Rihanna's subsequent artistic output. Some of Rihanna's post-2010 songs and videos make use of lyrics and imagery depicting sexual and physically intimate violence.[28] These explicit videos—"Bitch Better Have My Money," for instance, features Rihanna on a vengeful murderous spree, complete with shots of the naked and blood-soaked singer lounging in a trunk of cash—have been dismissed as an anti-feminist "woman-hating, sub-snuff video" (Ferreday 2017, 264).[29] Debra Ferreday reads such critiques as symptomatic of a white feminist gaze that (1) positions Rihanna as responsible for the gendered

[27] Oprah's exhortation could be seen as an example of popular feminism, which, as Sarah Banet-Weiser points out, taps into "a neoliberal notion of individual capacity" (Banet-Weiser 2018, 4). Oprah aims to "empower" Rihanna by entrusting her with the task to overcome, therefore precluding any discussions of deep structural inequities that enable this type of abuse in the first place.

[28] These singles include "S&M" (released on *Loud,* 2010), "Man Down" (released on *Loud,* 2010), "We Found Love" (released on *Talk That Talk,* 2011 and featuring DJ Calvin Harris), and "Bitch Better Have My Money" (released as a single in 2015).

[29] Such dismissals of Rihanna, which are rooted in limited understandings of what counts as a legitimate feminism, also draw on a politics of respectability that seeks to limit acceptable expressions of sexuality to white, monogamous, and hetero-normative contexts. In a recent book review, Robert Goddard expresses such a view: "The problem of course is that what to some viewers looks like subversion of patriarchy looks to others like submission to patriarchy. [Rihanna] is a tremendous talent, and has rightly made fortunes for herself and the media conglomerates that own her. But does she control her image and mobilize it in socially transformative ways? The contrast with Beyoncé, while invidious perhaps, is helpful. Both are pop divas, but Beyoncé is married to Jay Z, with whom she has a child, and is known for her political activism on behalf of civil rights. My daughters sum it up like this: Rihanna's music is irresistible, but role model she is not; Beyoncé is" (Goddard 2017, 163).

violence she is critiquing; and (2) portrays her, and by extension other Black women artists, as victims in need of rescue. She is depicted, to borrow Houlihan and Raynor's formulation, as both "risky" and "at-risk."

Nicole R. Fleetwood (2012) reads Rihanna's artistic decision to eroticize her body and make use of violent images in post-2010 music videos as a deliberate strategy to eschew narratives of transcendence and survival that surround Black women who are living/have lived through domestic violence. Instead of "abiding by the protocols of the black female survivor of violence who repudiated her abuser" (42), she repeatedly—and often scandalously—depicts an intricate nexus of intimacy, sexuality, eroticism, and violence. Fleetwood remarks that through these videos, Rihanna refuses to conform to common neoliberal narratives of "victimization and survival" to instead promote an alternate vision for Black female sexuality. Through her interpretation of Rihanna's musical and artistic output after the assault, Fleetwood shows how Rihanna avoids and rejects the pervasive stereotypes that stick to Black women. She refuses to be a *strong Black woman* who emerged unscathed from abuse; she rejects the neoliberal imperative to move on and overcome; and she refuses to be both victimized by and blamed for the assault. Additionally, Robin James (2015) has written on the negative reception of some of Rihanna's post-2010 musical releases. A *New York Times* review of the 2012 album *Unapologetic,* for instance, deemed Rihanna's decision to collaborate with Chris Brown on the track "Nobody's Business" as immature and pre-feminist. James frames this type of negative reception within cultural imperatives that oblige Rihanna to resiliently overcome abuse. Instead of following the prescribed path of resilience, James argues, Rihanna prefers to "perform a *melancholic* attachment to non-bourgeois black masculinity and to biopolitical death" (James

2015, 142). Both Fleetwood and James are concerned with the ways in which Rihanna's musical output *rejects* gendered and racialized narratives and archetypes of domestic violence.

McKittrick and Weheliye frame Rihanna's public and musical reactions to the assault as an example of "heartbreak": an "aesthetic-physiological practice" that emulates "what it means to be Black and human within the context of white supremacy" (2017, 22). The notion of heartbreak encompasses both the aesthetic pleasure that can be derived from musical practice while acknowledging the pain and suffering at its root. Rihanna, they write, has enacted heartbreak in the ways in which she faced the public after Brown's assault:

> Fenty refused again and again to become the proper and respectable poster child for victims of intimate partner violence, even though she was continually vilified as a "crazy Island woman" and confronted with her violated past and the images thereof as incontrovertible proof. In other words, the mainstream media demanded that she publicly provide the affective labor of being a violated Black woman by performing victimhood in very specific ways that would vilify Brown; she did neither… Fenty refuses being (and thus cannot be) conscripted in the longstanding narrative of the Black-super-woman-machine, who feels no pain, who does all the care work, who labors on behalf of everyone except herself. Instead, she implicitly states, "I can never be your robot." She sits with and lives on and with the heartbreak, moving on but never completely leaving the scene. (McKittrick and Weheliye 2017, 22–23)

Through her disengagement from harmful archetypes, Rihanna engages in a practice of heartbreak that calls on us to examine difficult questions about abuse and trauma. What happens if you still love your abuser? What happens if you feel empathetic toward your abuser? What happens if you don't want to be victimized, but still need care and empathy? What happens if you can't overcome, can't answer the neoliberal call to "move on", and don't want to be forever labelled as a survivor? These complex and sometimes contradictory feelings are evident, Donna Aza Weir-Soley argues, in Rihanna's public statements and interviews since the assault. Weir-Soley finds evidence of traumatic bonding in Rihanna's words and lyrics: feelings of denial, bonding, anger, shame, guilt, worthlessness, and loneliness (2015). McKittrick and Weheliye's notion of heartbreak provides a framework for understanding the complex nexus of emotions and seemingly conflicting narratives without having to choose one over the other.

Rihanna's willful disengagement with popular narratives surrounding abuse and survival is not restricted to interviews and public statements. There are two instances in which authors analyze Rihanna's *singing voice* to examine her performance of heartbreak. In their analysis of "We Found Love," McKittrick and Weheliye tie the "cool affect" of Rihanna's voice—along with its contrast with the song's complex instrumental texture—with a refusal to engage in the "care work demanded from the Black female voice in popular music" (2017, 24). Similarly, Robin James understands Rihanna's vocal delivery in "Love on the Brain" as a sarcastic reading of the lyrics that complicate "otherwise straight-forwardly misogynist lyrics about heterosexual relationships" (2020, 89). While James does not explicitly relate Rihanna's vocal performance in the single to Brown's assault, she is interested in the ways in which Rihanna can use vocal performance as a way to imagine more just and nurturing worlds.[30]

With the analysis presented earlier in this chapter, I aimed to complement McKittrick and Weheliye's and James's analyses through a close reading of Rihanna's voice in both versions of "Love the Way You Lie." Rihanna's vocal performance and the placement of her voice within the recordings can be read as a site of ambiguity that represents a nexus of emotions, relating both the notion of traumatic bonding as analyzed by Weir-Soley and to McKittrick and Weheliye's heartbreak.

While one might analyze Rihanna's musical performance *as* a performance of heartbreak, or as prompting the listener to experience heartbreak, I do not believe that I am in a position to

[30] In addition to relying on McKittrick and Weheliye's notion of heartbreak, James's analysis draws from Angela Davis's work on women's voices and the blues (1998). Davis studies singers who "use vocal techniques that produce an aesthetic dimension wherein the meaning and function of a song's otherwise oppressive practices and structures are changed" (James 2020, 83).

make such a claim. McKittrick and Weheliye posit that heartbreak is an aesthetic-physiological practice, a praxis of Black life. It is one of the ways, they assert, in which Black people survive white supremacy. As a white person, I cannot experience this type of heartbreak. Heteropatriarchy causes me suffering, but my experience of gender is different than Rihanna's because of my race. I, along with other cisgender white women, am more likely to be portrayed as a "good victim" who must be protected as opposed to being held responsible for violence. My embodied reaction to the song is therefore surely different than that of a woman who has lived experience with that of the archetypes and narratives of domestic violence that affect Black women specifically. Moreover, while I aim to present a feminist point of view throughout this chapter by considering the ways in which the song works within narratives of gendered violence, a significant power imbalance is still at play in my work: I am a white woman who is currently writing on—and therefore implicitly benefiting from—music performed by a Black woman.

I therefore do not equate my own experience of the song with that of heartbreak, but still point toward McKittrick and Weheliye to acknowledge their work and its applicability to the song. When documenting my own experience of the song, I am suggesting that I experience something *analogous* to heartbreak. The experience is gendered, and arises from my own experience with heteropatriarchy, but that does not map onto the specific experience of Black women under white supremacy. Rather than making sweeping statements about the meaning of the song, I explicitly centered my own embodied response to Rihanna's performance in order to highlight an additional facet of LTWYL and LTWYL II's complexity.

3.4 Conclusion

Through the above analysis, I have highlighted the conflicting feelings that arise when I focus on Rihanna's vocal delivery and the ways in which I relate to her voice throughout the virtual space. My reading of the song is based both on audio feature extraction allowing me to visually represent the song's virtual space, and on close examination of my body's mimetic engagement with Rihanna's voice. I have proposed that Rihanna's vocal performance—and the way it is represented throughout the virtual space—can be heard as conveying emotions including anger, affection, loneliness, frustration, bonding, and resignation. In her study of Rihanna's interviews after the assault, Weir-Soley ties this range of emotion to the notion of traumatic bonding. Drawing on McKittrick and Weheliye's notion of heartbreak, I understand the contradictory expressivity of this vocal performance as a way for Rihanna to avoid harmful tropes of domestic violence. This narrative represents only one way to experience Rihanna's vocal performance; other listeners may draw different meanings and experiences upon listening to LTWYL and LTWYL II.

The analysis presented in this Chapter has allowed me to display how the methodology for analyzing vocal placement can be deployed in service of close readings of individual pieces. In Chapters 4 and 5, I depart from close examination of individual performances to survey a larger-scale corpus of vocal collaborations. This corpus study allows me to verify the hypothesis outlined in the Introduction: that there is a tangible difference in the ways in which men's and women's voices are represented in recent vocal collaborations from the past decade.

Chapter 4 Vocal Placement and Gender in the *Billboard* Year-End Hot 100, 2008–18

This chapter applies the methodology outlined in Chapter 2 to a corpus of commercially successful collaborations between two or more artists. I examine the vocal placements of men's and women's voices in a corpus of 113 songs from the *Billboard* "Hot 100 songs" year-end charts released between 2008 and 2018. The previous chapter has shown how the methodology for analyzing vocal placement can be used to conduct close readings of individual songs. Now, I demonstrate how the same methodology can support a larger-scale reading of the ways in which voices tend to be positioned in virtual space. Through a corpus study, I describe trends in vocal placement as it interacts with formal function, types of vocal delivery, and artists' gender identity.

I first present and contextualize a newly assembled 113-song corpus of commercially successful collaborations (the Collaborative Song Corpus, or CS Corpus). In addition to discussing the provenance and the content of the corpus, I review the use of the *Billboard* charts in recent music-theoretical discourse. I argue that music theorists should take into consideration the gender dynamics that shape the *Billboard* charts in their analyses. Since the charts reflect a deeply biased music industry, they represent an ideal site for analyzing pervasive cultural stereotypes. I then provide a descriptive statistical analysis of the corpus by examining the five parameters of vocal placement that constitute the methodology outlined in Chapter 2: width, pitch height, prominence, environment, and layering. As discussed in the Introduction, I determined through preliminary listening that men's and women's voices tend to be sonically differentiated throughout *Billboard* chart-topping collaborations. This parameter-specific analysis allows me to verify this hypothesis by using audio feature extraction and close listening to identify specific trends regarding vocal placement and artists' gender. More specifically, I show that in recent recorded Anglo-American popular music collaborations, men's voices tend to be narrower, less reverberated, and less layered than women's voices.

4.1 The *Billboard* Charts

Established in 1894, *Billboard* magazine covers activities within the American popular music industry. Since its inception, the magazine has published a variety of record charts that track the weekly popularity of songs and records. These charts have varied in name, beginning with the "Hit Parade" of 1936, followed by the "Honor Roll of Hits" in 1945. *Billboard* began publishing Hot 100 weekly charts in in 1958, with the goal of providing an all-genre chart measure of popularity through airplay and sales.[1] The year-end charts under study in this chapter are compiled through "aggregated numbers for each artist and title from the weekly charts." Since 1991, *Billboard*'s weekly charts are calculated via data obtained through Nielsen Soundscan—a system which tracks album and song sales through a system similar to barcoding—and Nielsen Broadcast Data Systems—a cousin to Soundscan charged with tracking the radio, television, and internet plays of albums and songs.[2] The system has undergone various modifications in recent years to accommodate the rise of online streaming.[3] As of 2012, the

[1] In addition to the Hot 100 charts, *Billboard* currently publishes other Top 100 charts. These additional charts include "Hot R&B/Hip-Hop Songs," "Country Songs," "Christian Songs," and "Japan Songs."
[2] Prior to 1991, *Billboard* rankings relied on reports from retailers and selected radio stations. While the Nielsen system is arguably a more reliable method to gauge listeners' interest in particular songs and albums, it has received its share of criticism. In 1997, for instance, McCourt and Rothenbuhler argued that the increased speed in sales data might discourage innovation as record companies would privilege established, high-selling artists. For more information on the history of *Billboard*'s ranking methods and its effects on the content of the charts, see Hesbacher *et al.* 1975 and Sernoe 2005.
[3] Yahoo and AOL streams began being taken in consideration in 2007. Spotify streams were added in 2012 and YouTube views in 2013.

Billboard Hot 100 charts under study in this chapter reflected "accumulated radio, sales and streaming points, according to data provided by [Nielsen Broadcast Data Systems] and [Nielsen Soundscan]" (*Billboard* 2012).

Songs appearing on the *Billboard* charts are regularly used as objects of music-theoretical studies. Analysis of popular hits has been facilitated by databases such as the McGill *Billboard* project (Burgoyne *et al.* 2011), which contains time-aligned transcriptions of chord progressions in over 1000 songs randomly selected from the *Billboard* Hot 100 charts between 1958 and 1991.[4] The data is freely available online and has been the basis for corpus studies on popular music (Léveillé Gauvin 2015, de Clercq 2015). More recently, portions of the McGill *Billboard* Corpus have been supplemented with melodic, lyrical, and acoustic data (Léveillé Gauvin *et al.* 2017). Other music-theoretical studies have focused on post-1990 *Billboard* charts, with authors compiling their own corpora (Ensign 2015, Condit-Schultz 2017, Richards 2017).

There are three main advantages to studying hits from the *Billboard* charts from a music-theoretical perspective. First, because the charts are a marker of popularity at a certain point in time, you are analyzing music that is widespread, influential, and heard by many people. Second, popular songs appearing on the *Billboard* charts are relatively uniform in length, form, instrumentation, and language (English). Joe Bennett summarizes the common characteristics of mainstream hits of the last fifty years, noting that they frequently feature a short introduction, repeating choruses that contain the melodic climax of the song, underlying 4-, 8-, and 16-bar phrases, 4/4 time, a single tonal center, and a 2- to 4-minute length (Bennett 2011).[5] Since the songs on the *Billboard* charts generally follow similar structural and tonal conventions, an

[4] The corpus ends in 1990 because the Nielsen system was introduced in 1991.
[5] Hubert Léveillé Gauvin (2018) discusses the link between changing popular music compositional practices, attention economy, and increasingly short song introductions.

analyst can assemble these songs into a corpus and compare them. An analyst wanting to study the differences between harmonic progressions in verses and chorus, for instance, would benefit from using *Billboard* chart hits because they share similar formal features. Finally, the high number of composers, artists, and producers that collaborate on a single hit ensures that an analyst is not directly analyzing a single person's artistic decision but rather the product of trends.

Chart-topping music is analyzed so frequently that its appearance in music-theoretical studies is virtually taken for granted. Nonetheless, I would like to reflect on my decision to take this repertoire as an object of study. More specifically, I want to dispel the impression that my corpus, which is based on the *Billboard* charts, should be a "neutral" entity that represents an unbiased measure of popularity and quality. The *Billboard* charts do not objectively measure popularity, nor are they representative of some level of musical quality. In fact, the factors that determine the contents of the charts are constantly in flux. *Billboard'*s changing evaluation methods, record label conglomerates (Myer & Kleck 2007), and the way the magazine establishes, enforces, and modifies its genre labels (Kwame Harrison & Arthur 2011) all affect the trajectory of a song on the charts. Second, any corpus assembled from the *Billboard* charts is inherently biased to reflect the current state of a music industry shaped by rigid gender and racial norms. In an example of what Safiya Noble calls "algorithmic oppression," the charts both reflect and reproduce the inequalities embedded in the popular music industry (Noble 2018). They reflect imbalances by only celebrating artists who have "made it to the top," and reproduce them by establishing a subsequent blueprint for popularity.

4.2 Gendered Templates in the Music Industry

For the remainder of this chapter, "music industry" is used as a catch-all term for all the parties involved in the creation of mainstream commercial popular music: artists, sound engineers, producers, managers, journalists, publicists, and so on. While a thorough overview of the inner workings of the music industry as it pertains to gender is outside the scope of this study, the following section summarizes work that has addressed the specific gendered personas that are available to popular musicians wishing to achieve considerable success in the industry.

Kristin J. Lieb's "Gender, Branding, and the Modern Music Industry" (2018) is the most often-cited study of gender's impact on the American popular musicians. Through an exploration of the lives and careers of pop stars from the 1990s onwards, Lieb highlights the gendered constraints imposed upon women artists. In a music industry driven by profit, artists and their managers must strategically develop public images that sell. In the case of women artists, the results are rooted in specific notions of whiteness, femininity, and heterosexuality. An artist's success in mainstream popular music, she argues, is directly tied to the extent to which she is able to navigate these constraints. Using examples such as Lady Gaga, Rihanna, Beyoncé, and Katy Perry, Lieb asserts that "female pop stars are held to rigid standards of appearance and beauty that box them into a small number of highly patterned types" (Lieb 2018, 21). Her study culminates in the establishment of a "lifetime model." She identifies pre-established archetypes—the *good girl*, the *temptress*, the *whore*, the *legend*—into which female pop stars are fitted throughout their career. Male artists, she argues, have at their disposal a much wider range of personas because music is prioritized over their bodies, actions, and general appearance. Lieb's discussion focuses on the popular stardom attained by artists via album sales and ranking on the *Billboard* charts. Gendered discourses, which both limit and shape all artists' careers, are also at work in other aspects of the music industry. Marion Leonard (2007), for instance, argues that a masculinist representation of rock is upheld in rock mythology, canonization, and journalism. Others have discussed the masculinized discourses operating in the fields of sound recording and production (Wolfe 2019) and electronic music (Rodgers 2010). [6]

These studies foreground the way women artists have engaged with these discourses in various branches of the music industry. The same studies, however, are limited in their focus on the creative activities of white, middle-class women. Lieb does address the careers of some hit-making Black women such as Rihanna, Beyoncé, and Nicki Minaj and notes that the femininities afforded to them are more limited than to their white counterparts. Nonetheless, her critical framework is not built to explicitly address the ways in which race affects an artist's reception and career. Hip-hop feminist literature is rife with productive discussions on the gendered and racialized personas available to popular musicians. The writings of Regina N. Bradley and Cheryl K. Keyes, for instance, are especially useful in highlighting the gendered constraints facing Black artists in the mainstream popular music industry. Bradley provides an exhaustive list of the different male-gendered personas made available by hip-hop culture, such as the *Philosopher King,* the *Hustler,* the *Playa/Pimp* (Bradley 2015). Keyes' categorizations of female archetypes—the *Queen Mother,* the *Fly Girl,* the *Sista with Attitude,* and the *Lesbian*—documents a rich history of women's participation in hip-hop culture (Keyes 2000). In a commercial music setting, however, this rich array of gendered templates is "[flattened] … to those that are most easily digestible and profitable, those roles that are readily identified as 'Black' and stereotypical." In the popular music industry, "hip-hop masculinity is aggressive, dominant, and flattened while hip-hop femininity is submissive, (hyper)sexual, and silenced"

[6] The relationship between technology, music production, gender and creativity will be explored in more detail in the Conclusion to the dissertation.

(Bradley 2015, 185). These gendered tropes are commodified and rewarded through popularity and album sales (Bradley 2012). To achieve mainstream success, Black artists must therefore successfully navigate these racial stereotypes.

The sexist and racist discourses embedded in the music industry are reflected in the *Billboard* charts. Consider the following two case studies.[7] Jada Watson, in a 2019 study, outlines the ways in which gender-based programming in country music radio stations negatively influences women's performances on the *Billboard* "Hot Country 100" charts. Decades of radio programming in which women country artists occupy only 13 to 15% of country radio music programming—airplays, it should be reiterated, directly inform an artist's performance on the charts—contribute to women's erasure from country music culture (Watson 2019). Second, through a study of *Billboard* Rap year-end charts between 2007 and 2011, Wendy M. Laybourn determines that artists with lighter skin tones performed better on the *Billboard* charts. Colorism, she argues, operates in commercial rap music by rewarding "rap artists who fall within white standards of beauty" (Laybourn 2018, 14).

Gender's impact on the popular music industry can therefore be summarized in the following way. To achieve mainstream success, artists must successfully navigate highly codified templates of masculinity and femininity. For artists of color—especially Black artists, as shown by Bradley (2012)—these templates are compounded by racist discourses that further limit the personas they may adopt. If an artist achieves mainstream success, their performance on the *Billboard* charts may still be affected by external factors such as airplays and *Billboard*

[7] For more information on race, gender, and the *Billboard* charts, see Timothy J. Dowd and Maureen Blyler's (2002) study of Black performers' chart success between 1940 and 1990. Chart performances are affected by changes in the radio industry and Black musicians' rising popularity in white teen audiences during the 1950s and 60s. See also Lafrance *et al.* (2008) for data on race, gender, and the *Billboard* charts.

magazine's categorization of genres. The charts subsequently perpetuate these limited templates by establishing a model of popularity that is sought after and reproduced by other artists.

By studying the ways in which gender is sonically represented in this commercial music, we can better understand the pervasive cultural stereotypes about gender that shape popular music. By pointing out the biases intrinsic to the *Billboard* charts, I am not implying that they should not be used as objects of analysis. On the contrary, I believe that the charts are relevant snapshots of the American music industry at a given point in time. In this chapter, I am interested in studying differences in vocal placement between men and women specifically *because* the charts are rooted in a sexist music industry. By analyzing conventions regarding the vocal placement of different artists, I want to highlight the ways in which American popular music sonically creates gendered difference.

4.3 Assembling the CS Corpus

To analyze differences in vocal placement between men's and women's voice in recent commercial popular music, I assembled the CS Corpus, a 113-song corpus from the *Billboard* Hot 100 year-end charts published between 2008 and 2018. The one-decade interval allows the corpus to maintain a narrow stylistic range. In the year-end charts published during this period, there have been 305 songs in which more than one vocalist is featured. This number excludes songs in which a DJ or electronic music artist features a single vocalist. "Sweet Nothing" by Calvin Harris featuring Florence Welch (2012), for instance, is not included because Harris's voice is not heard on the song.[8] The data also excludes songs in which a group of several vocalists—such as The

[8] Songs in which a DJ appears as a main artist featuring a vocalist have enjoyed high popularity in the past decade, with DJs such as Calvin Harris, David Guetta, or Marshmello regularly appearing on the year-end *Billboard* charts. Guest artists—often female—supply the vocals for the entirety of the song. Such songs include "Titanium" by David

Pussycat Dolls or Fifth Harmony—exclusively sing together. The 305 vocal collaborations that appear on the *Billboard* Hot 100 year-end charts are sorted below into five categories:

(1) Songs with a lead male artist and a featured female artist (hereafter referred to as **M ft. W)**

Ex. “Too Good,” Drake ft. Rihanna (2016)

Ex. “No Limit,” G-Eazy ft. A$AP Rocky & Cardi B (2018)

(2) Songs with a lead female artist and a featured male artist (**W ft. M)**

Ex. “Work,” Rihanna ft. Drake (2016)

Ex. “Only,” Nicki Minaj ft. Drake, Lil Wayne & Chris Brown (2015)

(3) Songs with two or more artists, with no determined lead or featured artist (**Duet)**

Ex. “Love Me Harder,” Ariana Grande & The Weeknd (2015)

Ex. “Highway Don’t Care,” Tim McGraw with Taylor Swift (2013)

(4) Tracks with a lead male artist and a featured male artist/duets between men **(M ft. M)**

Ex. “Rockstar,” Post Malone ft. 21 Savage (2018)

Ex. “OMG,” Usher ft. will.i.am (2010)

(5) Tracks with a lead female artist and a featured female artist/duets between women **(W ft. W)**

Ex. “Side to Side,” Ariana Grande ft. Nicki Minaj (2017)

Ex. “Telephone,” Lady Gaga ft. Beyoncé (2010)

Figure 4.1 shows the distribution of these 305 songs into the five categories described above. Songs in which a male artist features another male artist (**M ft. M**) are in the majority at

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Guetta ft. Sia (2011); “I Need Your Love” by Calvin Harris ft. Ellie Goulding (2013); and “Summertime Sadness” by Lana Del Rey & Cedric Gervais (2012). While outside the scope of the current study, it would be productive to study the gendered implications of hits in which chart-topping DJs—exclusively male—assume an invisible position of control by producing and manipulating women’s voices.

56% (170 out of 305 songs). The rarest category, in which a female artist features another female artist, occupies only 3% (10 out of 305 songs) of the collaborations. Figure 4.2 displays the same data with added information on the year. In five of the ten years under study—2008, 2009, 2011, 2012, and 2016—no songs of the **W ft. W** category reached the *Billboard* Hot 100 year-end chart. Conversely, songs with two or more male vocalists consistently performed well on the charts, every year outnumbering songs from any other category. These trends are indicative of a music industry in which collaborations between men fare much better commercially than collaborations between women.

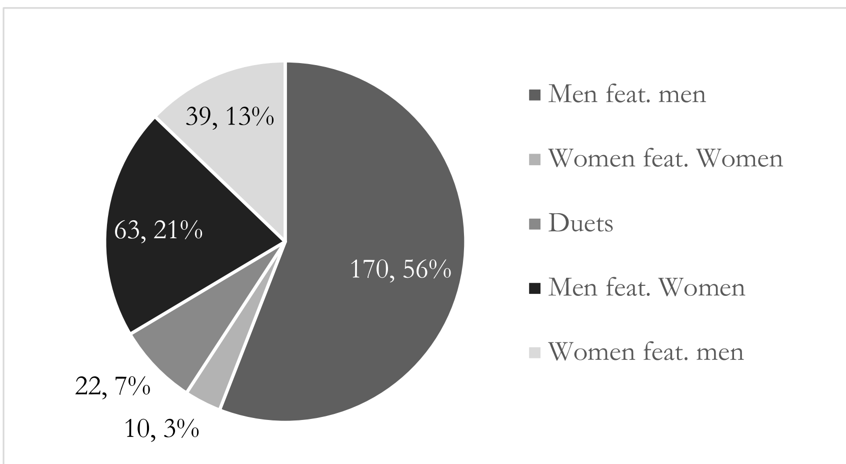

Figure 4.1 Total Collaborations in which (1) a man features a man; (2) a woman features a woman; (3) a man and a woman perform a duet; (4) a man features a woman; and (5) a woman features a man in the 2008–18 *Billboard* Hot 100 year-end charts

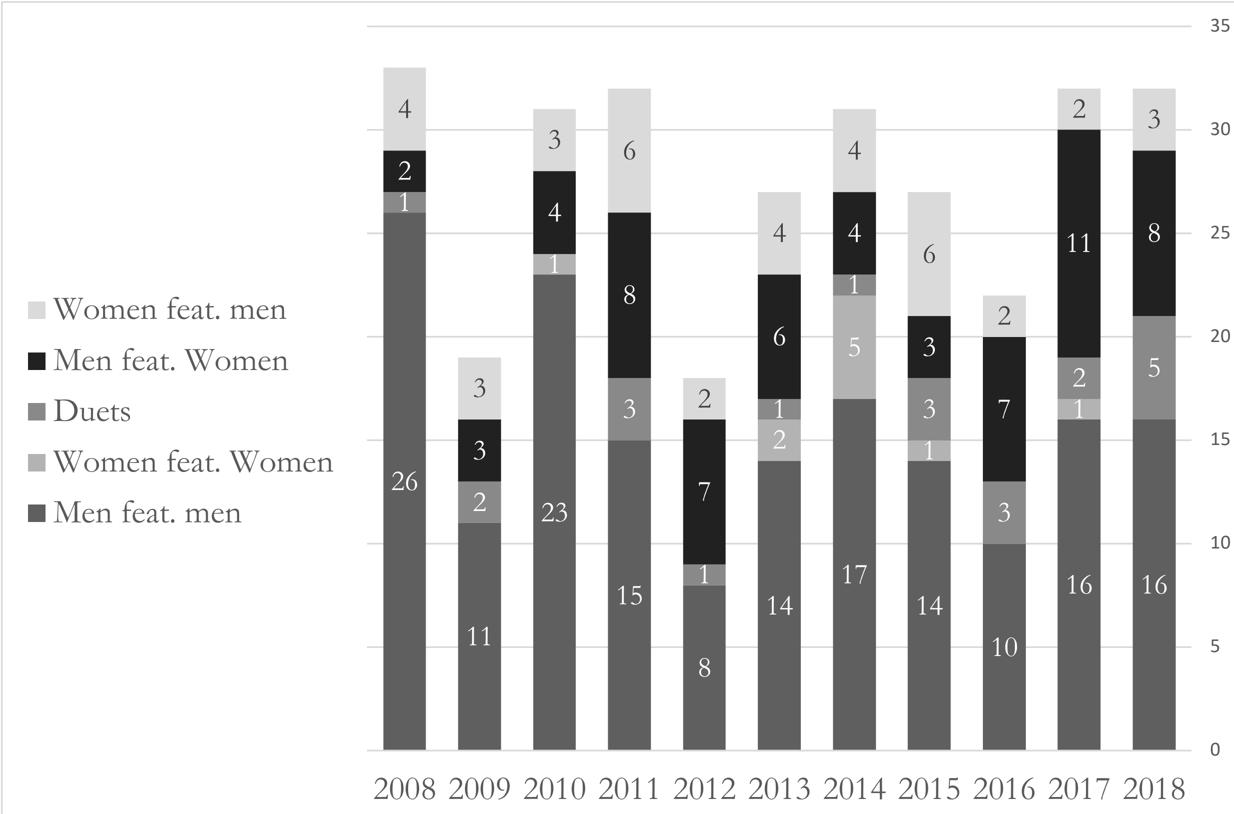

Figure 4.2 Collaborations in which (1) a man features a man; (2) a woman features a woman; (3) a man and a woman perform a duet; (4) a man features a woman; and (5) a woman features a man in the 2008–18 *Billboard* Hot 100 year-end charts, separated by year

The corpus analyzed in this chapter contains 113 songs out of the 305 songs shown above.[9] Since I am interested in analyzing the extent to which men and women vocalists are

[9] While assembling the corpus, I debated about whether I should include the music of artists who are known abusers. Chris Brown—who, as explained in Chapter 3, physically assaulted Rihanna—appears in four chart-topping collaborations with women since 2008. R. Kelly—who has repeatedly abused women and underage girls since the 1990s—appears in one. Music scholars have written about the implications of teaching the music of so-called "monstrous men." William Cheng, for instance, still chooses to teach their music to foster classroom discussions about power, relationships, and our vulnerability to music (2019). Emily Milius, conversely, prefers to omit such examples to avoid triggering past traumas in students (2020). Since the corpus study is not being used in a pedagogical (i.e., classroom) context, the stakes are slightly different. Ultimately, I chose to include both artists in the corpus despite my discomfort in doing so. By considering their music alongside that of others, I aim to give an accurate snapshot of a music industry that enables abusers. Artists who are known abusers are/were still given the chance to succeed and participate of in the soundscape of American popular music. As such, I consider their voices alongside those of others. I do not, however, use their voices in specific case studies and examples.

sonically represented in contrasting ways, the corpus only contains songs featuring both a male and female vocalist: categories **M ft. W**, **W ft. M**, and **Duet**. These three categories contain 125 songs in total. Twelve songs were eliminated because one of the artists was not featured as a solo singer (Table 4.1). For instance, "Party Rock Anthem" by LMFAO featuring Lauren Bennett & GoonRock (2011), while a part of the **M ft. W** category, is not included in the corpus because Bennett's voice only appears in the background vocals of a chorus sung by the main artist.

Figure 4.3 shows the distribution of the **M ft. W**, **W ft. M,** and **Duet** categories throughout the CS corpus. Most songs (57 out of 114, or 50%) belong to the **M ft. W** category. **W ft. M** is the second most frequent category, occupying 33% of the corpus (38 songs out of 114). The duet category is the rarest, comprising 17% of the corpus (19 songs out of 113). Figure 4.4 displays the different types of vocal pairings found in the corpus. There are 20 songs in which both a man and a woman rap, 45 songs in which a man raps and a woman sings, 5 instances in which a man sings and a woman raps, and 43 instances in which both a man and a woman sing.

Table 4.1 Examples of songs in which one of the artists is not featured as a solo singer

Title	**Artists**	**Year**
"4 Minutes"	Madonna Featuring Justin Timberlake & Timbaland	2008
"No Air"	Jordin Sparks Duet With Chris Brown	2008
"Say Hey (I Love You)"	Michael Franti & Spearhead Featuring Cherine Anderson	2009
"Two Is Better Than One"	Boys Like Girls Featuring Taylor Swift	2010

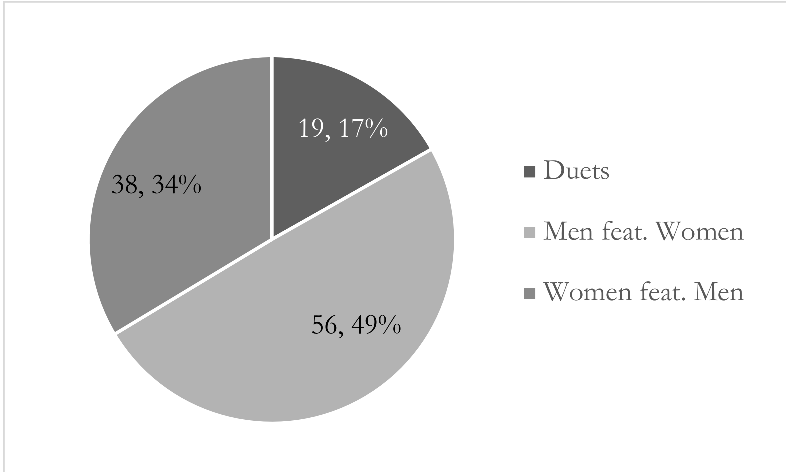

Figure 4.3 Three types of collaborations (1. a man and a woman perform a duet, 2. a man features a woman, and 3. a woman features a man) in the CS Corpus

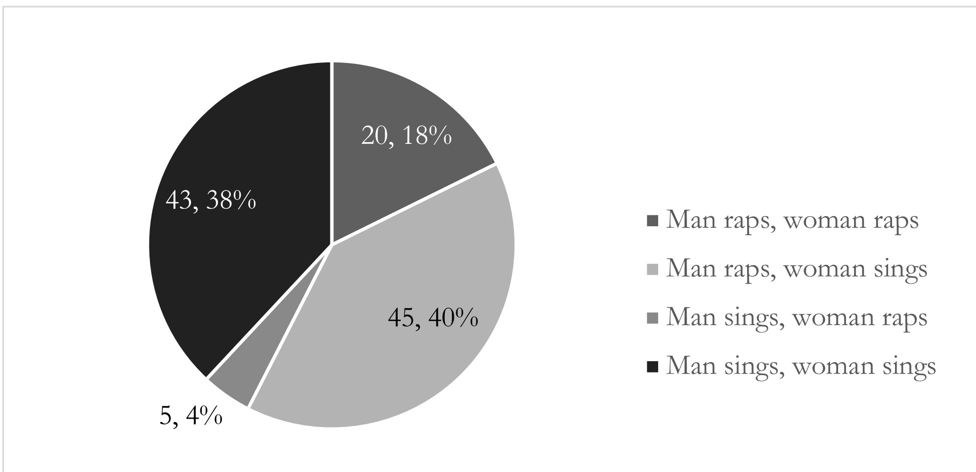

Figure 4.4 Four types of vocal pairings (1. a man raps and a woman raps; 2. a man raps and a woman sings; 3. a man sings and a woman raps; and 4. a man sings and a woman sings) in the CS Corpus

In the history of Anglophone popular music, there have been many instances of collaborations between independent acts. Note, for instance, Queen and David Bowie's collaboration on "Under Pressure" (1981) and the 1986 version of "Walk This Way" by Aerosmith and Run DMC. With the rising popularity of hip-hop in the late 1980s and early 1990s, the *Billboard* charts increasingly began including tracks with featured artists. The 1990 success of "She Ain't Worth It" by Glenn Medeiros feat. Bobby Brown marked the first time a sung and rapped collaboration reached #1 on *Billboard's* Hot 100. From the mid-90s onwards, tracks with one or more guest artists have been commonplace on the charts. These collaborations often take place across musical genre boundaries—2018 Pulitzer Prize winner Kendrick Lamar, who is generally labeled as a hip-hop artist, has for instance provided rapped verses to pop/country singer Taylor Swift's song "Bad Blood" (2015).[10] I chose to assemble a corpus of songs containing featured artists because this collaborative format allows for direct comparisons of how men's and women's voices are mixed in recorded popular music. Any sonic differences between two collaborating voices are made starker via their juxtaposition within a single track.

4.4 A Descriptive Statistical Analysis of the CS Corpus

The remainder of this chapter provides a descriptive analysis of the ways in which width, pitch height, prominence, environment, and layering operate throughout the *Billboard* year-end Hot 100 song corpus. To examine vocal placement in this corpus, I apply the methodology outlined in Chapter 2 to each of the 113 songs in the CS Corpus.[11] This study allows me to verify the hypothesis established during a preliminary auditory analysis of the corpus. As discussed in the Introduction to this dissertation, close listening of the CS corpus revealed that women's voices tend to be more diffuse, layered, and reverberant than men's voices. By examining how the five parameters responsible for vocal placement interact with gender, vocal delivery style (i.e., rapping or singing), and form, I show that men's voices tend to be localized, flat, and

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[10] Ordanini *et al.* have shown that songs featuring an artist from a different musical genre than the host artist are more likely to enter the Top 10 of *Billboard*'s Hot 100 charts.
[11] The reader is invited to refer to Appendices A and B for further information about the process behind this methodology.

singular. Conversely, women's voices are measurably diffuse, reverberant, and layered. These trends occur regardless of vocal delivery style.

4.4.1 Method

I use the methodology outlined in Chapter 2 to show how differences between vocal placements of men and women in recent *Billboard* hits can be reflected in extractable audio features. I examine the vocal placement data for choruses separately than that of other formal sections such as verses, bridges, and introductions. Choruses in late-20th- and 21st-century Anglo-American popular music tend to be characterized by thick musical textures that contrast with those of the surrounding formal sections (Peres 2016, Zinser 2020).[12] The onset of a chorus may coincide with the introduction of new instrumental layers, background vocals, or increased amplitude.[13] Vocal placement is also a key component of musical texture. Choruses may feature more reverberated or layered vocals to create a dense sonic atmosphere; conversely, a verse may feature a stripped-down voice that is singular and set in a non-reverberant environment. Choruses therefore tend to feature vocal placements that are wider and occupy more space in the virtual space.[14] I this chapter, I analyze choruses separately than other formal sections in order to account for this difference.

Moreover, I only analyze vocal placement in formal sections that are sung by one artist only. No vocal placement data is provided for sections sung by two or more vocalists. In cases

[12] Asaf Peres (2016, 2) asserts that form in 21st-century popular music is partially characterized by changes in sonic density— "the presence and amplitude of frequencies across the sonic spectrum." Such changes in texture can be reflected in audio feature analysis. Aided by spectrographic analyses, Peres notes that choruses are usually characterized by a higher level of sonic density than the preceding verses and pre-choruses.
[13] For more information on the buildup as a compositional technique in post-1950s popular music, see Spicer (2004) and Attas (2015).
[14] In an analysis of Radiohead's "Paranoid Android," David Sears (2011) uses panning visualization tool MarPanning to show how sound sources occupy a wider space in the chorus than they do in the verses.

where a vocalist is accompanied by background vocals provided by an additional singer—Sean Paul, for instance, provides occasional vocal interjections to accompany Sia's voice in the chorus of "Cheap Thrills" (2016)—I analyze the voice of the main singer and disregard the background vocals. I chose to focus on solo sections because a singer's individual vocal characteristics are more clearly heard when they are singing alone. Moreover, the state of music information retrieval technology as of Spring 2020 does not allow for a precise analysis of the individual features of two or more voices singing in harmony or at short time intervals. The different voices would need to be separated into two distinct audio files, an option which is currently unavailable given that source separation algorithms isolate all voices as a single component.[15]

Finally, the corpus study provides a comparison of vocal placement in rapped and sung vocals. The distinction between rapping and singing is porous, with many vocalists—such as Drake—adopting ambiguous modes of vocal delivery. I consider any formal section containing a sustained, pitched melodic line as sung. I chose to conduct the analysis of sung and rapped sections separately, because rap vocals tend to be mixed in a less reverberant way to grant more clarity to the lyrics.

The reader is invited to refer to Appendix C for a list of all songs contained in the CS corpus. Each item in the list contains the following data:

(1) **Index #:** An index number (1 to 113) is assigned to each song in the corpus. The songs are sorted by chart year, from newest to oldest. Within each chart year, song titles are sorted in alphabetical order.

(2) **Chart year:** The year of the song's first appearance on *Billboard*'s year-end Hot 100.

(3) **Position:** The chart position (between 1 and 100) attained by the song during the first year of

[15] Refer to Appendix A for an overview of the current state of audio source separation research and software.

its appearance on the year-end Hot 100.

(4) **Type:** Each song is labeled according to the following three categories: (1) **Duets** (songs with two or more artists, with no determined lead or guest); (2) **M ft. W** (songs with a lead male artist and a featured female artist); and (3) **W ft. M** (songs with a lead female artist and a featured male artist).

(5) **Title:** The title of the song as it appears on the year-end Hot 100 charts.

(6) **Artists:** The names of artists credited for appearing on the song. Like the *Billboard* charts, I do not include names of artists whose voices are sampled in a song. Consider for instance the song "Take Care" by Drake ft. Rihanna (2011). The bridge samples a version of "I'll Take Care of You" by Gil Scott-Heron (2010), who is not credited as a featured artist. I only analyze the vocal placement of artists who recorded original content for a particular track.

Appendix D contains data about vocal placement in each of the songs under study. For each song, I provide a .csv file summarizing information about the five parameters contributing to vocal placement: pitch, environment, prominence, layering, and width. Table 4.3 displays the .csv file for "The Monster," performed by Eminem and featuring Rihanna (2013). Each of the .csv files in Appendix D contains the following data:

- **Ind# (Index #):** The index number assigned to the song.
- **TS# (Time Stamp #):** Every song in the corpus is divided into discrete formal sections, the onset of which corresponds to a specific timestamp. Each timestamp is assigned a number. The Index number and the Timestamp number can be combined to refer to specific moments in the corpus: "Section 4.3," for instance, refers to the third section of the fourth song in the corpus.
- **Time (s):** The timestamps at which each formal section begins, in seconds.

- **Form:** The function of each formal section. I annotated the form by ear, categorizing each section into one of the following categories: introduction, verse, pre-chorus, chorus, post-chorus,[16] bridge, and outro.
- **Artist:** The name of the artist performing the bulk of the vocals in the section. If a given artist only provides background vocals, I do not include their name in this column. Note that I only provide vocal placement data for sections in which only one artist is featured vocally.
- **Gen (Gender):** The gender of the artist (F for women and M for men). The corpus consists entirely of cisgender artists, who also identify as men or women. To establish artists' gender identity, I relied on the pronouns they use and on statements made in interviews. As discussed in Chapter 1, this man/woman categorization does not encapsulate all modes of gender expression. It is symptomatic of a rigid gender binary that is unfortunately normalized in the *Billboard* charts in particular and in the commercial music industry as a whole.[17]

[16] Alyssa Barna (2020) coined the term "Dance Chorus" to refer to a recent development in contemporary popular music borrowed from Electronic Dance Music (EDM), in which an additional section follows the verse and chorus. This Dance Chorus is "an intensified version of the chorus that retains the same harmony and contains the hook of the song, which increases memorability for the audience." While I believe that Barna's categorization aptly describes this recent development in popular song form, I label all "Dance Choruses" in the corpus as "post-chorus" sections. Since Dance Choruses are primarily instrumental, they often exhibit vocal placement conventions that differ from the first chorus. As such, I prefer to keep them separate from the singing-oriented "traditional" choruses.

[17] When conducting the corpus study in the summer of 2020, I categorized every artist's gender identity based on interviews, social media statements, and the pronouns they used. At the time, this resulted in a corpus comprised exclusively of men and women. On May 19, 2021, singer Demi Lovato came out as nonbinary. They appear once in the corpus, in the song "No Promises" (Cheat Codes ft. Demi Lovato). My analysis, however, originally labeled Lovato as a woman based on the pronouns they used prior to their coming out. Wanting to accurately reflect Lovato's gender in the analysis, I considered some ways in which I could adapt the corpus study in light of their coming out. On the one hand, I could adjust the results of statistical analysis by assigning Lovato to a newly created non-binary gender category. This approach would accurately represent Lovato's identity, and would do away with the binary gender structure at play in popular music. This option is unsatisfactory, however, because it does not fully consider the gendered stereotypes that shaped Lovato's earlier reception as a vocalist. On the other hand, I could leave the corpus analysis untouched. This approach would account for how Lovato was marketed and depicted as a woman for years, and that they were sonically represented as such. Lovato has discussed this dynamic, noting that prior to their coming out, they were "suppressing who [they] really [were] in order to please stylists, or team members, or this or that, or even fans that wanted [them] to be the sexy, feminine pop star in the, in the leotard and look a certain way" (Blair 2021). When "No Promises" was released, in 2017, Lovato was "marketed" as a woman. Leaving the corpus study untouched would account for those circumstances and better represent the man/woman binary to which artists are subjected. This option, however, also seems unsatisfactory because it misrepresents Lovato's gender identity.

- **F(x) (Function):** This column indicates whether the vocalist performing the formal section is the main artist (main), the featured artist (feat), or positioned on equal footing with other artists in the track (neither).
- **Style:** This column indicates whether the formal section is primarily sung (S) or rapped (R).
- **PMin (Pitch, Minimum):** The minimum vocal pitch (Hz) of the formal section.
- **PQ1 (Pitch, First Quartile):** The vocal pitch (Hz) occupying the first quartile of the formal section's pitch range.
- **PMed (Pitch, Median):** The median vocal pitch (Hz) of the formal section.
- **PQ3 (Pitch, Third Quartile):** The vocal pitch (Hz) occupying the third quartile of the formal section's pitch range.
- **PMax (Pitch, Maximum):** The maximum vocal pitch (Hz) of the formal section.
- **Env (Environment):** The environment rating (E1, E2, E3, E4, or E5) of the voice for the formal section.
- **Lay (Layering):** The layering rating (L1, L2, L3, L4, or L5) of the voice for the formal section.
- **Prom (Prominence):** The prominence of the voice, expressed as a percentage, for the formal section.
- **Wid (Width):** The width rating (W1, W2, W3, W4, or W5) of the voice for the formal section.

I ultimately decided to combine both approaches. I refer to Lovato as non-binary in the metadata for the corpus study: in the list of songs presented in the corpus (Appendix C) and in the vocal placement data (Appendix D). The corpus study analyses were left untouched in order to (1) avoid tampering with already analyzed data; and (2) account for how Lovato was depicted as a woman for years. While I am uncomfortable with the way this decision subsumes Lovato within a binary framework of gender, I believe it more accurately captures the reality of the *Billboard* charts at the time the song was released. Finally, I added an appendix (Appendix E) with an updated statistical analysis that considers Lovato's non-binary identity.

When analyzing the results of the corpus study, I remove any duplicate formal sections contained within a song. Consider once more the .csv file for “The Monster” by Eminem ft. Rihanna (Table 4.2). The song contains four choruses, all performed by Rihanna. All these choruses have the same environment, layering, and width values. To avoid giving too much weight to repeated formal sections, the .csv file is therefore edited to look like the one shown in Table 4.3. Since pitch and prominence parameters are expressed as continuous data, similar formal sections may contain minute and therefore inconsequential differences. The second and third choruses in the “Monster,” for instance, have respective prominence values of 50.61% and 50.91%. I therefore eliminate the third chorus because it is too similar to the second. In other words, if two formal sections have identical width, environment, and layering values, I consider them as duplicates and eliminate one of them *even if their pitch or prominence values are different.*

Table 4.2 Sample .csv file: “The Monster,” Eminem ft. Rihanna (2013)

Index	Time	Form	Artist	Gender	Function	Style	PitchMin	PitchQ1	PitchMedian	PitchQ2	PitchMax	Environme	Layering	Prominence	Width
1	0	Chorus	Rihanna	F	Feat	S	165.726	328.65425	372.113	418.81525	677.941	E5	L1	89.0263179	W4
2	19.2271875	Verse1	Eminem	M	Main	R	112.998	182.339	202.215	238.143	725.299	E1	L1	62.0128366	W1
3	54.085875	Chorus	Rihanna	F	Feat	S	272.262	334.023	409.865	426.418	668.511	E5	L1	50.6056995	W4
4	71.5254792	Post-chorus	Rihanna	F	Feat	S	169.978	438.1415	557.189	745.883	947.054	E1	L3	41.2521104	W5
5	88.9275833	Verse2	Eminem	M	Main	R	88.4004	192.48175	248.3025	313.70425	496.985	E1	L3	71.5476851	W3
6	123.863375	Chorus	Rihanna	F	Feat	S	272.296	333.2805	410.2135	427.37925	669.636	E5	L1	50.9129484	W4
7	141.2965	Post-chorus	Rihanna	F	Feat	S	184.407	417.207	493.5335	728.18625	990.132	E1	L3	39.3647567	W5
8	158.776771	Verse3	Eminem	M	Main	R	136.396	232.59275	267.3	299.12675	496.756	E1	L1	65.6781243	W1
9	195.871	Chorus	Rihanna	F	Feat	S	253.148	329.9455	372.764	418.2865	669.544	E5	L1	92.31156	W4
10	213.321125	Bridge	Both												
11	230.767333	Outro	Rihanna	F	Feat	S	273.155	431.9445	552.175	732.5635	1040.3	E1	L3	38.9182194	W5
12	252.268104	End													

Table 4.3 Sample .csv file with duplicate sections removed: "The Monster," Eminem ft. Rihanna (2013)

Index	Time	Form	Artist	Gender	Function	Style	PitchMin	PitchQ1	PitchMedian	PitchQ2	PitchMax	Environment	Layering	Prominence	Width
1	0	Chorus	Rihanna	F	Feat	S	165.726	328.65425	372.113	418.81525	677.941	E5	L1	89.0263179	W4
2	19.2271875	Verse1	Eminem	M	Main	R	112.998	182.339	202.215	238.143	725.299	E1	L1	62.0128366	W1
4	71.5254792	Post-chorus	Rihanna	F	Feat	S	169.978	438.1415	557.189	745.883	947.054	E1	L3	41.2521104	W5
5	88.9275833	Verse2	Eminem	M	Main	R	88.4004	192.48175	248.3025	313.70425	496.985	E1	L3	71.5476851	W3

After removing all duplicate formal sections in the corpus, 583 distinct formal sections remain (Table 4.4). The following analyses and discussion of the corpus are based on these excerpts. The corpus is unbalanced, in that it does not contain an equal number of formal sections in each category. There are only 40 "Rap Other" sections performed by women, for instance, while 122 are performed by men. Conversely, women perform 95 choruses while men only sing 44. The uneven corpus reveals something about the gendered nature of *Billboard* collaborations, in that it shows how men's voices and women's voices tend to take on different sonic roles. In such collaborations, men rap more often than women, and woman are enlisted more frequently to perform choruses and other sung sections.

Table 4.4 583 distinct formal sections in the CS corpus, separated according to vocal delivery type, formal function, and gender of the performer

	Rap Choruses	Rap Other	Sung Choruses	Sung Other	Total
Men	12	122	44	95	273
Women	7	40	95	168	310
Total	19	162	139	263	583

4.4.2 Results

The following section describes how the five parameters under study—width, environment, layering, pitch, and prominence—are manifested across the CS corpus. I discuss each parameter separately, highlighting the similarities and differences between typical vocal placements for men and women across four formal categories: Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. Parameters are analyzed and described according to their data type. Prominence and pitch height values are *continuous* data. Such data can take the form of any value within a given range. Prominence values are expressed as a percentage, while pitch-height values in this corpus range from 61 to 969Hz. In this chapter, the pitch height and prominence parameters are described are compared through 1) t-tests,[18] and 2) mean and percentile values expressed through box-and-whisker plots.[19]

Width, environment, and layering parameter are expressed as *categorical* data. I sort them into a pre-defined number of categories on five-point Likert-type scales.[20] Consider, for instance, the scale for analyzing environment discussed in Chapter 2. A voice can be sorted into one of five categories: E1, E2, E3, E4, and E5. Each of these categories represent a different scenario under which a voice can operate in a recorded environment. I therefore describe and compare the width, environment, and layering parameters with 1) total counts, representing the number of instances a given category occurs; and 2) frequency count, representing the percentage of times a given category occurs. Note that despite being expressed as categorical data throughout this chapter, width, environment, and layering are in fact continuous data. As will be explored in Chapter 5, it would be possible for the environment of a voice to be better represented as existing somewhere between E1 and E2, or between E2 and E3. I nonetheless treat environment, layering, and width as categorical for the sake of a clearer visualization of the data.

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[18] The t-test assesses if the means of two groups are statistically different from each other. A t-test would be helpful in comparing, for instance, the means of prominence values for men's voices and for women's voices.
[19] Box-and-whisker plots display the minimum, first quartile, median, third quartile, and maximum value of a dataset.
[20] Likert and Likert-type scales are rating scales frequently used in questionnaires and surveys. Participants are asked to specify their thoughts on a given issue according to a 5- or 7-point scale (strongly disagree, disagree, neutral, agree, strongly agree are frequently used categories). Likert-type scales, like the ones used for measuring environment, width, and layering, are used to answer a single question. A full Likert scale considers the sum or average of responses over a set of individual questions (Irwing and Hugues 2018, 9).

Width

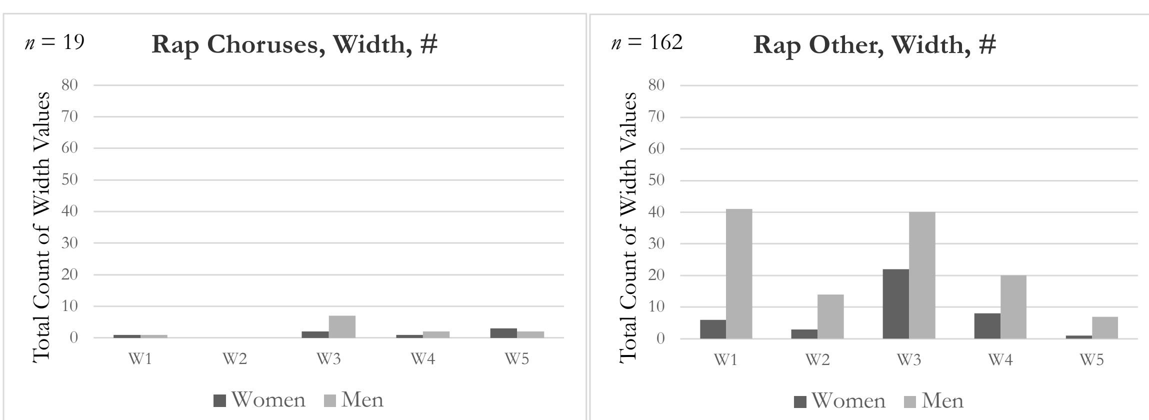
Figure 4.5 shows the total count of width values for men and women in the four formal categories under study—Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. The four charts display the number of times each width values occur. This data can answer questions such as, "In all the sung choruses found in the corpus, *how often* is a woman's voice set to W2?" or "Is the W5 profile *more frequently* applied to men's voices or to women's voices?" Figure 4.6 shows the relative frequency of width values for men and women in the four formal categories. The four charts display the number of times each width value occurs, divided by the total number of outcomes. The result is expressed as a percentage. This data can answer questions such as, "In all the sung choruses found in the corpus, *what percentage* of women's voices is set to W2?" Or "Is the W5 profile *more likely* to be applied to men's voices or to women's voices?"

The summary below focuses on the total count values found in Figure 4.5. The charts in this figure better encapsulate the frequency at which a particular width value occurs in the corpus. Consider, for instance, the similar relative frequencies at which men's and women's voices are set to W3 when singing non-chorus sections. The data displays the proportion of voices set to W3—23.8% for women and 25.3% for men—but does not encapsulate the much higher frequency at which women are enlisted to sing choruses. This unequal division of labor is better represented in Figure 4.5 than in Figure 4.6. I therefore discuss the total count values to account for the significant differences in the number of times in which men and women rap, sing, perform choruses, and perform verses.

The low number of "Rapped Choruses" (7 by women; 12 by men) prevents me from making generalized claims about vocal placement in this type of formal section. Nonetheless, note that a man's voice set to W3 is the most heard width profile in this type of subsection. In

"Rapped Other" sections, a man's voice set to W1 is the most frequently heard (41 instances), closely followed by W3 applied to a man's voice (40 instances). As shown in Figure 4.5, these two categories tower over the other potential width placements. The most frequently heard width category for women is W3, with a total of 22 different instances. To summarize, "Rapped Other" sections most frequently feature a man's voice that is narrow and panned to the center (W1), or mostly narrow with certain components panned toward both sides of the virtual space (W2).

In "Sung Choruses," the most frequently heard sound is that of a woman's voice panned throughout the virtual space. Higher width categories regularly appear, with 40 instances of a woman's voice at a W5 level, 27 instances at a W4 level, and 18 instances at a W3 level. Conversely, the 44 "Sung Choruses" by men are distributed almost evenly within the five categories, with W2 being the most common panning style for men. The "Sung Other" sections feature a slight uptick in the number of men's voices set to broader width values. A wide woman's voice is still the most likely to be heard, with W4, W3, and W5 emerging as the most common categories for this parameter.



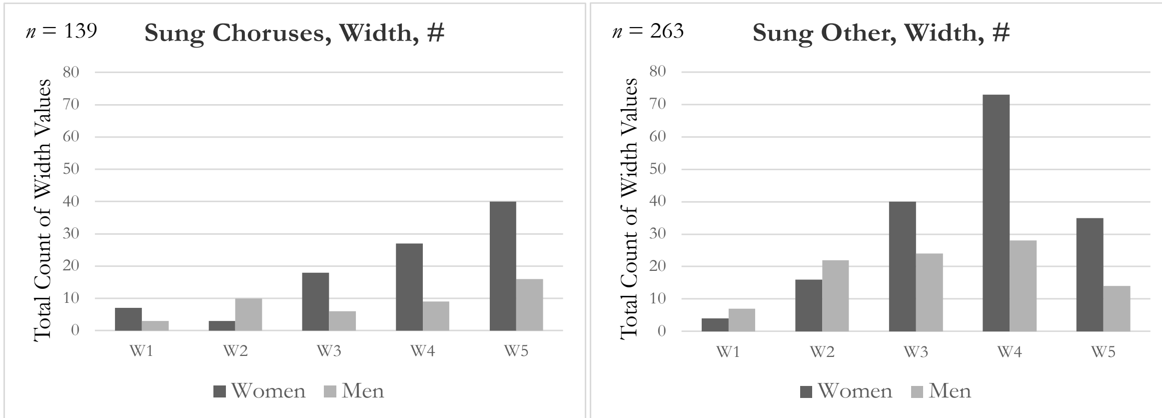


Figure 4.5 Total count of width values in the CS corpus

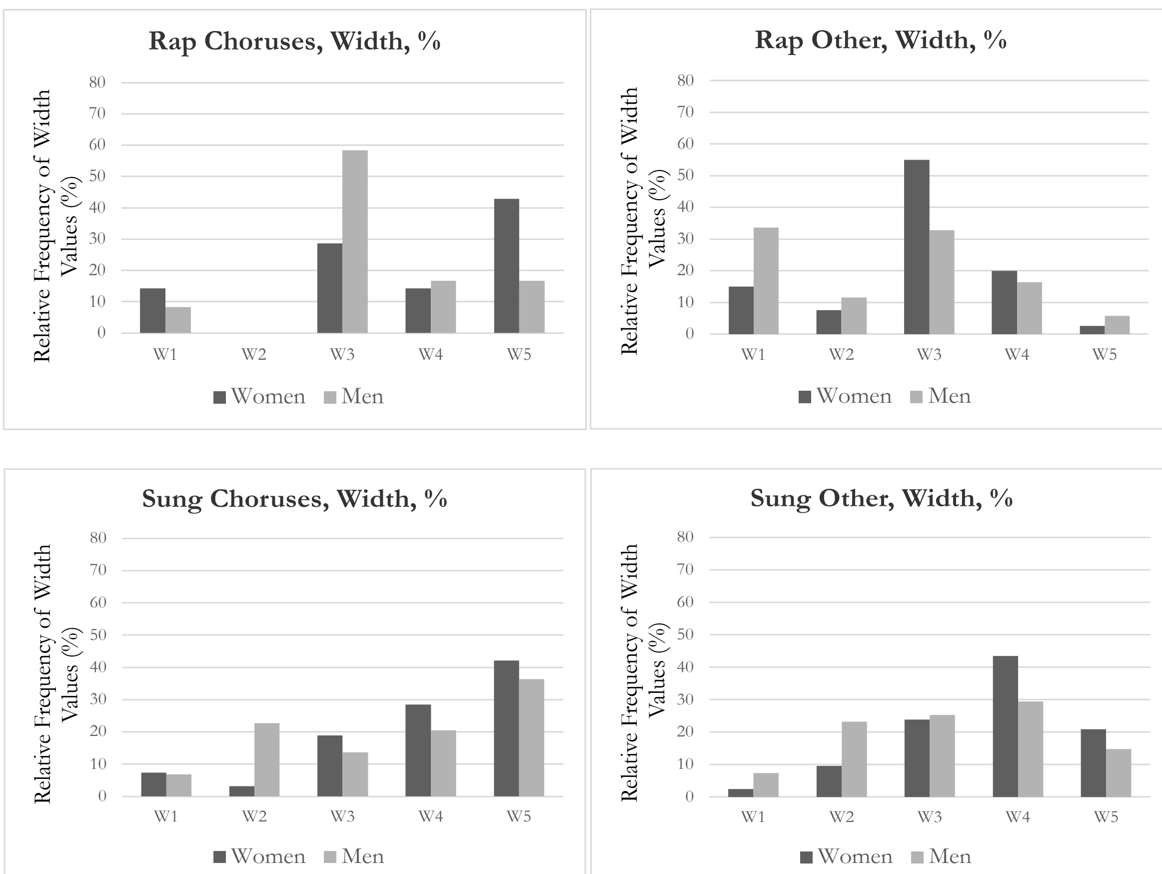


Figure 4.6 Relative frequency of width values in the CS corpus

Environment

Figure 4.7 shows the total count of environment values for men and women in the four formal categories under study—Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. Figure 4.8 shows the relative frequency of environment values for men and women in the four formal categories.

In "Rapped Choruses," lower environment values such as E1 and E2 are more frequent, both for men's and women's voices. "Rapped Other" sections also frequently feature low environment values, with 80 instances of E1 and 31 instances of E2 for men's voices. Women's voices are also frequently set to E1 and E2, with a total of 16 instances for each of these categories. While lower environment values are commonly attributed to both men's and women's voices, the high number of "Rapped Other" sections performed by men contributes to a soundscape in which the most commonly heard sound is a man's voice set to a E1 environment.

E1 is the most common type of environment in "Sung Choruses," with 48 instances for women's voices and 27 for men's voices. "Sung Other" sections are more often set to higher environment values. In addition to a striking 63 instances of women's voices set to E1, the values of 28, 37, and 32 appear for E2, E3, and E4 respectively. Men's voices in "Sung Other" sections follow a similar curve, with a high point of 46 instances at E1 and decreasing values for the remaining environment profiles. Given the higher number of women performing sung sections, the most commonly heard sound is a woman's voice set to E1.

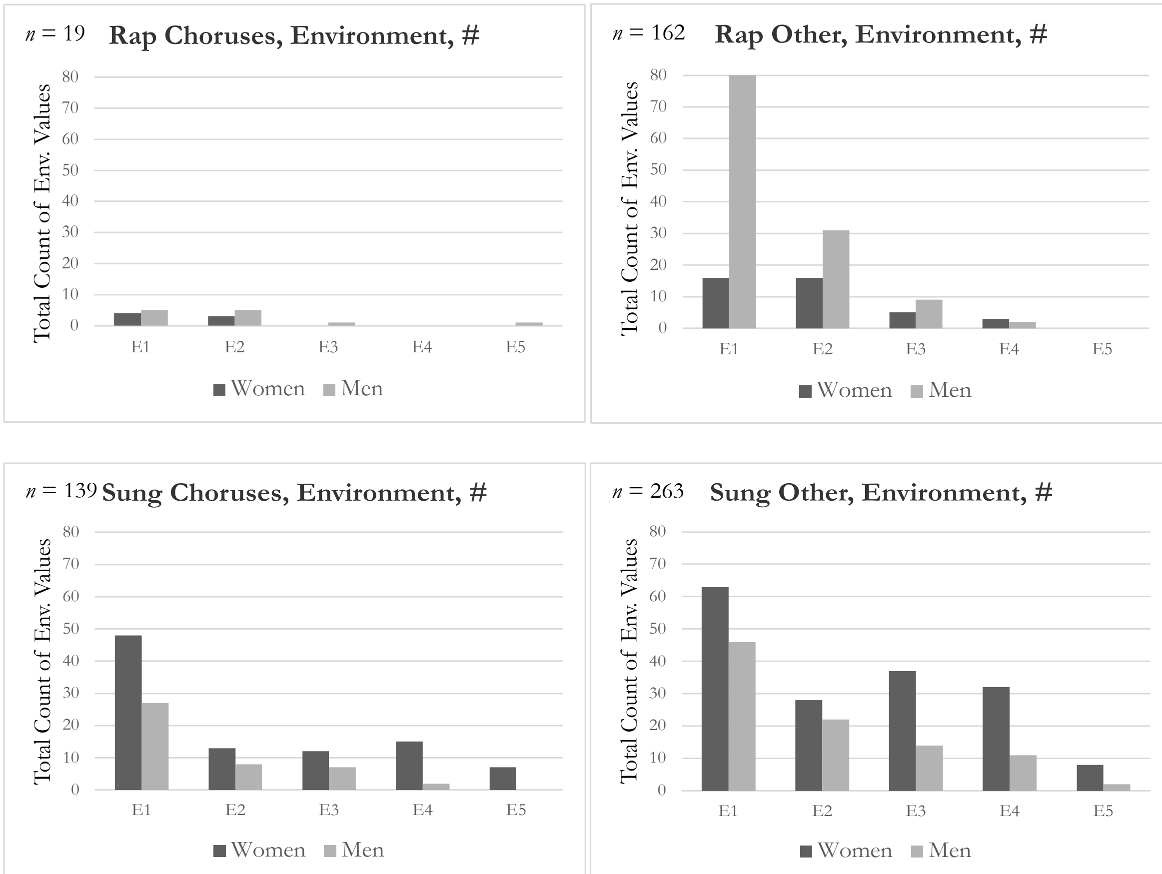


Figure 4.7 Total count of environment values in the CS corpus

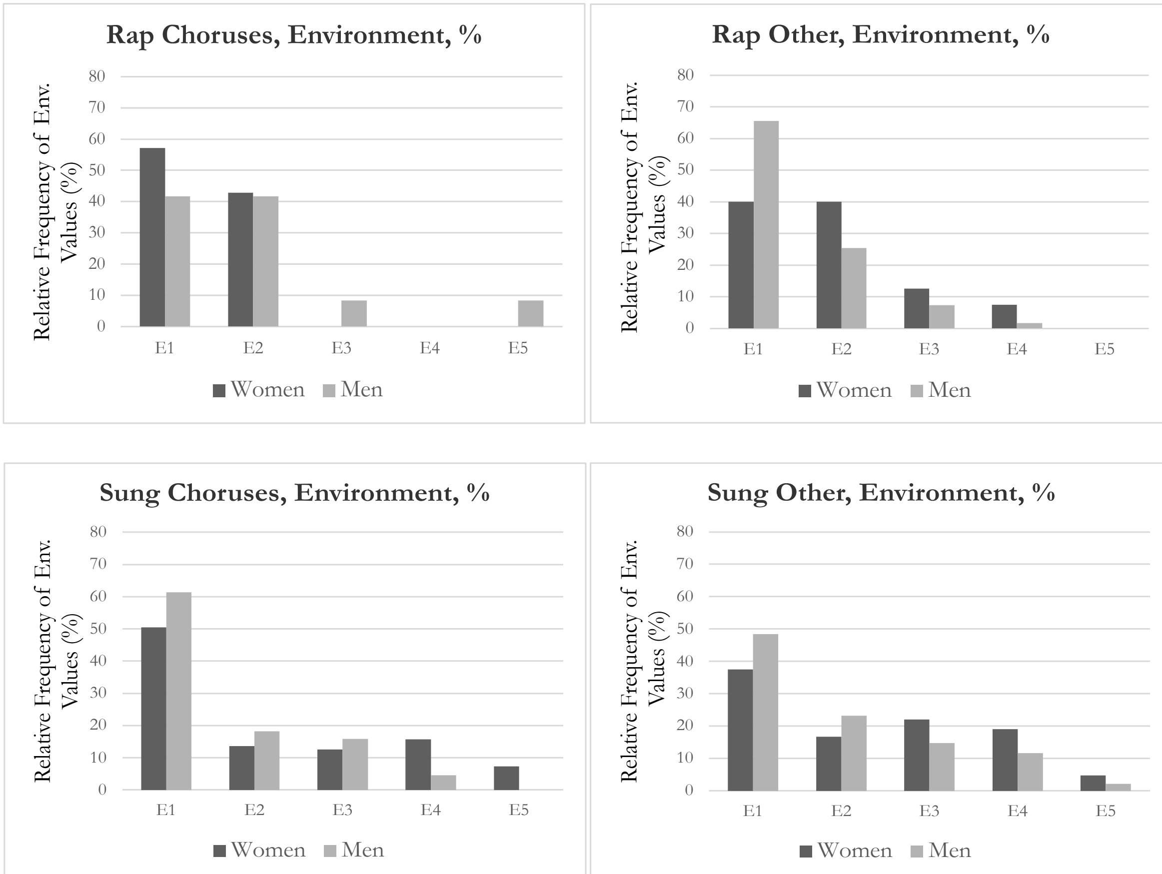


Figure 4.8 Relative frequency of environment values in the CS corpus

Layering

Figure 4.9 shows the total count of layering values for men and women in the four formal categories under study—Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. Figure 4.10 shows the relative frequency of layering values for men and women in the four formal categories. In “Rapped Choruses,” men’s voices have no added vocal layers (L1) in 9 out of 12 cases. More variety is to be found in women’s voices, whose 7 occurrences are divided between L1, L3, and L4. Men’s voices set to L1 and L3 are common in “Rapped Other” sections. The most commonly heard layering profiles in this formal category are an unlayered man’s voice (L1), or one that is subtly layered at the end of phrases (L2). Women’s voices follow a similar trend, with higher values on the lower end of the layering spectrum. In “Sung Choruses,” there are 29 instances in which a woman’s voice is assigned a profile of L1. No clear trend toward lower layering values is found in this formal category, however; there are 26 instances of women’s voices set to L3 and 22 instances set to L5. Finally, “Sung Other” sections tend to be set to lower layering values (L1, L2, and L3) both for men and women. The most common layering type for both men and women is L1, with respective totals of 49 and 71 instances.

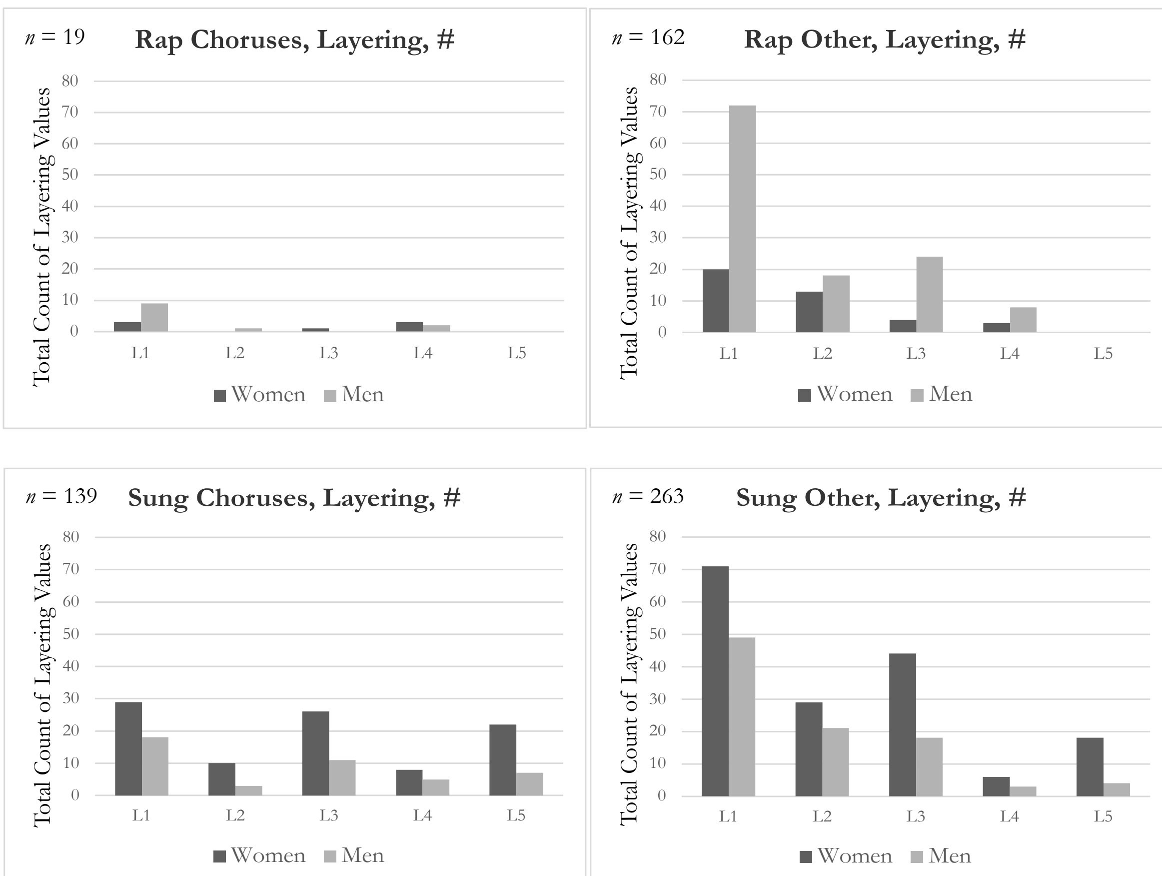


Figure 4.9 Total count of layering values in the CS corpus

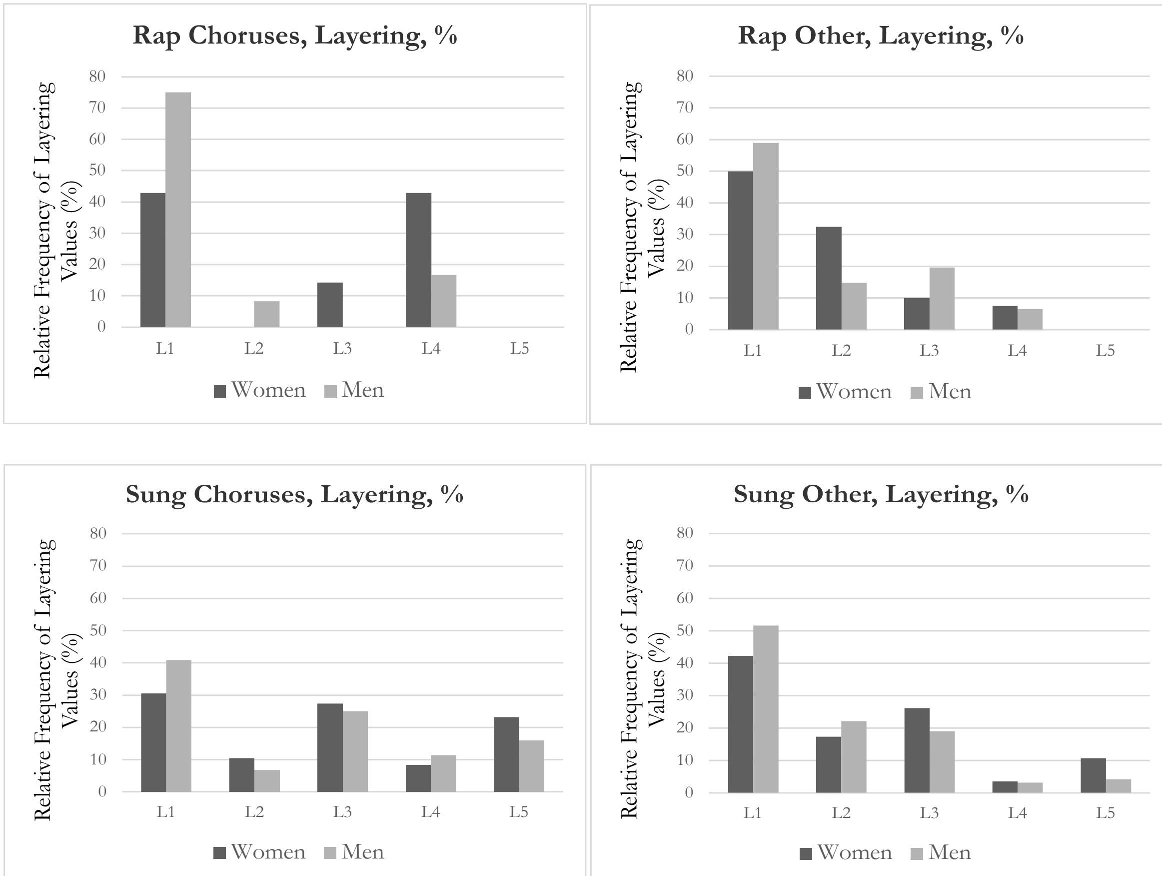
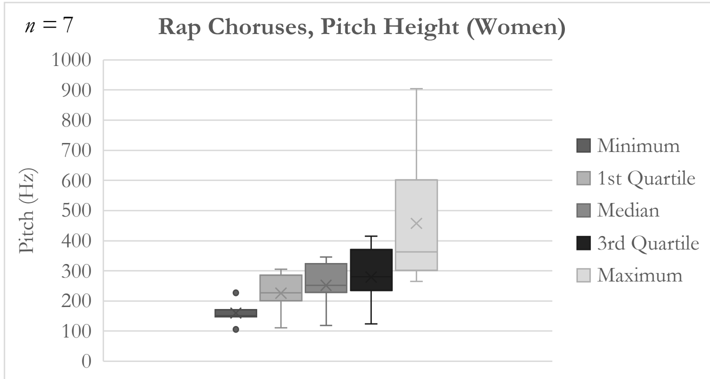


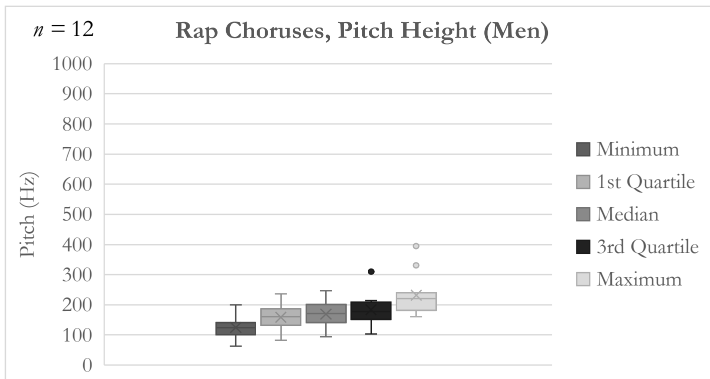
Figure 4.10 Relative frequency of layering values in the CS corpus

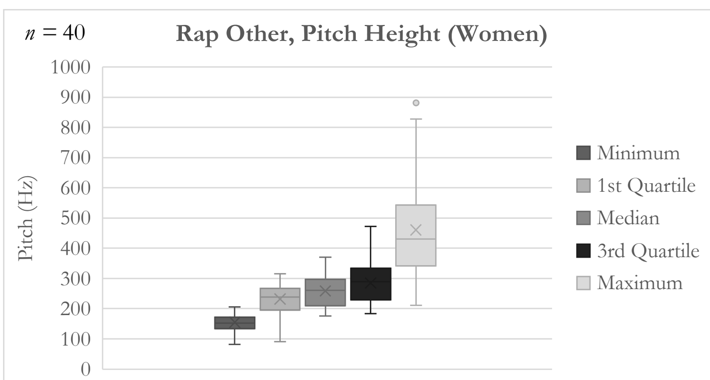
Pitch Height

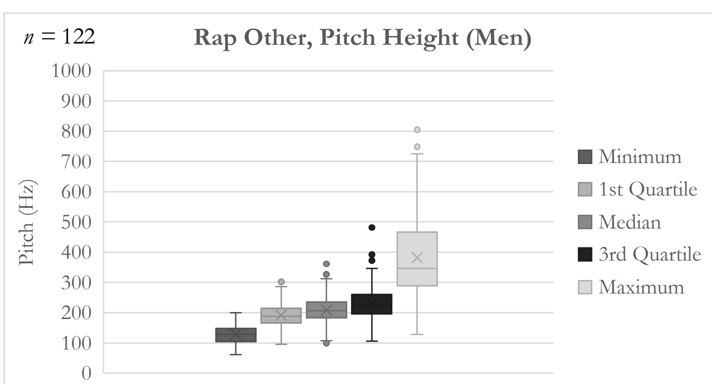
The song-specific vocal placement data reproduced in Appendix C displays pitch data for each formal section of the songs under study. Every section is assigned five values in Hz: a minimum value, the first quartile, the median, the third quartile, and the maximum. Figure 4.11 summarizes this data according to the four categories under study—Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. Consider, for instance, the pitch-height data for women who rap in "Rapped Other" sections. The box-and-whisker plot for the *minimum* value represents all minimum pitch data points in "Rapped Other" sections performed by women. The *Q1* value represents all first quartile pitch data points in "Rapped Other" sections performed by women. The plots in Figure 4.11 therefore illustrate the overall pitch profile taken on by the voices.

No specific trends emerge from the pitch data, except for a difference in tessitura between men's and women's voices. Overall, this variation means that men's voices generally appear slightly lower on the vertical axis of the virtual space than women's voices. There is, however, a notable difference between the pitch heights of rap choruses performed by men and women. The sections performed by men all remain below 400Hz, suggesting a lower and more speech-like delivery. Rapped choruses performed by women generally remain below 600Hz but may reach 900 Hz. The CS corpus only contains only 19 rapped choruses—7 are performed by women, and 12 by men. This small sample size may be responsible for the stark difference in pitch height values between men and women in this type of formal section, and more data would be needed to determine whether this is a trend or a feature of the small sample.


n = 7
Rap Choruses, Pitch Height (Women)
Pitch (Hz)
1000
900
800
700
600
500
400
300
200
100
0
Minimum
1st Quartile
Median
3rd Quartile
Maximum


n = 12
Rap Choruses, Pitch Height (Men)
Pitch (Hz)
1000
900
800
700
600
500
400
300
200
100
0
Minimum
1st Quartile
Median
3rd Quartile
Maximum


n = 40
Rap Other, Pitch Height (Women)
Pitch (Hz)
1000
900
800
700
600
500
400
300
200
100
0
Minimum
1st Quartile
Median
3rd Quartile
Maximum


n = 122
Rap Other, Pitch Height (Men)
Pitch (Hz)
1000
900
800
700
600
500
400
300
200
100
0
Minimum
1st Quartile
Median
3rd Quartile
Maximum

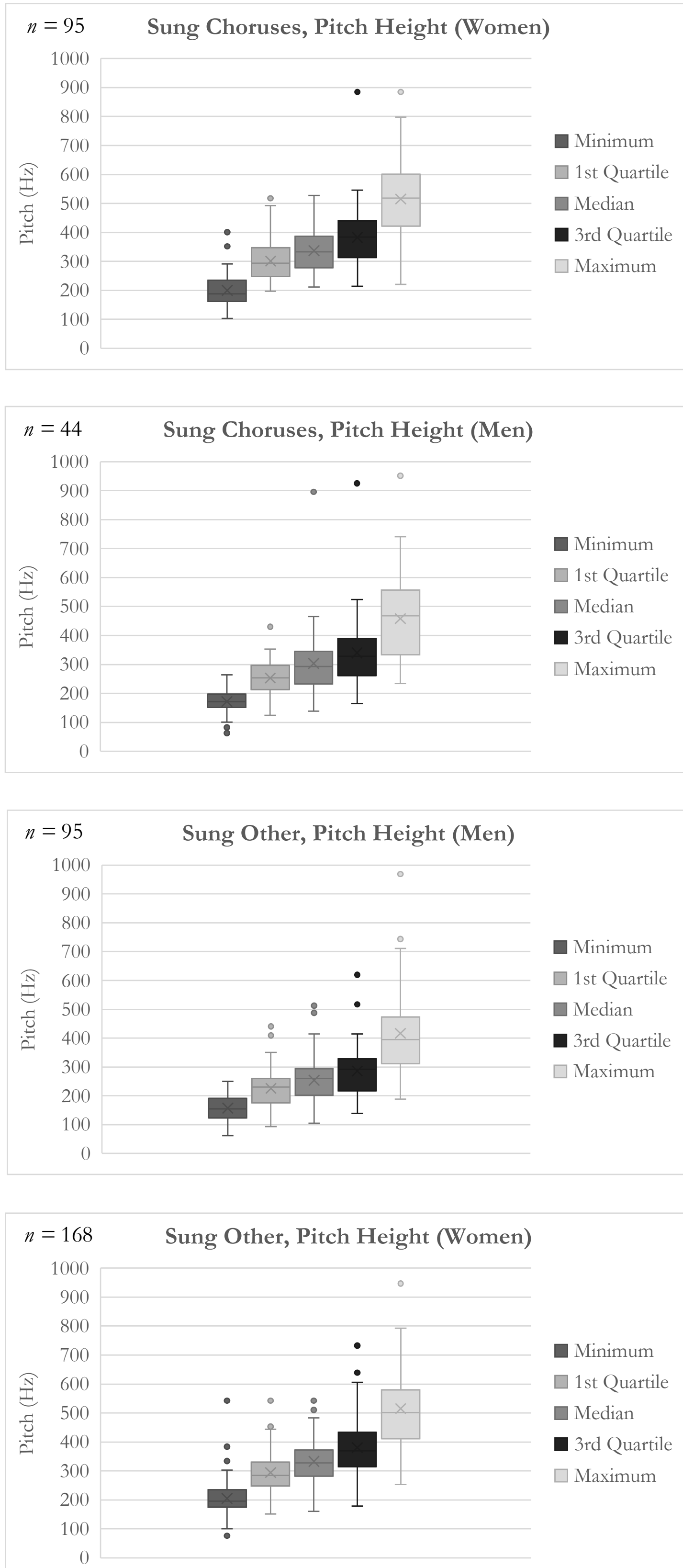


Figure 4.11 Pitch values in the CS corpus

Prominence

The box-and-whisker plots in Figure 4.12 graphically depict the prominence values of men's and women's voices in the four formal categories under study—Rapped Choruses, Rapped Other, Sung Choruses, and Sung Other. T-tests revealed that the differences between prominence values for men and women in all formal sections under study were not statistically significant.[21] It is indeed easy to see the similarities between prominence values. Consider, for instance, the box plot for "Sung Other" sections. The mean of prominence values for women's voices (54.24%) is almost identical to that of men's voices (54.25%). Through the T-tests and visual comparison of prominence data, we can therefore conclude that there is no significant difference between the way men's voices and women's voices tend to be positioned on the depth axis of the virtual space. A more refined algorithm for voice separation might contribute to more accurately quantifying and comparing prominence values.

[21] The difference between prominence levels in rap choruses performed by women (M = 37.9, SD = 12.6) and in those performed by men (M = 41.8, SD = 19.5) was not statistically significant, $t(17) = -0.53$, $p < 0.05$
The difference between prominence levels in other rap sections performed by women (M = 47.4, SD = 12.1) and in those performed by men (M = 49.9, SD = 14.5) was not statistically significant, $t(78) = -1.94$, $p < 0.05$
The difference between prominence levels in sung choruses performed by women (M = 53.7, SD = 15.3) and in those performed by men (M = 49.5, SD = 15.2) was not statistically significant, $t(85) = 1.51$, $p < 0.05$
The difference between prominence levels in other sung sections performed by women (M = 54.2, SD = 15.3) and in those performed by men (M = 54.2, SD = 17.3) was not statistically significant, $t(176) = -0.002$, $p < 0.05$

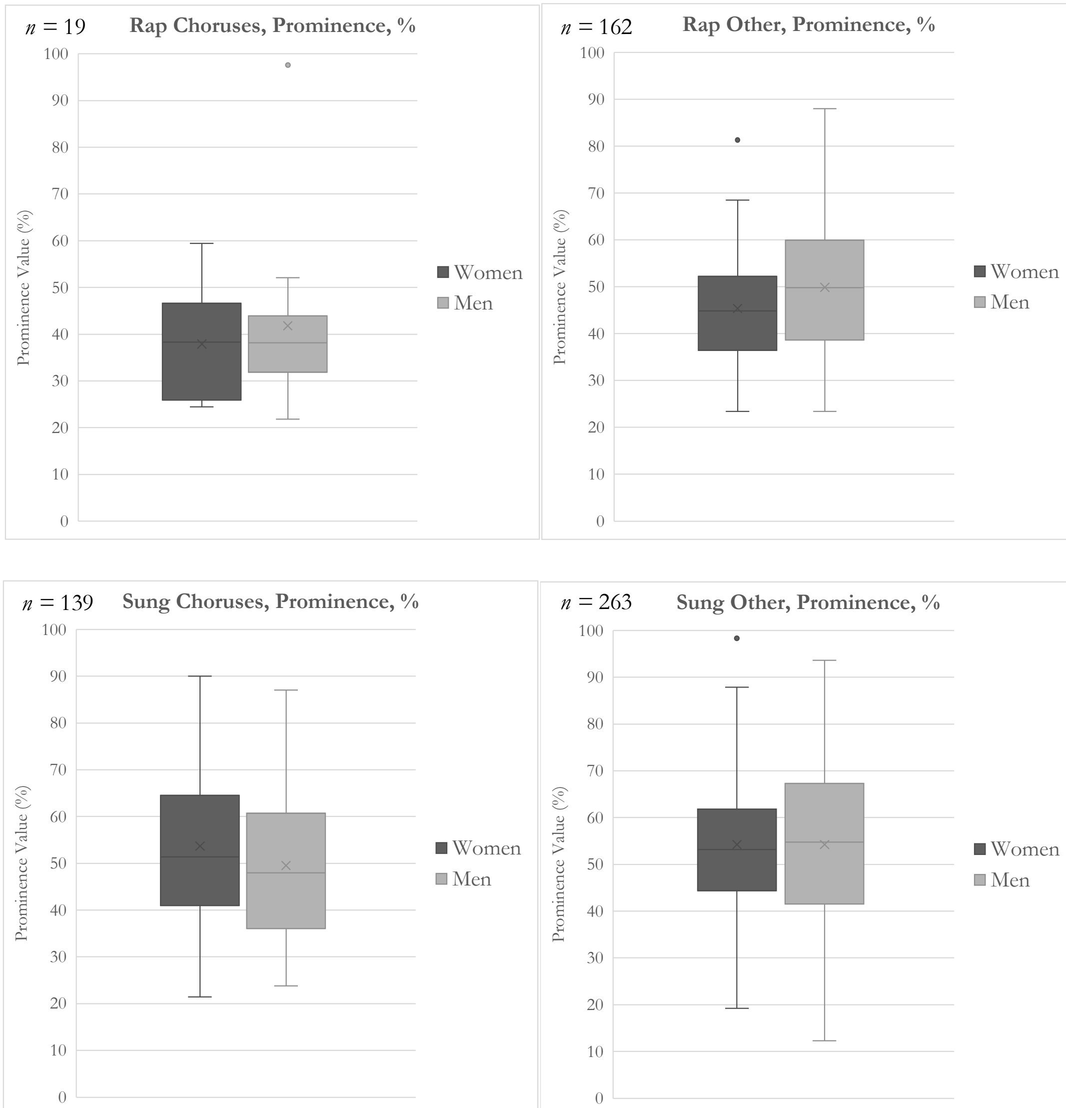


Figure 4.12 Prominence values in the CS corpus

4.5 Summary

The above statistical descriptions of the five vocal placement parameters in the CS corpus highlight important trends in the way in which women's and men's voices are differentiated through vocal placement. While there are no significant divergences between men's and women's pitch height and prominence, the width, layering, and environment parameters are manifested differently across genders, vocal styles, and formal section types. Women's voices—whether they are rapping or singing—tend to be wider, more layered, and more reverberated than men's voices. While a separate consideration of width, layering, and environment highlights interesting trends about the spatial depiction of voices, this approach artificially divides virtual space into individual components. Noting that a particular voice is "highly layered," for instance, does not paint a complete picture of this voice's vocal placement. Are these vocal layers distributed across the virtual space, or positioned in a narrow position on the stereo stage? Are they reverberated, or presented in dry environments? To show the interaction of different parameters, the next chapter examines how width, layering, and environment create distinct vocal placements.

Chapter 5 Vocal Placement Profiles in the *Billboard* Year-End Hot 100, 2008–18

In this chapter, I examine how the parameters of layering, width, and environment interact with one another to create distinct vocal placements. I use the *k*-means algorithm to conduct a cluster analysis of the 583 distinct formal sections found in the CS corpus established in Chapter 4. The algorithm groups similar vocal placements into categories. Through this cluster analysis, I identify four *vocal placement profiles* that are understood as umbrella categories encapsulating similar vocal placements:

(1) Profile 1 encapsulates vocal placements with low layering, width, and environment values. Voices set to this profile are therefore singular, narrow, and non-reverberated.

(2) Profile 2 encapsulates vocal placements with low environment and layering values and mild or fair amounts of width. Voices set to this profile are often singular and non-reverberated, but they are occasionally spread throughout the virtual space.

(3) Profile 3 encapsulates vocal placements with low layering values, high width values, and high environment values. Voices set to this profile are singular, occupy a wide space, and reverberated across the stereo stage.

(4) Profile 4 encapsulates vocal placements with high layering values, high width values, and low environment values. Voices set to this profile are layered, wide, and non-reverberated.

I show how "low" profiles—1 and 2—are more often assigned to men who rap, and that "high" profiles—3 and 4—are more often assigned to women who sing. Finally, I survey the different ways in which the four vocal profiles are juxtaposed in songs, allowing me to identify frequent vocal profile pairings in the corpus.

5.1 *K*-Means Cluster Analysis

Figure 5.1 shows a three-dimensional scatterplot in which the 583 formal sections under study are mapped. This scatterplot does not represent the virtual space; rather, it displays each section's width, environment, and layering values. The X axis displays environment values. The 1 to 5 scaling of the axis represents the five environment values (E1 through E5). The Y axis displays width values. The 1 to 5 scaling of the axis represents the five width values (W1 through W5). Finally, the Z axis displays layering values. The 1 to 5 scaling of the axis represents the five layering values (L1 through L5). The points on the scatterplot represent the 583 distinct formal sections under study in the corpus, mapped according to their width, environment, and layering measurements. The opaquer the point, the more frequently this particular width, environment, and layering configuration occurs. For instance, consider Point A (labeled in Figure 5.1). This point represents a vocal placement with an environment value of E2, a layering value of L1, and a width value of W1. The high transparency of Point A indicates that the "E2, L1, W1" vocal placement occurs only few times in the corpus. Point B (also labeled in Figure 5.1) represents a vocal placement of "E1, L5, W5." Its high opacity shows that this vocal placement configuration occurs several times in the corpus.

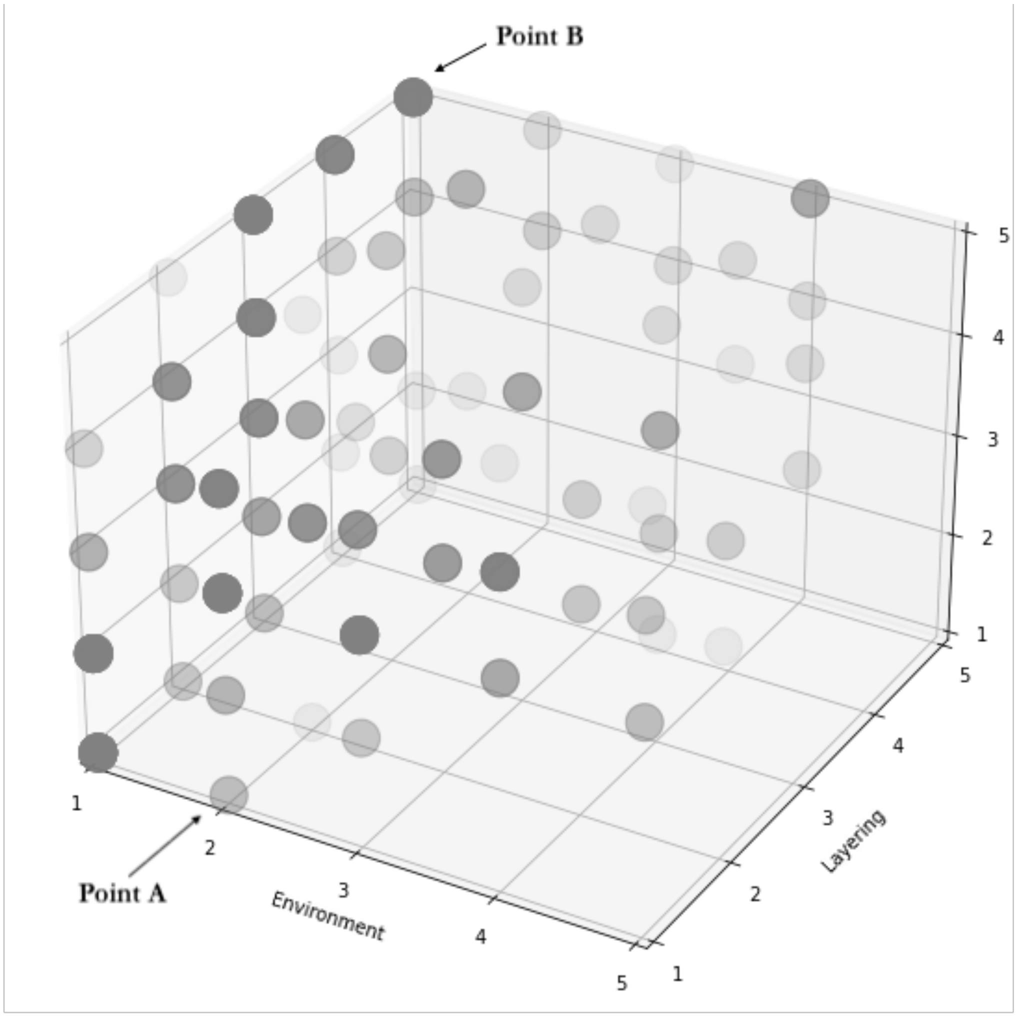


Figure 5.1 Scatterplot displaying width, environment, and layering values in the 583 distinct formal sections found in the CS corpus. The opacity of the points increases with the number of occurrences of the vocal placement. The transparency of Point A indicates that this vocal placement occurs only a few times in the CS corpus. The opacity of point B indicates that this vocal placement is more frequent.

The scatterplot in Figure 5.1 raises an important question: how can similar vocal placements be grouped together? How, for instance, could we account for the high concentration of vocal placements with high layering values and width values of W5? Surely, these vocal placements resemble each other enough to provide similar aural impressions. How many other distinct vocal placement categories could we identify, and what would these categories sound like? Comparing similar types of vocal placements could better highlight the different ways in which men's and women's voices are sonically presented through space. We could verify, for instance, whether certain vocal placement types are distributed evenly across gender.

In order to identify different types of vocal placements, I use the *k*-means[1] clustering algorithm to categorize the vocal placement data shown in Figure 5.1 into four distinct clusters. One of the most frequently used clustering algorithms, the *k*-means algorithm "tries to find cluster centers that are representative of certain regions of the data." (Müller & Guido 2017, 168). Figure 5.2 displays the clustered data. The four Xs in Figure 5.2 represents the cluster centers, or *centroids* of each cluster. Determined by the algorithm, these centroids represent the "prototype" for each cluster.

Running the *k*-means algorithm on the same data always yields different results. There are no *a priori* clusters or categories to identify; rather, running the algorithm once provides only one possible interpretation of the data. The clustered data in Figure 5.2 represents one of such possible results. After running the *k*-means algorithm on the vocal placement data a few times, I noticed that the algorithm always identified four roughly similar groups: the first consisting of narrow, dry, and non-layered vocal placements; the second corresponding to vocal placements that were narrow, slightly reverberated at the end of the phrases, and subtly layered; the third encompassing wide, reverberant, and non-layered vocal placements; and the fourth corresponding to vocal placements that were wide, dry, and highly layered. The following analysis relies on the clustering shown in Figure 5.2, but I could have chosen another set of

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[1] The *k*-means algorithms partitions n number of observations into k clusters. In this particular study, $n = 583$ (the number of distinct formal sections under study), and $k = 4$. I chose to use four clusters because this separation seemed to me as the most intuitive way to represent different subtypes of vocal placement. The resulting clusters effectively grouped similar vocal placements while presenting four distinct sonic profiles. The *k*-means clustering for the vocal placement data was conducted with Scikit-Learn and visually displayed with Matplotlib.

similar results identified by the *k*-means algorithm. These alternate results might have displayed minute differences in the clusters but would have nonetheless grouped similar vocal placements together in the same way.

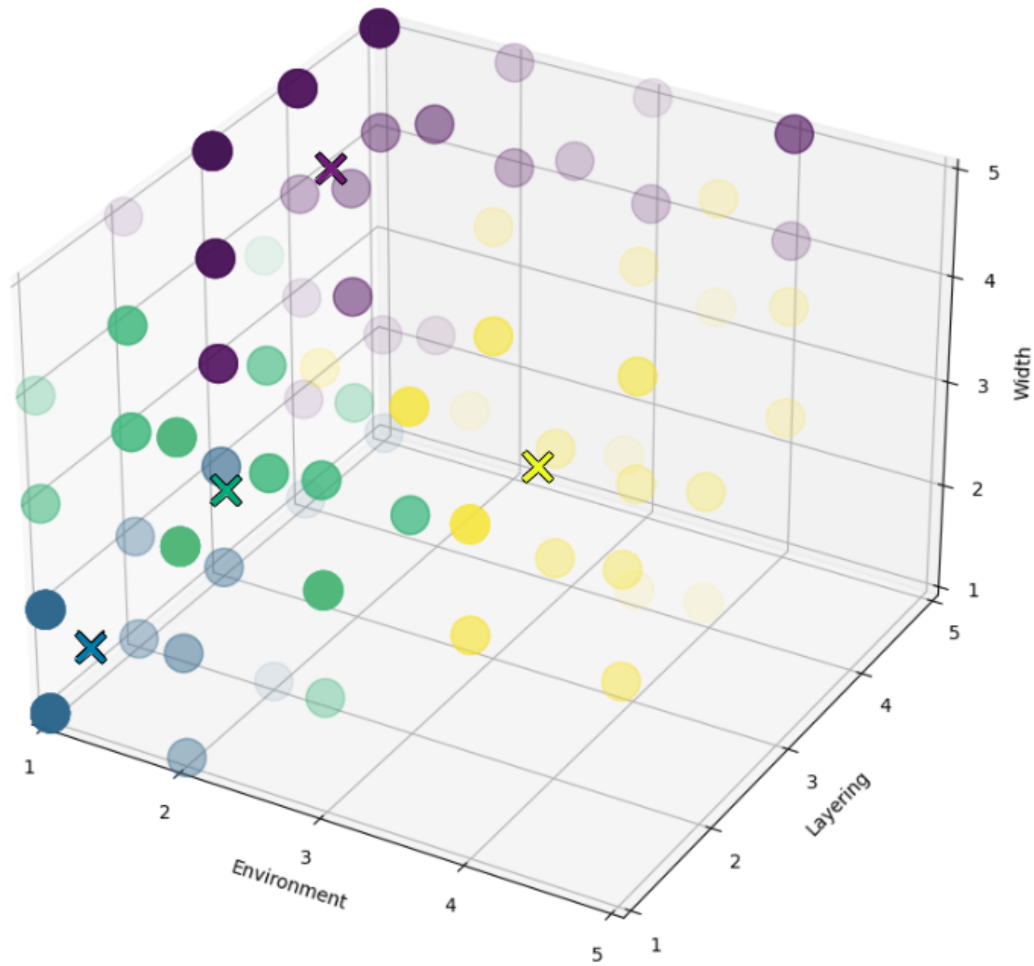


Figure 5.2 *K*-means clustering algorithm applied to the 583 distinct formal sections found in the CS corpus. The data is parsed into four clusters, which are each assigned an individual color. The four X markers indicate the centroid of each cluster.

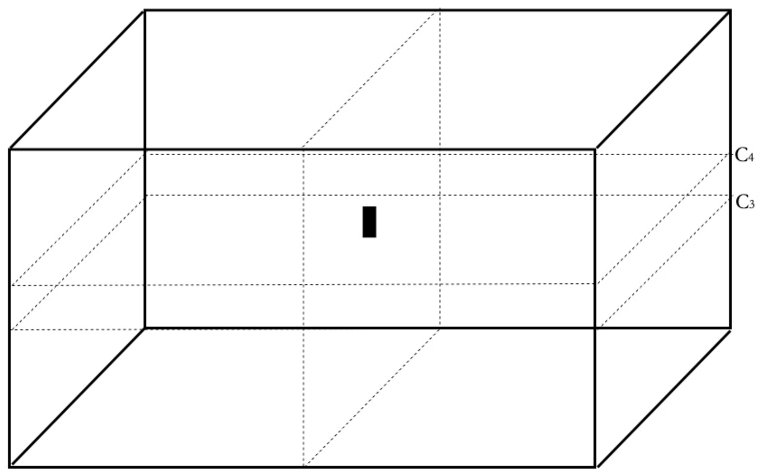
I posit that each cluster identified by the *k*-means algorithm corresponds to a distinct *vocal placement profile.* A vocal placement profile is an umbrella category under which a set of vocal placements is grouped by virtue of similar width, layering, and environment values. Two distinct vocal placements might belong to the same profile despite minute differences in their parameter measurements if they convey similar sonic impressions. For instance, "W1, E1, L2" and "W1, E1, and L1"—two distinct vocal placements characterized by a narrow position on the stereo stage, a dry environment, and little or no layering—are similar enough to be grouped in the same profile. While I identify two typical examples for each profile below, vocal placement profiles should be considered as porous categories. The *k*-means algorithm's categorization of a vocal placement in a particular cluster can be uncertain, and some vocal placements might seem to fall outside of the four profiles. I will bring attention to such cases when necessary, with the hope that the four profiles described below convincingly encompass the range of sonic impressions heard throughout the corpus.

5.2 Four Vocal Placement Profiles

The blue cluster corresponds to vocal placement profile 1. The cluster centroid for Profile 1 is [E1.09, L1.34, W1.47]. This rounds to [E1, L1, W1].[2] The low environment, width, and layering values characteristic of this particular profile point toward a narrow vocal placement that is centered and localized in the virtual space, treated with little to no salient reverberation or echo, and presented as a single or subtly layered voice. Voices set to Profile 1 are not audibly filtered and modified by several effects. Figure 5.3 displays two vocal placements representative of Profile 1: Drake's verse in Rihanna's "Work" (2016) and 21 Savage's verse in Cardi B's "Bartier Cardi" (2018).

[2] As explained in Chapter 4, the environment, layering, and width parameters are treated as *categorical* values even if they are technically *discrete.* The environment parameter, for instance, is described as having five possible categories: E1, E2, E3, E4, or E5. The methodology outlined in Chapter 2 does not explicitly describe what a voice with an E1.5 value would sound like; that being said, it would be possible for a voice to have an environment value located somewhere between E1 and E2. To allow for simpler visualization of the data, I continue treating the E, L, and W parameters as categorical throughout this chapter. The cluster centroids, however, fall somewhere in between these categorical values.

"Work," Rihanna ft. Eminem (2016). Verse by Drake, 2:10–3:03



"Bartier Cardi," Cardi B ft. 21 Savage (2018). Verse by 21 Savage, 1:37–2:05

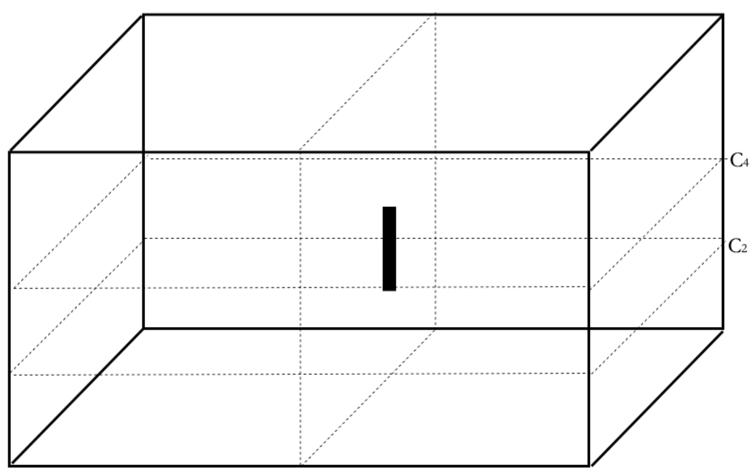


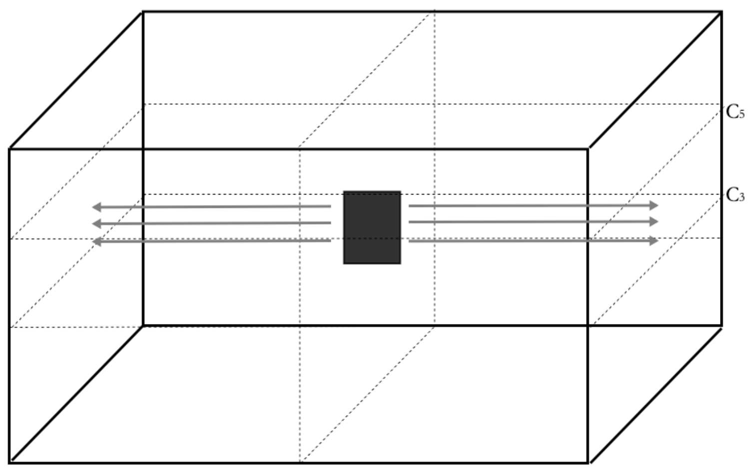
Figure 5.3 Two representative examples of vocal placement profile 1

The green cluster corresponds to vocal placement profile 2. The cluster centroid for this profile is approximately [E2, L2, E3].[3] Profile 2 is characterized by low environment and layering values along with mild or fair amounts of width. The voice is often layered or

[3] Rounded from [E1.63, L1.61, W3.35].

reverberated at the end of phrases, and these phrase endings are subsequently spread horizontally across the virtual space. Voices set to Profile 2 are slightly more sonically modified than those set to Profile 1. Figure 5.4 displays two vocal placements representative of Profile 2: Nicki Minaj's verses in "Only" (2015) and Snoop Dogg's verse in "California Gurls" (2010).

"Only," Nicki Minaj ft. Drake, Lil Wayne, Chris Brown (2015). Verse by Nicki Minaj, 0:09–1:13



"California Gurls," Katy Perry ft. Snoop Dogg (2010). Verse by Snoop Dogg, 2:26–3:04

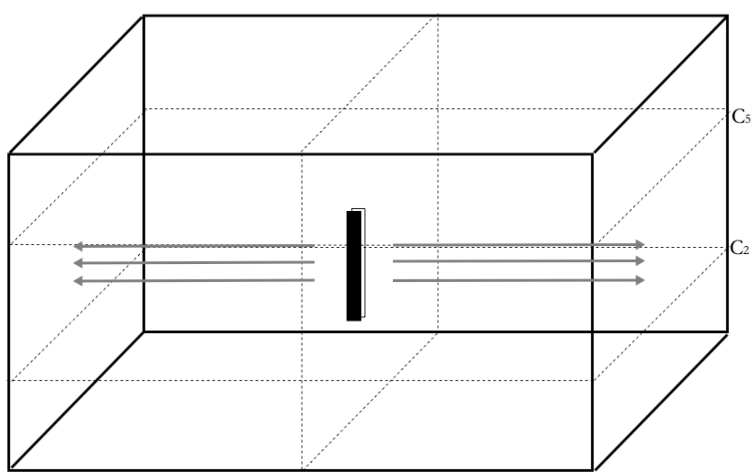
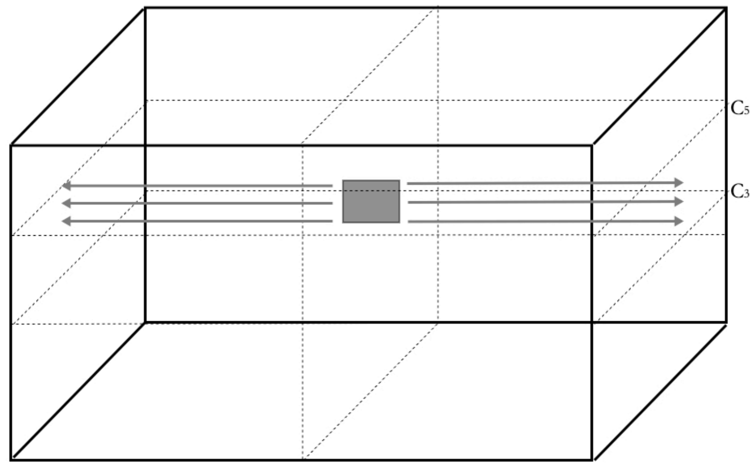


Figure 5.4 Two representative examples of vocal placement profile 2

The yellow cluster corresponds to vocal placement profile 3. The cluster centroid for this profile is approximately [E4, L2, W4].[4] This third vocal placement profile is characterized by high environment and width values applied to a voice with no to little layering. The voice has a single layer, is presented in a wide space, and is often reverberated across the stereo stage. Voices set to Profile 3 sound more filtered and processed due to the addition of echo and reverberation, while still evoking a realistic space in which a voice could reverberate. Figure 5.5 displays two vocal placements representative of Profile 3: SZA's verse in "What Lovers Do" (2018) and Rihanna's chorus in "Wild Thoughts" (2017).

[4] Rounded from [E3.597, L1.58, W3.58].

“What Lovers Do,” Maroon 5 ft. SZA (2018). Verse by SZA, 1:01–1:18



“Wild Thoughts,” DJ Khaled ft. Rihanna, Bryson Tiller (2017). Chorus by Rihanna, 0:29–0:44

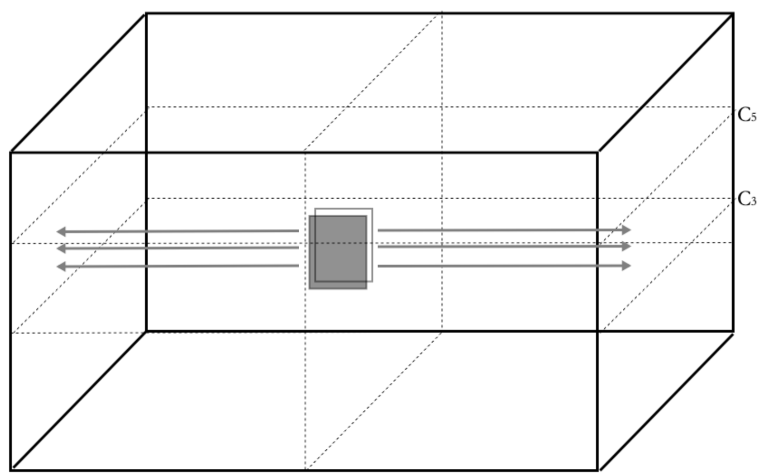


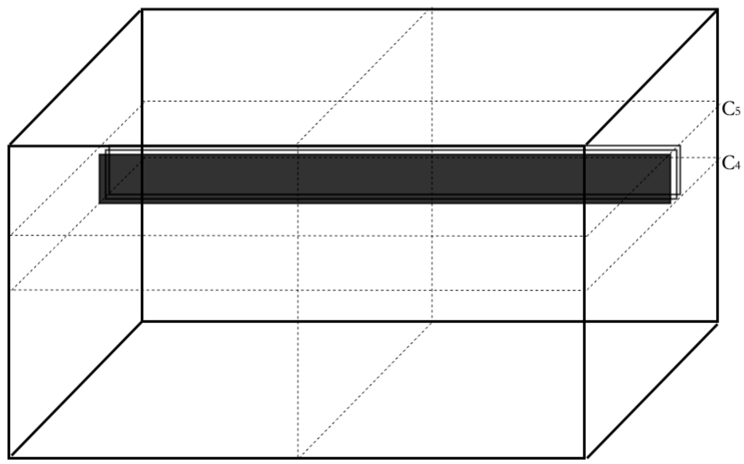
Figure 5.5 Two representative examples of vocal placement profile 3

Finally, the purple cluster corresponds to vocal placement profile 4. The cluster centroid for this profile is approximately [E1, L4, W5].[5] Profile 4 is characterized by low environment values, in which a highly layered voice is spread across the horizontal axis of the virtual space.

[5] Rounded from [E1.46, L3.87, W4.65].

Voices set to Profile 4 sound highly filtered and processed, as they evoke a fully abstract space in which an individual's voice is layered with copies of itself. Figure 5.6 displays two vocal placements representative of Profile 4: Katy Perry's chorus in "Chained to the Rhythm" (2017) and Anne-Marie's chorus in "Rockabye" (2017).

"Chained to the Rhythm," Katy Perry ft. Skip Marley. Chorus by Katy Perry, 0:55–1:38



"Rockabye," Clean Bandit ft. Sean Paul & Anne-Marie. Chorus by Anne-Marie, 2:12–2:31.

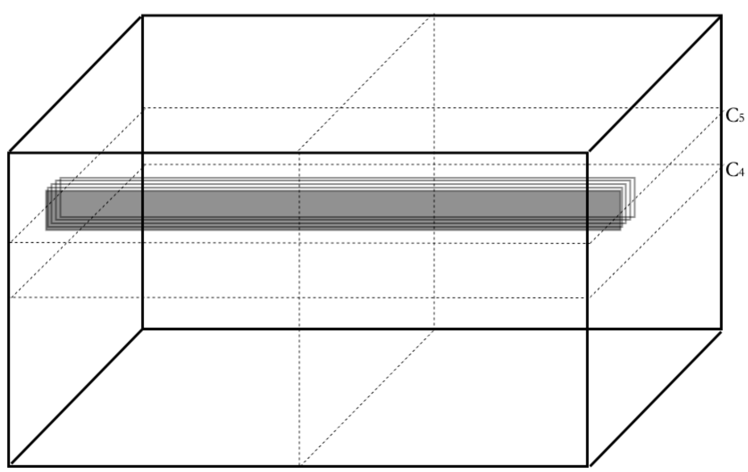


Figure 5.6 Two representative examples of vocal placement profile 4

The four vocal placement profiles are distributed differently according to gender and vocal style. Figure 5.7 displays the total count of each vocal profile in Rapped Choruses, Rapped

Other Sections, Sung Choruses, Sung Other Sections. The profiles are shown on the X axis of the graphs. The orange columns represent men's voices, and the blue columns represent women's voices. The higher the column, the more instances there are of this specific type of vocal placement.

Since Rapped Choruses are rare, it is difficult to generalize about vocal placement based on data shown in Figure 5.7. Notice how there are only seven instances in which a man's voice is set to Profile 2, whereas only two women's voices are set to this profile. In Rapped Other Sections, the most commonly heard sound is a man's voice set to Profile 1, with 53 instances of this type of vocal placement. The second most common profile is Profile 2, assigned to a man's voice 37 times. Women's voices also are set only to Profiles 1 and 2—nine and eighteen times, respectively.

Sung Choruses display a different trend. The most commonly heard sound is a woman's voice set to Profile 4 (41 instances), followed by a woman's voice set to Profile 3 (28 instances). Men sing choruses less often, but when they do, they are set frequently set to Profile 4 (19 times) and Profile 1 (12 times). In other sung sections, women's voices spike in popularity for the higher profiles, with 67 instances of Profile 3 and 49 instances of Profile 4. Men's voices are more likely to be set to Profile 1 (28 instances), followed closely by Profiles 2 and 3.

Figure 5.7 allows us to make the following observations: Rapped sections—both Chorus and Others—are most often performed by men, whose voices have been set to Profile 1 or 2. Sung sections—both choruses and others—are most often performed by women, whose voices have been set to Profile 3 and 4. Wider, larger, reverberant profiles are more often assigned to women, and narrow and focused profiles are more often assigned to men.

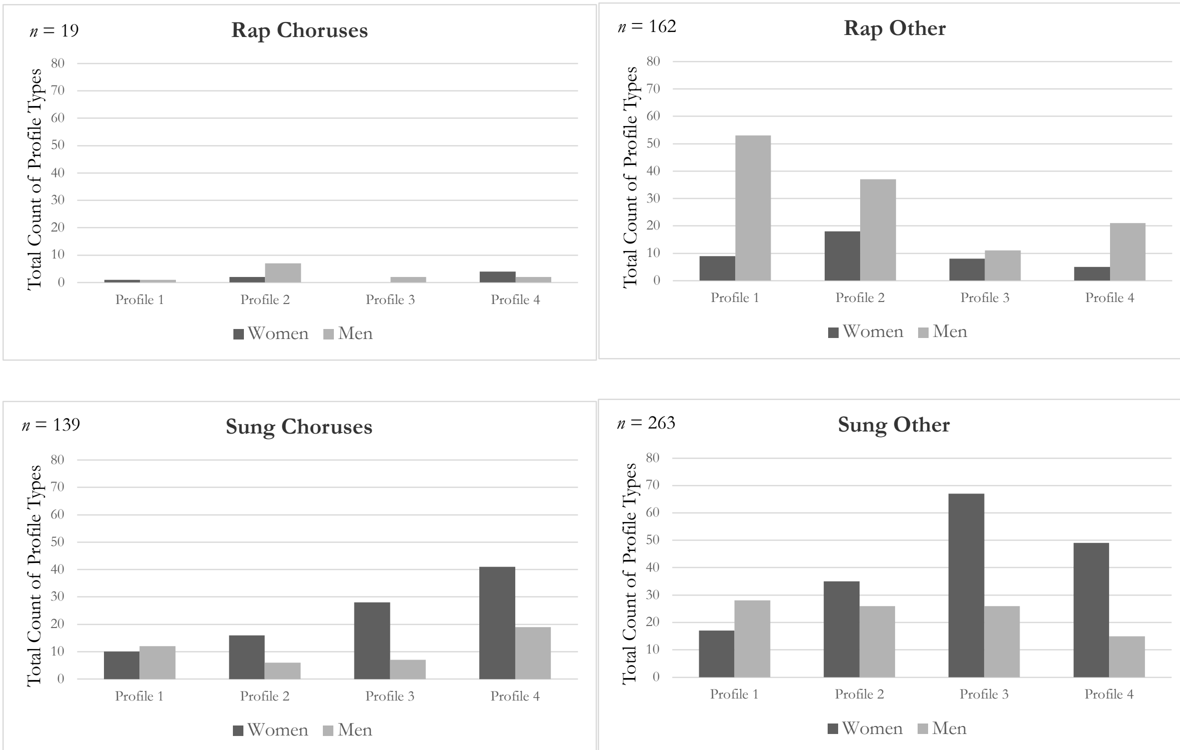


Figure 5.7 Total count of four vocal placement profiles in the CS corpus.

5.3 Combining the Vocal Placement Profiles

The four profiles outlined above are juxtaposed to one another in various ways throughout the corpus. I identify six possible categories of pairings in order to ascertain how men's and women's voices are made to sound when they are presented within the same track:

(1) **Woman Always Higher:** Women are always assigned higher vocal placement profiles than men throughout the track.

(2) **Woman Highest, Man Lowest:** There is some overlap between the profiles assigned to men's and women's voices, but overall, the highest profile heard is applied to a woman's voice and the lowest profile heard is applied to a man's voice.

(3) **Man Always Higher:** Men are always assigned higher vocal placement profiles than women throughout the track.

(4) **Man Highest, Woman Lowest:** There is some overlap between the profiles assigned to men's and women's voices, but overall, the highest profile heard is applied to a woman's voice and the lowest profile heard is applied to a man's voice.

(5) **Same:** Men and women are assigned the same vocal profile(s) throughout the track.

(6) **Other:** Miscellaneous vocal pairings in which no voice is clearly assigned higher or lower profiles.

Figure 5.7 displays the six different vocal pairings as they are distributed across the entire corpus. Figure 5.8 displays the six different vocal parings as they are distributed across different types of songs in the corpus: songs in which men rap and women sing, songs in which men sing and women rap, songs in which both men and women rap, and songs in which both men and women sing.

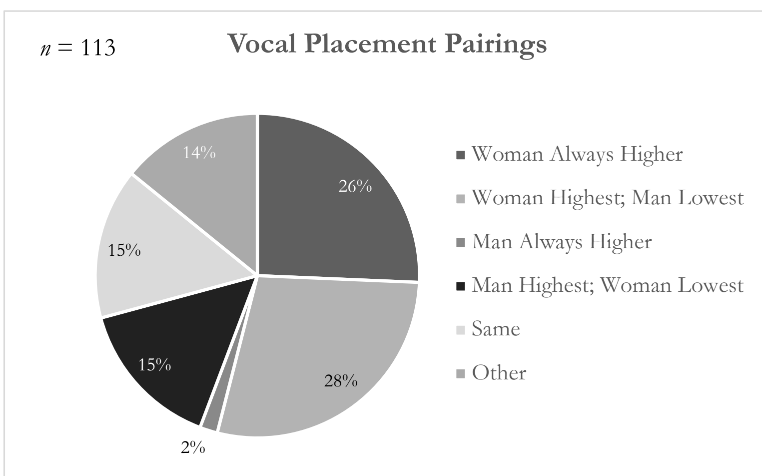


Figure 5.8 Pairings of the four vocal placement profiles in the CS corpus

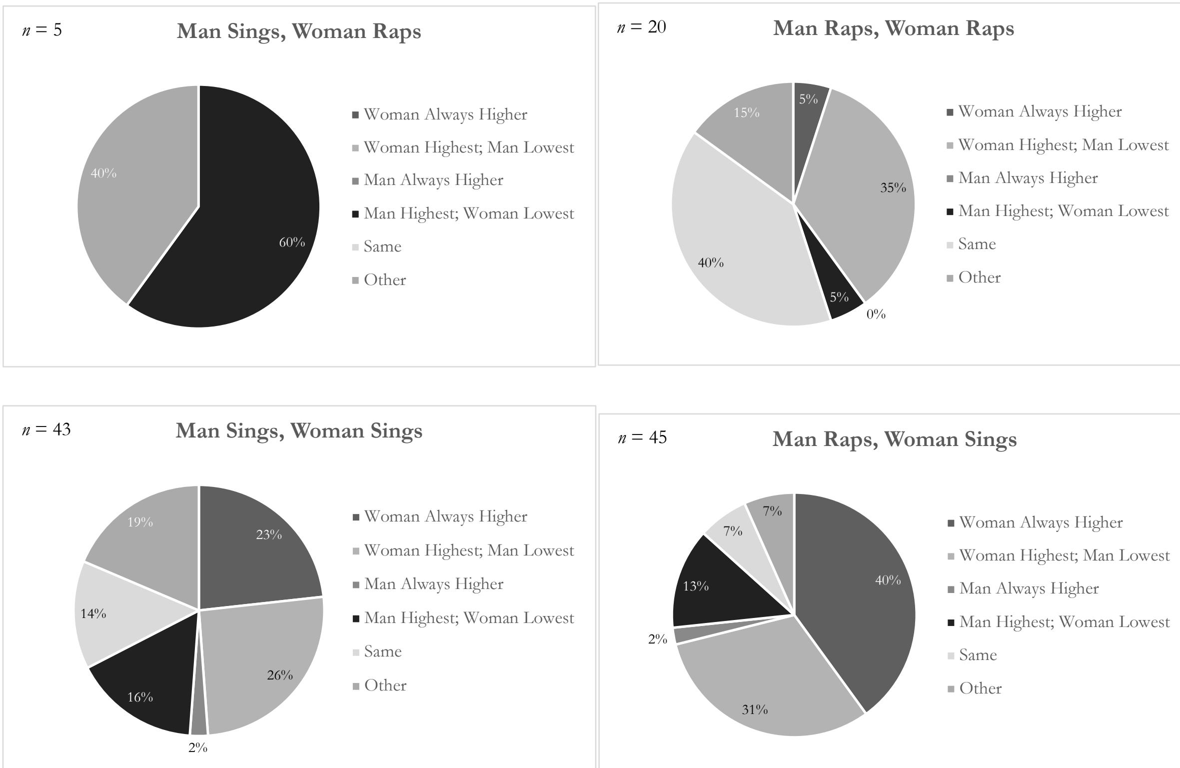


Figure 5.9 Pairings of the four vocal placement profiles in the CS corpus, separated according to collaboration type (1. Man sings, woman raps; 2. Man raps, woman raps; 3. Man sings, woman sings; 4. Man raps, woman sings)

5.4 Summary

The results of the corpus study are summarized below in a series of statements. These statements encapsulate the different ways in which men's and women's voices are presented differently via vocal placement on *Billboard*-charting collaborations between 2008 and 2018:

1. *Men rap more often than women.*
2. *Women sing more often than men.*
3. *Other rapped sections are most often performed by men set to a low vocal placement profile such as Profile 1 or 2.* There are not enough rapped choruses (hooks) to make definitive statements about vocal placement in these sections. Men's rapping voices tend to be localized in the virtual space, set in a dry environment, and presented as a single

vocal track. Women’s rapping voices do not follow this trend as closely.

4. *Sung Choruses and Other sung sections are most often performed by women and set to a high vocal placement profile, such as Profile 3 or 4.* Women’s singing voices tend to be diffuse in the virtual space, set in reverberant environments, and layered with multiple vocal tracks. Men’s singing voices do not follow this trend as closely.
5. *The most common type of collaboration features a man rapping and a woman singing* (45 instances, or 40% of the CS corpus). Given that men’s rapping voices tend to be localized, dry, and single while women’s voices are diffuse, reverberated, and layered, these collaborations frequently feature vocal pairings in which the woman’s voice is set to a higher profile than the man’s.
6. *The second most common type of collaboration features a man and a woman who both sing* (43 instances, or 38% of the CS corpus). Nearly half of these collaborations feature a woman’s voice always set to a higher profile (23%) or generally higher (26%) than the man’s voice. The reverse categories are much rarer, with men’s voices being rarely set to a consistently higher profile than women’s voices.
7. *In collaborations in which both a man and a woman rap, vocalists most commonly share a vocal placement* (40%), followed closely by pairings in which the woman’s voice is generally set to a higher profile (35%). In only 5% of these collaborations are men’s voices generally higher than women’s. There are no instances in which a man’s voice is always set to a higher profile than the woman’s voice.

The above observations share an overarching theme: *men’s voices tend to be narrower, dryer (less-reverberated), and less layered than women’s voices.* This difference is often highlighted in specific collaborations, such as the ones in which a woman sings and a man raps. In the following chapter, I will explore the socio-cultural implications of these findings.

Chapter 6 Reflections on Vocal Placement and Gender

In this chapter, I adopt a feminist music-theoretical lens to examine the analyses of vocal placement outlined in previous chapters. In Chapter 1, I highlighted the three main components of feminist music theory: (1) an expansion of music-analytical repertoire; (2) the development of analytical tools that create new modes of engagement with music; and (3) a focus on the identity of the composer, performer, and/or analyst (Figure 6.1). Throughout the dissertation, I have focused on the first two components. First, I expanded traditional analytical repertoire by studying recent popular music, with a special focus on the music of Rihanna. Second, I developed a methodology for analyzing vocal placement in virtual space, detailed in Chapter 2, that provided a tangible way to characterize how the voice is sonically treated within recorded songs.

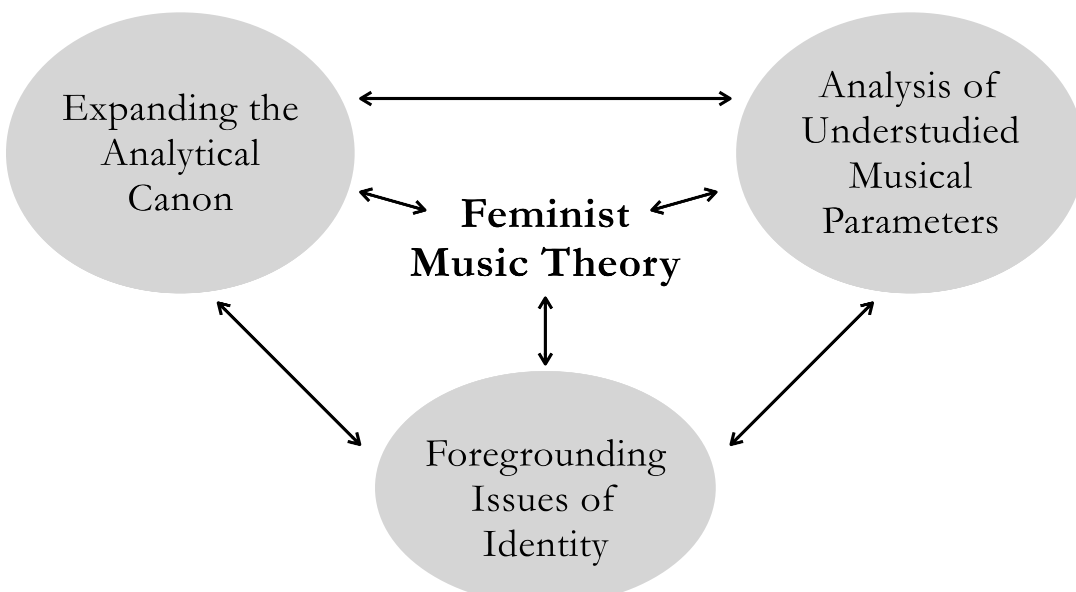


Figure 6.1 Three trends in feminist music theory

Now, in this chapter, I bring my focus to the third point by exploring the relationship between vocal placement and identity. I relate the analysis of "Love the Way You Lie" to the vocal placement trends determined through the corpus study, and I consider the results of the corpus study in Chapters 4 and 5 through the lens of gender. In Chapter 4, I showed how the parameters of width, layering, and environment tend to be applied differently to the voices of men and women in a 113-song corpus of musical collaborations between men and women. Regardless of vocal delivery type or formal section, men's voices are consistently mixed as narrower, less layered, and less reverberated than women's voices. In Chapter 5, I examined the ways in which these three parameters—width, layering, and environment—function together to create four distinct *vocal placement profiles.* Profiles 1 and 2, which correspond to generally narrow, localized, and focused vocal placements, tend to be assigned to men who rap. Conversely, the wider, more reverberant, and layered Profiles 3 and 4 are more often assigned to women who sing. I have shown how the most frequent collaboration type is between a man who raps and a woman who sings, ensuring that contrasting vocal placements are made especially obvious within collaborations between two or more artists.

In this chapter, I examine three aspects of the relationship between vocal placement and gender in Anglo-American popular music. First, in section 6.1, I propose that we think of this repertoire as a *gendered soundscape* (Järviluoma *et al.* 2012). This concept entails that pop music contributes to the creation of gender. Contrasting vocal placements within this soundscape create a sonic gender binary that differentiates the way in which men's and women's voices should sound. Second, in section 6.2, I consider in more detail the sound of this gender binary. I show how voices are often presented according to stereotypes that position women's voices as ornamental, and men's voices as active and direct. Third, in section 6.3, I consider how the use of differentiating vocal placements creates different sonic stereotypes. A wide and reverberant vocal placement, I argue, can be marked as “feminine” even if the vocalist is not a woman. Similarly, narrow vocal placements can come to evoke masculinity regardless of the actual identity of the vocalist. I relate my conception of sonic expression of gender to work on sonic expressions of race, summarizing Mendi Obadike’s notion of black acousmatics (2005) and Matthew D. Morrison’s concept of Blacksound (2019) to discuss some of the ways in which vocal placement and commodified notions of Blackness may intersect. By exploring these topics, I contextualize the analyses of Chapters 3, 4, and 5 to show how vocal placement contributes to the formation of a gendered sound.

6.1 Anglo-American Popular Music as a Gendered Soundscape

The CS corpus analyzed in Chapters 4 and 5 features collaborations by men and women vocalists. I understand the vocal placements heard in this corpus as being representative of Anglo-American popular musical from 2008 and onwards. As such, this chapter considers the results found in the CS corpus as being representative of post-2008 Anglo-American popular music in general. As discussed in Chapter 4, the music industry is highly gendered. As Lieb (2018) shows, women artists, for instance, tend to be categorized within a limited number of artistic personas. As Keyes (2000) and Bradley (2012, 2015) discuss, these personas exist at the intersection of race and gender. Additionally, the lack of women sound engineers and producers results in an unbalanced industry in which the sound of popular music is generally determined by men.[1] Helen Reddington (2018) argues that this imbalance often results in a form of “gender

[1] In a study of 700 popular songs from 2012 to 2018, Smith *et al.* (2019) found that only 2.1% of producers were women. Out of 871 producers, only 4 were women of color. A report from the Audio Engineering Society reveals that only 5 to 7% of producers and audio engineers are women (Mathew *et al.* 2016).

ventriloquism," in which men producers speak through the voices of women artists. Given the highly gendered context under which popular music is created, I believe that it is crucial that we consider how vocal placement—that is, the way in which artists' voices are sonically presented to listeners—contributes to the formation of gendered stereotypes.

Through the analysis in Chapters 4 and 5, I have shown how men's and women's vocal placements tend to contrast with one another. To frame this contrast in terms of gender, I propose that we conceptualize the *Billboard* charts—and Anglo-American popular music in general—as a *gendered soundscape*. A gendered soundscape is a site in which sounds can reify, construct, or contest gender (Järviluoma *et al.,* 2012).[2] By attuning our ears to the ways in which gender is made to sound in commercially successful popular music, we can "conceptualize sound as a space where categories of 'male' and 'female' are constituted … and by extension the ways that power, inequality and agency might be expressed in the sonic realm" (Ehrick 2015, 7). In other words, by paying attention to how men's and women's voices are treated in virtual space, we can reflect on how a binary conception of gender category—which may seem natural or just "how things are"—is a cultural construction that is partially created and reinforced through sound.

Thus, in the pop soundscape, contrasting vocal placements contribute to the sonic construction of gendered difference. If you listened to a radio station that played *Billboard* Hot 100 hits sometime in the past decade, you were likely exposed to a particular type of sonic femininity characterized by a reverberant and wide sound, juxtaposed with a specific type of sonic masculinity that occupies a focused and narrow space. These vocal placements are the results of conventions about vocal delivery style, mixing, and genre, which coalesce into certain

[2] Any physical environment or medium that has sound (radio, television, cities) could be considered a gendered soundscape. Ehrick (2015), for instance, writes about the gendered soundscape of commercial aviation, in which the pilot's voices heard through airplane speakers are usually male.

configurations that sonically differentiates men's and women's voices. Given that commercial popular music features more men that rap than women, for instance, one is more likely to hear a man's voice mixed in a narrow vocal placement profile. You may become used to hearing men's voices mixed in this way, and come to find it natural, especially since it may be frequently presented alongside a woman's wide and reverberated singing voice.

By paying attention to trends in vocal placement in the Anglo-American popular music soundscape, we can further explore the constructed nature of sex and gender categories such as "male" and "female" and "man" and "woman."[3] In *Gender Trouble* (1990), Judith Butler argues that gender is not an innate characteristic of humans, but rather a cultural performance. Individuals constitute themselves as gendered through the repetition of gender-coded social acts. The man/woman binary is constructed through various social processes, some of which include sound. Vocal placement in popular music is one of the many social processes through which the categories of "man" and "woman" come to be constructed. Wide and reverberant representations of femininity, along with narrow and focused depictions of masculinity, do not arise from any innate psychological or personal characteristics of the vocalists. This gendered difference is quite literally constructed: the ways in which men's and women's voices are mixed in virtual space are the result of a series of technological decisions and artistic conventions about how men and women should sound.

Listening to popular music as a soundscape in which gender is constructed can make us more "ear-oriented" scholars. In *Radio and the Gendered Soundscape,* Christine Ehrick writes that while "many of us have been well-trained to look for gender," she wants to encourage her

[3] Refer to Chapter 1 for a lengthier discussion of the distinction between sex and gender, and the ways in which both concepts are often framed as binaries.

readers to “consider what it might mean to listen for it” (Ehrick 2015, 7). When listening to recorded voices, we draw on timbre, pitch, and other delivery mechanisms to make assumptions on the vocalist’s identity.[4] We might assume that a high-pitched voiced, for instance, belongs to a woman. I believe that we should pay equal attention to the way vocal placement allows us to make assumptions about artists’ identities. A wide woman’s voice/narrow man’s voice may seem natural or unmarked to a listener who is familiar with several other collaborations appearing on the *Billboard* charts. Many sung and rapped collaborations between men and women, after all, use a similar vocal placement configuration. By discussing vocal placement in relationship with gender, however, I hope to encourage more reflection about the implications of such a norm. What kinds of assumptions might one make about a vocalist upon hearing a reverberated and wide voice? A narrow and focused voice? What do these sonic characteristics seem to reveal about the vocalist’s identity?

Chapter 3 has addressed these questions in a specific case study by demonstrating how Eminem’s narrow vocal placement, which conveys a sense of anger, frustration, and violence, contrasts with Rihanna’s wide vocal placement, evocative of loneliness and vulnerability. This interpretation, however, was contingent on the vocal delivery and lyrics performed by both artists. The corpus study has shown that throughout the American popular music soundscape, this wide woman’s voice/narrow man’s voice configuration is widespread across songs with different themes, lyrics, and types of vocal delivery. In the next section, I interrogate the larger-scale implications of the frequent contrast between the ways in which men’s and women’s voices are presented in the virtual space. I propose that we pay more attention to such contrasts in vocal placement and the way in which they contribute to the formation of a sonic gender binary.

[4] See Malawey 2020, 59 –62 for an overview of the link between vocal pitch and gender identity.

6.2 Constructing a Sonic Gender Binary

The corpus study of Chapters 4 and 5 shows how men's voices tend to be narrower and less reverberant than women's voices. Here I discuss how this contrast constructs a sonic gender binary by making men's voices more engaging, direct and personal, while making women's voices more decorative, evasive, and distant. This gender binary, as described in Chapter 1, is a socially constructed concept that does not encapsulate the lived reality of several individuals. Additionally, it does not account for how women's voices can be strong, direct, and clear. The sonic construction of "masculinity" and "femininity" upheld in the American popular music industry reifies a binary conception of gender.[5] In collaborations between artists whose personas are marketed according to gendered stereotypes, vocal placement establishes and upholds the man/woman binary.[6]

Ragnhild Brøvig-Hanssen and Anne Danielsen's work on technological mediation provides a useful lens for interpreting the contrasting vocal placement profiles often assigned to men's and women's voices outlined in Chapters 4 and 5. In *Digital Signatures,* the two authors analyze how audio processing technology is made sonically obvious in recorded popular music. The titular "digital signatures" are sonic fingerprints of technology on recorded music, the

[5] The sonic construction of a gender binary may also occur in other musical repertoires. Danielle Sofer (2017) analyzes the construction of a gender binary in Barry Truax's *Song of Songs* (1992), noting that Truax first establishes a clear aural distinction between the male and female characters. This distinction is progressively blurred as the piece unfolds, "[teaching] the listeners that [male and female] categories are neither reliable nor stable—not within the work and not in the world beyond" (Sofer 2017, 10).

[6] Further research should explore how various artists have been subsumed into, pushed back against, or co-opted this gender binary through sound. Blanchard (2018), for instance, studies late trans femme singer and artist SOPHIE, and her use of pitch-altering technology to raise her vocal pitch. The case of Demi Lovato, who was depicted as a woman for years in the popular music industry prior to their coming out as non-binary, could also shed more light on the way in which the popular music industry upholds the gender binary. Due to biases in data collection, larger-scale analyses of the voices of non-binary singers may be difficult to organize. Epps-Darling *et al.* (2020), for instance, note that streaming platform Spotify's metadata only has four gender-based categories: male, female, mixed-gender group, and unknown/other. The last category encapsulates both non-binary artists and artists whose gender is unknown. This categorization prevents an accurate gender-based analysis of the data. A corpus of singers with more accurate gender metadata would therefore be needed for further study.

moments in which "the use of digital technology is *revealed* to the listener" (2016, 2). Through their analyses of digital signatures in a variety of popular musical recordings, Brøvig-Hanssen and Danielsen establish a distinction between *transparent* and *opaque* technological mediation.[7] Transparent mediation seeks to conceal the aural artifacts of technology, in order to present the recorded sound as natural sounding as possible.[8] A transparent voice may be spatially presented, for instance, with naturally occurring acoustic reflection patterns or no added layers. Opaque mediation, conversely, belies the use of technology by making it discernable to the listener. An opaque voice may be spatially presented, for instance, with echo or reverberation patterns that differ from those naturally occurring in the physical world. Transparent effects "mimic the real world," while opaque mediation "make obvious the fact that their sounds have been split off from their original spatial setting and remade as something else" (2016, 27).[9]

I posit that the four vocal placement profiles outlined in Chapter 5 (Profile 1, 2, 3, and 4) represent increasing levels of opacity (Figure 6.2). Higher profiles are marked by the audible use of technological manipulation, while the lower profiles can be interpreted as transparent and more likely to imitate real-world environments. Profile 1, with its dry environment, non-layered

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[7] Victoria Malawey proposes a similar framework in her 2020 book *A Blaze of Light in Every Word: Analyzing the Popular Singing Voice.* She suggests that the technological processes applied to recorded voices can be organized along a wet/dry continuum. The "wet" pole of the spectrum, which aligns with Brøvig-Hanssen and Danielsen's "opaque" mediation, refers to "obvious or audible" technological processes. Wet processes include clear uses of distortion, compression, and reverb. A "dry" process, such as the subtle use of digital pitch manipulation, creates a sound that "aligns with an acoustic, unmediated signal" (Malawey 2020, 127).

[8] The authors note that *transparent* and *opaque* are flexible terms, whose meaning might differ according to musical style. They write, for example, that "fans of acoustic jazz may perceive the aggressive use of the compressor as opaque, whereas fans of contemporary pop music may perceive it as transparent" (Brøvig-Hanssen and Danielsen 2016, 7).

[9] It is important to note that the distinction between transparent and opaque mediation does not depend on whether technology was used to process the voice. As Malawey points out, *all* recorded performances are electronically mediated. The difference between transparent or opaque mediation, then, is "not the degree to which processing is actually used in recordings, but rather in how some recordings *seem* more mediated or modified than others" (2020, 145). Brøvig-Hanssen and Danielsen note that "pure" or "natural" sounding vocals, while they may aurally suggest an unmediated recording, are in fact "highly processed according to the conventions of pop song technology" (2016, 132).

voices, and narrow placement on the stereo stage, is the most transparent vocal placement profile. Among the four vocal placement profiles, it best emulates an in-person encounter with the artist: the focused vocal placement provides an intimate, close relationship between listener and vocalist.[10] Profile 2 is slightly more opaque, as the narrow vocal placement is enhanced by layering and widening at the end of musical phrases. Profile 3 is even less transparent, with its pervasive use of studio-produced echo and reverberation effects. Finally, Profile 4 is fully opaque. The high amount of layering, coupled with the width of the voice, contributes to an otherworldly spatial impression in which the artist's voice is replicated into multiple instances of itself.

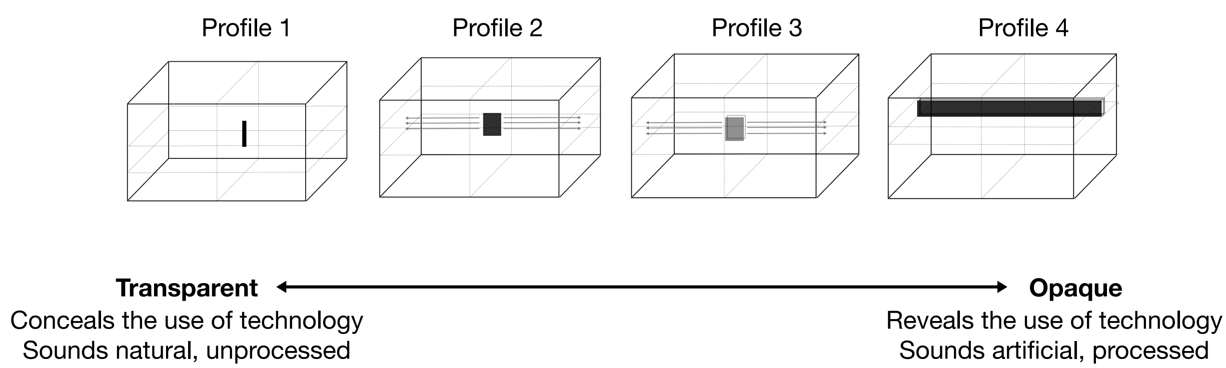

Figure 6.2 The four vocal placement profiles, arranged on a transparent/opaque spectrum (Brøvig-Hanssen and Danielsen, 2016)

Given that men's voices are generally set to lower vocal placement profiles than women's voices, men's voices are generally heard as more transparent than women's voices. This contrast is made especially salient when a man's low vocal profile is directly juxtaposed with a woman's higher profile within the same track. Both LTWYL and LTWYL II, which I

[10] For a discussion of spatiality as a sonic marker of intimacy in recordings, see Kraugerud (2017). He argues that the apparent proximity of instruments to the listener can contribute to a sense of intimacy and closeness. Moore, Schmidt, and Dockwray (2011), Dibben (2013), and Heidemann (2014) make similar arguments.

analyzed in Chapter 3, are prime examples of this type of contrast. In both versions of the song, Rihanna's voice is consistently reverberated, spread across the stereo stage, or layered with additional vocal tracks. Eminem's vocal placement offers a stark contrast with Rihanna's voice as it is distinctly narrow and non-reverberated. Rihanna's vocal placement is therefore more opaque than Eminem's, because the technological manipulations applied to her voice are made obvious. The CS corpus I analyzed in Chapters 4 and 5 contain several more examples of the same type of contrast. Consider for instance Beyoncé's "Drunk In Love," featuring Jay-Z. Throughout the verses and choruses, Beyoncé's voice is consistently set to a wide and reverberant Profile 3. In addition to being ornamented with reverberated images of itself (E3), her voice is spread across the stereo stage (W3). It takes on a larger-than-life presence, commanding the listener's attention as it echoes throughout the virtual space. Jay-Z's verse offers a stark contrast. Set to Profile 1, the rapper's voice is distinctly narrow (W1), which positions him squarely in the center of the virtual space. Not audibly treated with reverberation (E1) or layering (L1), Jay-Z's voice evokes an in-person experience in which he is positioned directly in front of the listener. The technological mediation applied to Jay-Z's voice is more transparent because it better evokes a real-world experience; conversely, Beyoncé's voice is marked by technological opacity that positions her in an artificially reverberant space. In LTWYL and "Drunk In Love," Eminem's and Jay-Z's voices are made more relatable through their transparent vocal placement. Rihanna's and Beyoncé's voices, conversely, sound less "natural" because they are more distinctly altered by technology.

Songs in which women's voices are opaquely mediated, contrasting with the transparent technological mediation of the man's voice, exemplify one of the ways in which dichotomous conceptions of gender are reinforced through the technological mediation of the voice. The idea that technology and sound in recorded popular music reinforce a sonic gender binary has been previously explored in different contexts. Rebecca Leydon's work, for instance, focuses on the gendered implications of the "hazy, syrupy" quality of lush string arrangements in so-called easy listening recordings of the 1950s and 1960s (Leydon 2001, 97). She argues that this particular sound quality—understood as soft, effeminate, and amateurish—was gendered feminine, especially in the eyes of audiophiles who preferred crisp, clearly located sounds as signs of male-coded technological advancement and refinement. More specifically, Leydon explores how this particular type of sound quality was used in Hollywood movies to portray women characters. In characterizing the timbre and atmosphere of these heavily reverberated sounds, Leydon addresses the envelope, agogic fringe, timbral characteristic, and spatial ambiguity of these sounds. The concept of spatial ambiguity is especially relevant to this discussion of virtual space. While the recordings under study in this corpus are varied in style and recording technique, Leydon's argument that spatially ambiguous recorded sounds and voices are feminine-coded resonates with the results of the corpus study. Women's voices generally occupy a broader space in the virtual space, often positioned ambiguously as their voice is reverberated or layered across the stereo stage. By virtue of consistently hearing women's voices set to higher profiles, especially when they are juxtaposed to that of men presented in more "natural" sounding environments, frequent listeners of commercial popular music may come to associate the wide, reverberant, and layered vocal profiles with femininity.[11]

The frequent juxtaposition of opaque/transparent voices has an important gendered implication: men's transparently mediated voices are generally sonically presented as less

[11] Interestingly, the common depiction of men in "natural" environments challenges the pervasive social construction of nature as feminine and technology/culture as masculine (Ortner 1972; Marsh and West 2003).

processed, while women's voices are audibly manipulated and modified through added delay, echo, and additional vocal tracks. As such, women's voices could be seen as taking on a more decorative function than men's voices. This dichotomy is made especially salient in tracks where the male vocalist performs verses and bridges, while a woman performs the chorus or hook. Men often assume the main subject position of the song by advancing the narrative through verses, while women arguably take on a decorative role by repeating choruses with the same words. In "Coming Home" (Diddy – Dirty Money ft. Skylar Grey, 2010), for instance, Skylar Grey's wide (W5) and layered (L1, L3, and L5 at different points in the song) voice takes on the decorative function of the chorus, serving as a commentary for the narrative outlined by Diddy in the verses. In this frequent collaboration type, women's voices are treated more as ornamental sound than as representations of individual subjectivity or experience.

When considered under this lens, recorded women's voices act as raw sonic material, to be manipulated and mediated by (opaque) technology. Once recorded, women's voices are diluted through the process of opaque mediation, which may depict their voices are layered, reverberated, or spread out throughout the virtual space (vocal placement profiles 3 or 4). As the corpus study shows, men's voices are more often mixed in spatial contexts that emulate face-to-face and in-person experiences (vocal placement profiles 1 or 2). We can think of such contrasting vocal representations as sonically constructing a gender binary that relies on stereotypical notions of femininity and masculinity. Women's voices are often sonically presented as ornamental, excessive, and artificial, while men's voices are stripped-down, direct, and full of agency.

6.3 Sonic Stereotypes

In this section, I suggest that we can consider vocal placements as sonic stereotypes that evoke notions of masculinity and femininity, regardless of the singer's identity. Recall how the vocal placements in "Love the Way You Lie" represent Rihanna's voice as wide and reverberant, and Eminem's voice as narrow. Chapter 5 shows how this vocal placement configuration is widespread throughout the CS corpus. Because it is so common, this contrast becomes normalized as a sonic trope that represents women's voices as ornamental, and men's voices as direct and relatable.

In some collaborations, however, the common wide woman's voice/narrow man's voice configuration is reversed. Consider for instance the Justin Bieber song "Beauty and a Beat," featuring Nicki Minaj (2012). This song is one of only five in which a male vocalist is accompanied by a female rapper. The typical gendered vocal placements roles heard throughout the corpus are reversed. When Bieber sings, his vocal placement can be characterized with Profiles 3 and 4. Layered (L1, L2, and L3) and reverberated (E1, E2, and E3) across the virtual space, his voice is sonically presented in a way that is often assigned to women singers. The vocal placement of Minaj's rapping voice, first heard in the introduction to the song, aligns with Profile 2. When she returns to perform the bridge, her vocal placement (E1, L2, W3) contrasts with Bieber's subsequent section (E3, L3, W4). Minaj's vocal placement—which is more transparent than Bieber's—allows her to take on a sonic persona that is generally assigned to male rappers. While Minaj is a woman, she takes on a role that is coded as "masculine" during this bridge *because* her vocal placement type is more frequently assigned to men. Bieber, conversely, has a vocal placement that is marked as "feminine" because it is more often assigned to women.[12] Through their common association with women's voices, Profiles 3 and 4 also evoke stereotyped sonic notions of femininity even when applied to a man's voice. Conversely, the more-frequently-male Profiles 1 and 2 can be thought of as carrying associations with masculinity, even when they characterize the placement of a woman's voice.

Here, I want to stress that I am not arguing that vocal placements sonically represent something inherently true or universal about "masculinity" and "femininity." Rather, I envision vocal placements as different kinds of sonic packagings of the voice that accrue gendered meanings through their common associations with gendered singers. Vocal placements can evoke gender through "dynamic cultural associations, dependent entirely on listeners and performers' sociocultural, historical, and geographic context" (Malawey 2020, 20). In the soundscape of Anglo-American popular music, collaborations between men and women generally feature a reverberated or layered woman's voice contrasting with a single and flat man's voice. This is especially the case when the man raps and the woman sings. The rare reversals of this scenario, such as displayed in the Bieber and Minaj collaboration, therefore imply an exchange of gender roles.[13] By asserting that wide vocal placements evoke commodified notions of "femininity" and that narrow ones evoke "masculinity," I am pointing to sonic tropes, or stereotypes, that are at play in the *Billboard* charts and the music industry in general.

[12] Future work could explore the implications of such a reversal of typical vocal placements, especially as they relate to race and gender. What does it mean when an artist such as Minaj, who is especially known for her reclamation of sexual agency, takes on a vocal placement profile that is more frequently assigned to men? What dynamics are at play when a young white man like Bieber is assigned a vocal placement more generally assigned to women, and then put in direct juxtaposition with Minaj's voice?

[13] The gendered associations of certain vocal placements are strongly linked with post-2008 commercial popular music. As such, the "masculine" and "feminine" connotations of these vocal placements might not directly map onto different musical genres or sociocultural contexts.

The notion of sonic stereotype resonates with recent work on Black aurality. In this body of work, several authors reflect on the ways in which notions of racialized identity, often as it intersects with gender and sexuality, can be aurally represented. Mendi Obadike's fruitful concept of *Black acousmatics* is especially relevant here (2005). Obadike draws on Michel Chion's notion of acousmatic sound (1994) to theorize how Blackness can be referenced sonically without being visually present. In her analysis of the movie *Boiler Room,* for instance, Obadike notes that hip-hop is used to evoke Black masculinity, even though "black men are completely absent from the film as characters in the visual narrative" (2005, 137). While Obadike's work focuses on film, one could easily apply her theory to music in order to interrogate "the cultural signifiers of sounds" (2005, 137).[14] How, for instance, is Black masculinity sonically evoked in the popular music that reaches the *Billboard* charts? Are these sonic signifiers manipulated, co-opted, and re-purposed to evoke Blackness even when no Black musicians are involved in a track? Drawing on Obadike's work, Matthew D. Morrison addresses the harmful blackface-rooted scripts that permeate American popular music. His 2019 article puts forth the notion of *Blacksound,* which Morrison defines as "the sonic and embodied legacy of blackface performance." Using sound as a starting point of inquiry allows Morrison to track the different ways in which "Blacksound informs the way we understand the making, economics, and racialization of popular music, racial identity, intellectual property relations, and culture at large" (Morrison 2019, 782). While Morrison's article focuses on Jim Crow-era sheet music publications, the notion of Blacksound can be applied to other musical contexts.

[14] Nina Sun Eidsheim indeed extends Obadike's concept to vocal music, suggesting that acousmatic blackness "may also capture the perceived presence of the black body in a vocal timbre, whether or not that body is determined to be black by other metrics" (Eidsheim 2019, 4).

Obadike and Morrison's work, along with that of other authors addressing Black aurality, provides a valuable theoretical framework for exploring how notions of Black femininities and masculinities are sonically constructed, performed, and co-opted in popular music.[15] The notion of Blacksound, for instance, can account for the ways in which white and other non-Black artists in the *Billboard* charts utilize commodified notions of Blackness in their recorded performances. Consider the song "No Limit" by white rapper G-Eazy, featuring Black rapper A$AP Rocky and Afro-Latina rapper Cardi B. Throughout the song, the three artists' rapping voices are characterized by Profile 2.[16] The vocalists are centered in the stereo field, and their prominent voices are set in a relatively flat environment (E2). Occasional doublings, or hype vocals, are added to the ends of musical phrases to emphasize the rhyme scheme and provide textural variation. These busier phrase endings are generally panned throughout the virtual space (W4). As shown in Chapter 5, this profile is especially typical of rap vocals; additionally, it tends to characterize men's voices more often than those of women. As such, I associate this particular profile with a sonic notion of masculinity often heard in rap, a musical genre defined by hip-hop scholar Tricia Rose as "a black cultural expression that prioritizes black voices from the margins of urban America" (1994, 2). Through the adoption of this vocal placement, G-Eazy therefore engages in a form of Blacksound. This occurs through various sonic cues: aspects of vocal

[15] In surveying theories that engage with the appropriation and absorption of Blackness in popular culture, Morrison cites "Nina Eidsheim's 'sonic blackness' (the perceptual phantom of a vocal timbre, projected by the listener, which happens to match current expectations about blackness, or the shaping of a vocal timbre to match ideas about Blackness); Barbara Savage's 'aural blackface' ('sounding' black by performing what might be recognized as black dialect); Kristin Moriah's 'sounding blackness' (black performance, singing, and listening as a political act); and Daphne A. Brooks's 'sonic blue(s)face' ('a palimpsest of spectacular aural racial and gendered iterations' developed out of minstrelsy by black and white women performers)" (Morrison 2019, 794). See Eidsheim 2011; Savage 1999; Moriah 2018; and Brooks 2010.

[16] While the three artists have a vocal placement that falls into the Profile 2 category, Cardi B's voice is the only one that is layered (L2). G-Eazy's and A$AP Rocky's voice do not feature added layers (L1). The added layers make the use of technology more obvious for Cardi B's voice. Her slightly more opaque vocal placement sets her apart from the two other (male) vocalists. In my hearing, this difference reifies the gender binary that differentiates Cardi B, who is a woman, from men G-Eazy and A$AP Rocky.

delivery and timbre that are essentialized as Black (Eidsheim 2019), the stylistic associations with hip-hop, and the vocal placement profile typically assigned to Black male rappers in a commercial musical context.[17]

G-Eazy's voice has been compared to that of Drake in various contexts.[18] A feature in *The Guardian* subtitled "G-Eazy looks like James Dean but makes songs like Drake," for instance, both points to his whiteness and what is implied to be an incongruity between his *looks* and his *sound* (MacInnes 2014). The author, in other words, implies that G-Eazy looks white but "sounds Black." Such statements rely on essentialist notions of voice and race. Eidsheim explains that listeners rely on "a culturally derived system of race [that] renders a given vibrational field attached to a person as a *white voice,* a *black voice*" (2019, 4, emphasis in original). The "vibrational field" at play here encompasses aspects of vocal placement that sonically tie G-Eazy's voice to that of other rappers (such as Drake). Upon hearing "No Limit," a listener may therefore associate G-Eazy with notions of Black masculinity that are sonically spread through the gendered soundscape of popular music.[19] By adopting sonic markers that are readily typecast as "Black," G-Eazy engages in a form of Blacksound that allows him to gain

[17] Other aspects of G-Eazy's career can be viewed under the lens of co-optation and appropriation of Black culture. A *New York Times* article, for instance, notes that a promotional image for the rapper's tour features "a painted tableau of G-Eazy and his fellow headliner Logic (born to a black father and white mother), flanked on either side by the opening acts, YG and Yo Gotti, both of whom are black. But in a sleight of hue, everyone in the image appears to have similar skin tone" (Caramanica 2016).

[18] A reddit thread by u/extracheesepls, for instance, presents G-Eazy's track "Me, Myself & I" as "kinda sound[ing] like Drake" (2016). On a forum dedicated to discussions of Kanye West, user ovotariq asks whether "G-Eazy [was] inspired by Drake" (2016).

[19] During my first encounter with G-Eazy's music, I incorrectly assumed that he was Black. The realization that I had guessed a vocalist's race based solely on sound was a thought-provoking experience. First, it was a needed opportunity for me to reflect on the biases I bring to new listening situations. By automatically assuming G-Eazy's race, I was responding to implicit expectations I hold about how Black or white hip-hop artists do/should sound. After this experience, I chose to more carefully attend to and question the links I make between voice and identity. In what contexts do I consciously or subconsciously assume the race or gender of a vocalist based on sonic cues? How does my own identity as a white woman inform these assumptions? Finally, what do these assumptions reveal about the culture of listening I am immersed in?

authenticity as a rapper. As a white rapper, he can still profit from essentialized notions of Black masculinity heard on the *Billboard* charts. The implications of such a dynamic are explained by Morrison: "… Black people have experienced, and continue to experience, systemic racism, while white (and other nonblack) people freely express themselves through the consumption and performance of commodified black aesthetics without carrying the burden of being black under white supremacist structures" (2019, 791). These commodified Black aesthetics are then circulated for consumption for, among others, white middle-class listeners. Heidemann (2014, 30) writes that since white middle-class listeners are often the target audience in the entertainment industry and popular media, the way they perceive meaning influences cultural narratives about identity. This dynamic therefore contributes to the continued racialized and gendered perceptions of artists through sound in the *Billboard* charts.

Through the study of vocal placement, we can begin to better understand some of the ways in which racial and gendered dynamics are at play in the sound of commercial popular music. Future work may further explore the relationship between vocal placement and instances of Blacksound in popular music. How do white and non-Black artists—such as Ariana Grande, Macklemore, Iggy Azalea, and Bruno Mars—co-opt or create commodified tropes of Black femininity and masculinity through vocal placement? By studying such questions, we could better understand how vocal placement contributes to musical appropriation and further entrenches harmful sonic stereotypes. As explained in Chapter 1, such research should be framed within an intersectional perspective that considers the ways in which race, gender, sexuality, ability, and other structures overlap to create specific sonic stereotypes. Additionally, analysts undertaking this work should reflect on the ways in which their own positionality influences their understandings of such issues. Making explicit one's identity makes visible the various biases through which they perceive and produce musical meaning. My perception of sonic stereotypes, for instance, is directly linked to my identity as a white middle-class woman. My understanding of race and gender is shaped by my exposure to targeted music, news, and other media that rely on racial and gendered stereotypes. As such, the discussion outlined above—on G-Eazy, sonic stereotypes, and Blacksound—is inevitably shaped by my own experience of the world. It is my own racialized and gendered expectations as a listener, in other words, that create the meanings I perceive and describe in G-Eazy's voice.

In this chapter, I have considered the gendered implications of the corpus study outlined in Chapters 4 and 5. The chapter therefore contributes to the trend of feminist music theory that studies the relationship between music and identity. I discussed three aspects of the relationship between vocal placement and gender. First, I posit that the *Billboard* charts can be considered as a gendered soundscape in which notions of gender are created and reproduced: American popular music to a binary notion of gender through the frequent depiction of men's voices as narrow and focused, and women's voices as wide and reverberated. Second, I explore how this binary depicts women's voices as a decorative sonic material to be processed and controlled, while men's voices are portrayed as more direct and relatable. Finally, I discuss how vocal placement may contribute to the formation of sonic stereotypes that signify gendered and racialized identities regardless of the identity of the vocalist. I hope the reflections outlined in this chapter will serve as a springboard for analyses of identity and vocal placement in the music of specific artists. In the next chapter, the conclusion to this dissertation, I propose some further avenues of research and explore different ways in which the analytical methodology outlined in Chapter 2 could be enriched by additional considerations.

Conclusion

This dissertation presented an analytical methodology for analyzing vocal placement in virtual space. With this methodology, I have explored the relationship between vocal placement and gender in popular music through (1) a close study of Rihanna's vocal performance in "Love the Way You Lie" and "Love the Way You Lie (Part II)" in Chapter 3; and (2) a corpus study of vocal placement in a newly assembled 113-song corpus in Chapters 4 and 5. The corpus comprises all songs in the *Billboard* year-end charts from 2008 to 2018 in which at least one man and at least one woman vocalist were featured. Through the corpus study, I identified four common vocal placement profiles that are commonly used in popular music. By studying the ways in which vocal placement profiles were paired within songs, I determined that men's voices are often mixed as narrow and centered and are juxtaposed to women's voices that tend to be more widespread through the virtual space.

Chapters 1 and 6 framed the studies of vocal placement within discussions of feminist music theory. The dissertation is positioned within this subfield of inquiry through its expansion of the music-analytical canon, its establishment of an analytical methodology that allows for new modes of engagement with recorded music, and its focus on the relationship between musical material and notions of gender. Through the corpus study, I showed that the vocal placement contrasts established in the *Billboard* charts contribute to the formation and diffusion of gendered stereotypes that position women's voices as ornamental, and men's voices as direct. Ultimately, I discussed how such contrasting vocal representations sonically construct a gender binary, exemplifying one of the ways in which dichotomous conceptions of gender are reinforced through sound.

To conclude the dissertation, I discuss some future work and avenues of research that consider gender and vocal placement. Additionally, I revisit the analytical framework used to study vocal placement in virtual space (Figure 0.1). Throughout the dissertation, I have adopted the position of a listener/analyst studying a series of recordings. These recordings depict a performance that was technologically mediated through various processes before being released. I discuss how this analytical framework could be complemented and complicated by other research. First, I discuss how a consideration of the technological mediation process (i.e., the arrow from the Performer to the Recording) could enrich our understandings of vocal placement. Second, I raise questions and further considerations regarding the analyst's positionality—in my case, my positionality as a white woman aiming to produce feminist music-theoretical analysis—in relationship to the music (i.e., the arrow from the Analyst to the Recording).

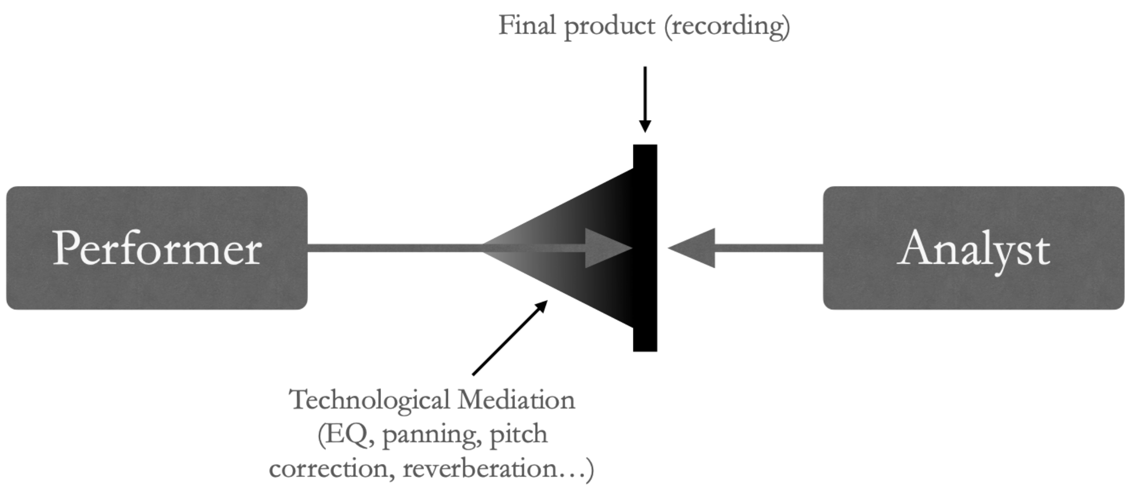

Figure 0.1 Analytical positioning used in the dissertation. The analyst studies—and only has access to—a final product (the recording).

Future Work

The methodology outlined in Chapter 2 could be used for further research into the relationship between vocal placement and gender. The CS corpus could be expanded to include all twenty-first century musical collaborations that appeared on the *Billboard* Hot 100. This broadened corpus would include collaborations in which men feature other men, and in which women feature other women. The study of vocal placement in this repertoire would clarify how sonic gendered stereotypes—such as a wide and reverberant chorus performed by a woman—are adapted or eschewed in same-gender collaborations. Genre-specific corpus studies could also be conducted to highlight the relationship between vocal placement, gender, and musical genre. Looking forward, I plan to make the tools developed for my methodology available to the wider research community by integrating them in the AMPACT toolkit, which contains tools for extracting data on recorded musical performance (Devaney *et al.* 2012). I also plan on making the CS corpus study data available for download on a website. Like other publicly available musical corpora (Bertin-Mahieux *et al.* 2011; Burgoyne *et al.* 2011), the data would be of use to researchers studying related topics.

The analysis of vocal placement could also be used for more close readings of individual pieces. As mentioned in Chapter 6, future inquiries could focus on artists who make use of vocal placement to move beyond the gender binary established in popular music. Additionally, I am particularly interested in using the methodology for studying the ways in which vocal placement contributes to the formation of white femininity in recorded popular music. Imogen Heap's album *Ellipse* (2009), for instance, could be seen as centering a white feminist perspective that privileges the lived experiences of middle- and upper-class white women. By making frequent use of domestic sounds such as birds chirping through a window or water dripping from a faucet, Heap uses the traditionally white female-gendered domestic sphere (hooks 1984; Eisenstein 2009) as an artistic resource. The track "Bad Body Double," which was recorded in a bathroom, highlights Heap's bodily presence in the virtual space through body percussion, breathing sounds, and layered vocals. By evoking the space of a bathroom with shower sounds and reverberation, and abruptly shifting her vocal placement within this virtual space, Heap physically immerses the listener into an intimate setting where her audible white body is positioned as a central focal point.

I also envision a study of white femininity in Taylor Swift's album *Folklore* (2020). In the track "Exile," which features singer-songwriter Justin Vernon, Swift vocally constructs a persona that relies on sonic conventions and extramusical tropes of white-coded indie music. The intimate virtual space and prominent vocal placement of Swift's voice exemplifies Brøvig-Hanssen and Danielsen's (2016) notion of transparent technological mediation. As discussed in Chapter 6, this form of mediation conceals the use of recording technology, making it inaudible and therefore unmarked to a listener. By emulating a private in-person performance setting that has not been altered by recording technology, Swift's transparent vocal placement depicts her as a neutral subject devoid of racial markers. This persona allows her to align with other white indie artists who have built their artistic identities through narratives of intimacy, isolation, and exile into nature. One could also draw on studies of whiteness in indie music (Delciampo 2019; Hsu 2019) to link the "cabin-in-the-woods" imagery at play in the music video with Swift's recent aesthetic rebranding as an indie artist. In Chapter 1, I discussed how white femininity, which is often depicted as natural or unmarked, is rarely explicitly discussed in feminist music-theoretical studies. These projects would therefore expand the purview of feminist music theory by critically addressing some of the ways in which white, feminine identities are constructed through sound in popular music.

From the Performer to the Recording: Gendered Spaces, Studios, and Power

The analyses presented throughout the dissertation have only considered released tracks (Figure 1). The study of virtual space and vocal placement, however, may be enriched by a consideration of the recording, mixing, and production processes.[1] Such work would feature, in addition to music analysis, ethnographies of the recording studio. Studies of how a performance is mediated through technology could be framed within studies of the recording studio as a gendered space.[2] Most studio engineers and producers are men, and the act of recording and editing is still primarily understood as a male-gendered endeavor. This gendering also occurs because studio work is associated with characteristics—assertion, control, creative genius—that

[1] This future work would fit within the emerging subfield of critical approaches to record production. These studies discuss the creative processes through which sounds are assembled in a musical recording, often by linking sound production to cultural dimensions such as race and gender (Zak 2007; Frith and Zagorski-Thomas 2012; Théberge *et al.* 2015; Bennett and Bates 2018; Zagorski-Thomas *et al.* 2018; Bennett 2019). This developing body of scholarship explores how recorded sounds are manipulated through studio production techniques that "guide us toward hearing in a particular way" (Zagorski-Thomas 2014, 72).

[2] These studies relate to a branch of feminist theory that addresses the gendering of physical space and shows how this type of theoretical inquiry informs a body of work that explores the role of women within the recording studio. In the introduction to *Space, Place, and Gendered Identities,* Beebe e*t al.* explain that feminist scholarship and gender studies have played a crucial role in the so-called "spatial-turn" in the humanities and social sciences (Beebe *et al.* 2015). The social importance afforded to some spaces have long been intertwined with the opportunities accorded to women. An especially telling example of this is found in Virginia Woolf's *A Room of One's Own,* where she attempts to consult a manuscript only to be told that "ladies are only admitted to the library if accompanied by a Fellow of the College or furnished with a letter of introduction" (Woolf 1929). Her description of spaces that are accessible to women is linked with the thesis of her book, in which she outlines the material conditions necessary for women to be able to succeed—an income, and space to work. More recent studies have addressed the link between space, identity, and accessibility more explicitly. Donovan Lessard (2016), for instance, studies the impact of gentrification on the creation of gay and lesbian spaces. Daphne Spain (1992) explores the ways in which physical separation—in homes, offices, schools, and other public spaces—have contributed to and reinforced the inequality between men and women. Finally, recent inquiries into the development of online spaces is a testament to the flexibility and adaptability of the notion of space (Kendall 1998, *Queering the Map* 2021).

are traditionally understood as "masculine." As such, the recording studio is socially constructed as a masculine space.[3]

Future work may for instance study the use of vocal placement in music that is self-produced by non-male artists.[4] Despite plenty of exploration into the practices of women who produce their own music (Smith 2009; Wolfe 2012, 2019), the structure and musical content of these artists' works have rarely been addressed in musicological and music-theoretical literature. Further study would be needed to assess the extent to which women artists, engineers, and producers use vocal placement as an artistic resource. One may for instance study how vocal placement unfolds in the music of artists like Lauryn Hill and Imogen Heap, who have captured aspects of domesticity in their recordings.

Additionally, considerations of the recording process could shed more light on the power dynamics at play in the recording studio. The analysis of Rihanna deployed in Chapter 3

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[3] According to Boden Sandstrom, this gendering occurs mainly because of the position of power held by the sound engineer, who possesses a creative license that "involves control of the mix and overall sound, which affects the final product and thus helps to sell records and tickets" (Sandstrom 2000, 293). Tara Rodgers writes that this creative power pushes against what is socially expected of women, who are seen "entwined with reproduction, passivity, receptivity, maternality" (Rodgers 2010, 12). Moreover, the mastering of technology required of sound engineers also contributes to the social understanding of the recording studio as a male-gendered space. In her study on the gendered use of Auto-Tune and other pitch correction software in recorded popular music, Catherine Provenzano also writes about the gendered dynamics of technological mediation in the recording studio. She understands pitch correction as a form of gendered control, one that is often applied—sometimes non-consensually—to women's voices by the men who work in recording studios. This practice can be read as a practice of containment, one meant to control the excesses of the female voice. She writes, "women sing and may even be prized for their 'rawness' in doing so. But this rawness needs first to be refined, or it, too, will be bad to hear. Pitch correction [software] and the engineers who implement them … [pass] the female voice from its raw, ungoverned state through the rational, emotionally savvy male virtue, enacted through technologies that dissociate and control sound" (Provenzano 2019, 73). This implies that women's voices need to be refined, controlled, or harnessed, perhaps through the power of technological mediation.

[4] In a series of recent publications, Paula Wolfe examines an alternate type of music recording practice: women who engage in independent music production in a home studio (Wolfe 2012, 2019). By documenting this practice, Wolfe explains that a growth in women's self-production practices presents a challenge against the legacy of the professional studio as a male space. Through a series of interviews with independent women producers and sound engineers in the United Kingdom, she tracks the reasons for which women might choose to record and edit their music in a domestic space. Their motivations include family obligations, career choices, or better access to creative freedom. Wolfe explicitly ties this move toward self-production to a tradition of women seeking their own space, writing that "the desire expressed by all the women in this study to create in a private space […] resonates with early observations from Woolf and also with Simone De Beauvoir" (Wolfe 2012).

explicitly ties musical material to extra-musical narratives and their relation to a musician's identity.[5] Implicit in this mode of analysis is the notion that Rihanna, as an individual, has the power and agency to freely express her unfiltered experience with gendered violence through her vocal performance. It is difficult to know, however, the extent to which Rihanna was involved in the mixing and production process of LTWYL and LTWYL II. She recorded vocals for LTWYL while she was on tour and was not physically with Eminem when the song was produced. Is it possible to read agency and the expression of realistic feelings in a situation where Rihanna's voice is manipulated by others in what Helen Reddington (2018) calls an instance of gender ventriloquism? Knowing more about the process through which voices are mediated in popular music could help us further engage with the gendered power dynamics at play in musical material. Who gets to define what femininity and masculinity sound like? The artists themselves, recording labels, producers, or sound engineers? Which artists gets to modify or reinvent established sonic narratives about gender? What are the material conditions under which an artist may, for instance, completely control their sound in a way that pushes against established sonic narratives about gender?

From the Analyst to the Recording: Feminist Music Theory, "Hungry Listening," and "Knowing, Loving Ignorance"

In this last section, I address the relationship between the analyst and the analytical object. I reflect in more detail about the power dynamics that arise when analysts—who, as feminist music theorists have shown, are individuals who bring their own points of views and biases to analysis—consider a final product such as recorded popular music.

[5] As noted in Chapter 1, this mode of analysis is central to feminist music theory.

First, I explore some dynamics at play when white women such as myself conduct analytical studies of music by women of color. Since the plenary session at the 2019 meeting of the Society for Music Theory, several white music theorists have engaged in a reckoning about the ways in which their teaching, research, and service uphold the field's "white racial frame" (Ewell 2020).[6] The field seems to be currently witnessing an increase of white scholars who take on research projects on performances, theories, and compositions by musicians of color. As several of the artists studied in the Chapter 4 and 5 corpus are people of color, and since I center Rihanna—a Black woman—in Chapter 3, I believe it is crucial that I explore the racial dynamics at play in my analyses. One could perceive the recent push in white, liberal music studies to label oneself as a proud antiracist within Ahmed's assertion that antiracist work can "become a matter of generating a positive white identity that makes the white subject feel good" (Ahmed 2012, 170).

Because of these dynamics, I do not believe that white music theorists reading about, writing on, and teaching music or theories by people of color are necessarily engaging in an antiracist act that dismantles the field's white racial frame. In fact, work aiming to increase the representation of musics by people of color in music theory classrooms, conferences, and publications can serve to further benefit white people at the expense of people of color. White scholars researching the music and theories of people of color can become "experts" in the topic, winning prizes, obtaining tenure-track positions at academic institutions, and ultimately getting to define the terms of academic discourses. In a field with a racial imbalance as stark as that of music theory, this dynamic can further marginalize scholars of color.

[6] The plenary session, titled "Reframing Music Theory," featured (1) a talk by Philip Ewell on music theory's white racial frame; (2) a talk by Yayoi Uno Everett on the East-West binary; (3) a talk by Joseph N. Straus on music and disability; and (4) a talk by Ellie M. Hisama on gender, sexism, and homophobia in music theory.

The work of Dylan Robinson, moreover, is crucial for addressing the settler colonial structures at play in music-theoretical analysis. Robinson identifies a form of settler colonial perception that he terms *hungry listening*. He notes that music analysis, with its "content-locating practices that orient the ear toward identifying standardized features and types" (Robinson 2020, 50), is a form of hungry listening. Analysis, according to Robinson, is a form of resource extraction that is teleologically oriented toward progression and resolution. In other words, it is a form of listening that relies on identification, classification, and categorization. This mode of analysis is clearly at play throughout the dissertation; it is a staple of both corpus studies and close readings. Through this lens, in my analyses of vocal placement, I extract resources—pitch data, isolated vocal tracks, panning information—from audio files, with the goals of using these resources to subsequently identify and categorize musical features. As music theorist Robin Attas—a white settler like myself—wonders, "How do our analyses, analytical methods, and theories demonstrate hungry listening practices? How much of music theory is about collecting musical or sound artifacts, pinning them to the page in a colonial and violent manner similar to the ethnographers that Robinson critiques at various points in the book?" (Attas 2020). Reflecting on Robinson's concept of hungry listening, and on the questions raised by Attas, I wonder what alternative modes of listening could highlight the relationship between voice and gender. What might a less "hungry" analytical methodology look like? Alternatively, what if I abandoned structured methodologies in favor of less extractive and rigid discussions on voice and gender? What new types of musical engagement might such an approach invite?

As a white scholar who is committed to improving the field of music theory by making it a more equitable and accessible environment, the statements and questions above are uncomfortable to face. White feminist music theorists such as myself, however, should face and address the reality that one's well-intentioned analyses may rely on settler colonial modes of listening while further erasing the works, ideas, and thoughts of women of color.[7] Aspects of this complex dynamic are captured by Mariana Ortega's notion of *loving, knowing ignorance.* This concept encapsulates the way in which white women can produce ignorance on women of color all while claiming that they are concerned and invested in them (Ortega 2006). White feminists, Ortega writes, can be well-meaning in their goal of working on and citing women of color. This work, however, can both (1) be used to validate the ideas of women of color, implying that white women need to endorse women of color for them to be heard, and (2) validate the white feminists who wish to be respected in academic fields that supposedly value the thoughts and lives of women of color. In this instance, then, women of color become instrumental to white women's career advancement. As such, Ortega writes that "we may find the feminist who wants to perceive lovingly, who wants to see women of color in their own terms, does not want to homogenize them, does not want to be coercive with them, does not want to use them but who, despite her well intentions, turns women of color into something that can be used to further her own desires" (Ortega 2006, 61). In writing about Rihanna, and citing women of color throughout the dissertation, I am therefore implicitly benefitting from them for career advancement in a field where music-theoretical knowledge by women of color is commodified. Despite white women's best intentions, then, our work can still harm.

Ortega, however, proposes a way out. By engaging in *world-traveling* (Lugones 2003), white women can engage in work that benefits women of color. World traveling involves a commitment to engage in the activities and experiences lived by others, to prioritize real people

[7] In this context, I use the term "white feminists" to refer to feminists who are white. The term is distinct from the notion of "White Feminism," a form of feminism that exclusively centers the struggles of white women while ignoring women of color.

over theoretical constructions aiming to represent these people, to learn languages, and to exercise true empathy without positioning oneself as a savior. As of now, I do not know what world-traveling could look like in feminist music theory. I wonder what kinds of shifts in thinking would be needed for me and other white feminist music theorists to engage in world-traveling, what kinds of transformations and rethinkings of what counts as music theory would be needed. I wonder if world-traveling is even possible in the context of a field that is over 80% white and mostly male, and within the current power structures of neo-liberal academia. Ortega's theorization of *knowing, loving ignorance* nonetheless helps us understand that white feminist scholars must move beyond the notion of "representation" to truly do anti-racist work, and that citational ethics may not be sufficient or satisfactory. The questions raised by Ortega, Ahmed, and Robinson are not answered in this dissertation. I discuss them here in the hopes that they will be explored in further work addressing the relationship between musical material and identity.

Throughout this dissertation, I have proposed ways to approach vocal placement in light of gender. I have shown that vocal placement contributes to the creation of a gender binary that sonically differentiates men's and women's voices, and established an analytical methodology that allows for further close and distant readings of vocal placement in recorded music. In addition to pursuing new the avenues of research—larger-scale corpus studies, close readings of musical works that complicate the gender binary, and studies of sound and white femininity—discussed above, I envision my future work as complicating the analytical positioning adopted throughout the dissertation. By further exploring the dynamics at play in recording processes that result in vocal placement, and by questioning the conditions and context under which I engage in music-theoretical work, I hope to create new modes of analytical engagement that allow for the exploration of gender and sound.

Appendix A Instructions for Isolating the Vocals from a Finished Mix

Appendices A and B contain detailed instructions for applying the methodology outlined in Chapter 2, along with information on the state of audio feature extraction technologies used in the methodology. These instructions are intended for readers interested in conducting their own analyses of vocal placement, or who simply want to better understand the process behind the analyses described throughout this dissertation. The sound-processing techniques and tools outlined in Appendices A and B, along with their associated literature reviews, are up to date as of July 2020. I anticipate that the methodology will evolve in tandem with technologies for voice separation, pitch identification, and panning analysis. The methods outlined here are representative of the most accessible approach to describing vocal placement at this point in time.

A.1 Overview of the Methodology for Analyzing Vocal Placement in Virtual Space

The following materials are required to analyze vocal placement in a finished mix:

(1) A high-quality .wav file of the finished mix under study (i.e., a .wav file of the complete song)

(2) A high-quality .wav file of the isolated vocals, obtained through source-separation model Open-Unmix (Stöter *et al.* 2019)

(3) Sonic Visualiser, along with its associated plugins *PYIN* (Cannam *et al.* 2010) and *libxtract Vamp plugins* (Cannam 2012)

(4) MarPanning (McNally *et al.* 2009, 2015)

The flowchart in Figure A.1 summarizes the methodology, which combines aural analysis and audio feature extraction. First, an isolated vocal track is extracted from the full mix. This isolated track will allow the analyst to extract information specific to the placement of the voice, without having to consider additional sound sources in the virtual space (guitars, bass, percussion, etc.). Width is analyzed through close listening aided by stereo panning visualization tool MarPanning. Data on pitch height and prominence is extracted through sound analysis software Sonic Visualiser. Finally, the environment and layering parameters are determined with the aid of 5-point scales meant to guide the analyst's listening. In addition to presenting detailed instructions for each section of the flowchart, I provide guidance on compiling and visually representing the data obtained from the analysis. Appendix A provides instructions for isolating the vocals from a finished mix, while Appendix B provides instructions for analyzing width, pitch height, prominence, environment, and layering.

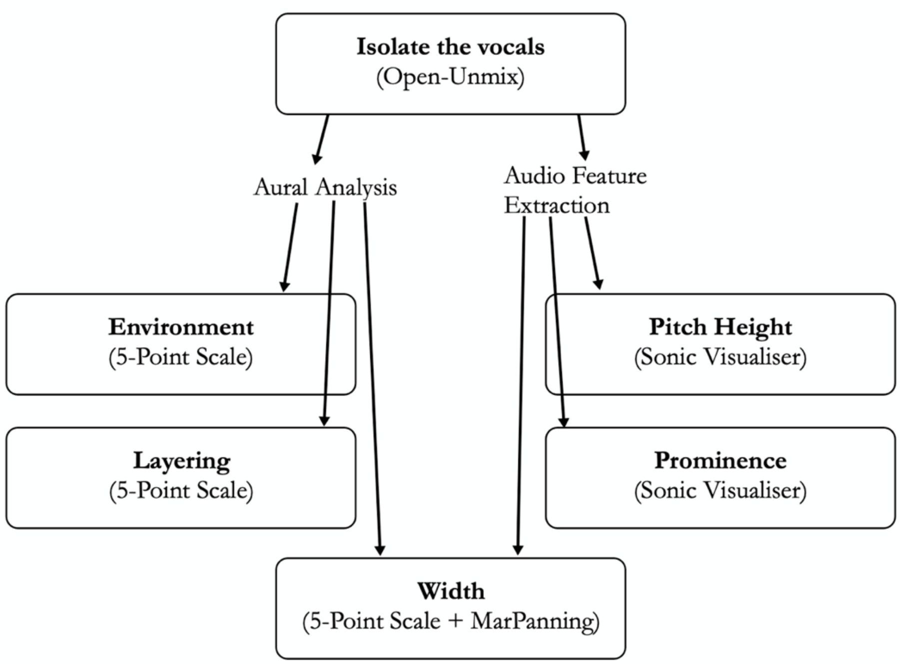

Figure A.1 Overview of the methodology for analyzing vocal placement in virtual space

With its combination of aural analysis and audio feature extraction, the methodology outlined in Chapter 2 is an example of a mixed method. Mixed methods combined qualitative and quantitative research techniques with the goals of gaining a broader understanding of a phenomenon. In music research, mixed methods are most commonly employed in the fields of pedagogy (Fitzpatrick 2014, West 2014) and music therapy (Bradt *et al.* 2013). By employing a mixture of qualitative—close listening—and quantitative—audio feature extraction—for analyzing vocal placement in virtual space, I aim to show how different approaches can be combined in music-theoretical studies.

A.2 Isolating a Vocal Track with Open-Unmix

To isolate the vocal track from a full mix, I propose to use source separation algorithm *Open-Unmix.* As of September 2019, Open-Unmix is the "current state of the art open-source separation system" (Stöter *et al* 2019, 4). It consists of an open-source implementation of Uhlich *et al.*'s source separation model (2017).

Open-Unmix makes available a pre-trained Deep Neural Network (DNN)[1] that allows users to separate a complete mix into four separate tracks: 1) Vocals; 2) Drums; 3) Bass; and 4) Other.[2] The source code can be downloaded and used on Linux or OSX, and the website also provides a tutorial for installation and application of the pre-trained model to audio files. The model has no graphic user interface (GUI), a minor barrier to users with no experience with

[1] DNNs are a subset of machine learning, which is a type of artificial intelligence that develops computer programs able to automatically learn and improve from experience. Below, I discuss in more detail the way source-separation DNNs are trained with various databases containing full audio tracks and their corresponding isolated sources. For more information on the structure of the DNN used by Open-Unmix, see https://sigsep.github.io/open-unmix/details.html.

[2] The separation of a complete mix into four components—vocals, drums, bass, and other—is a typical feature of DNN-based models for source separation. For a reevaluation of this practice, see Lee *et al.* 2019.

coding language Python. Despite this potential difficulty, Open-Unmix is rife with advantages: it's free, malleable, and represents the state-of-the art in blind source separation.[3] Moreover, it allows for batch separation of multiple .wav files, making it an ideal choice for corpus studies.

Vocal tracks can be isolated with the following steps:

(1) Install Open-Unmix[4]

(2) To separate a full mix into four separate tracks (Vocals, Drums, Bass, and Other), run the pre-trained source-separation model UMXHQ on the audio file[5] using the following command: python test.py input_file.wav --model umxhq.

Open-Unmix is generally able to capture all essential components of a voice in the "Vocals" track: the main voice panned in the center of the stereo stage along with its reverberated images, echoes, and added layers. The result, however, is not always perfect. These three issues are especially common:

(1) Some remnants of the percussion can be heard in the "Vocals" track.

(2) Aspects of the reverberated vocals may bleed into the "Others" track. This track may contain any of the following: faint reverberated images of the voice, added harmonies, or components of the main vocal line.

(3) In the "Drums" track, a trace of the voice appears along with every percussive onset.

Upon considering these issues, it is best to think of the "Vocals" track as a fuzzy representation of a mix's vocal component, as opposed to a crystal-clear reproduction of the

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[3] Other publicly available software for source separation include openBlissart (Weninger *et al.* 2012), *FASST* (Ozerov *et al.* 2011), *untwist* (Roma *et al.* 2016), and *Nussl* (Manilow *et al.* 2018).

[4] Information on the Open-Unmix model, along with installation instructions, is available at the following link: https://sigsep.github.io/open-unmix/

[5] The model accepts .wav, .flac, and .ogg files.

voice in a mix. As voice separation technology improves, crisper images of the voice in a mix will become available.

A.3 Other Methods for Source Separation

The following section provides an overview of existing methods for isolating the vocals of a finished mix. The outlined methods can be used by an analyst wanting to explore alternatives to Open-Unmix, or simply wanting to learn more about source separation. The overview ends with a comparison of the performance of Open-Unmix with that of other commercially available DNNs.

A.3.1 Stems

A *stem* is an audio file containing a composite of individually recorded sound sources. A vocal stem, for instance, may contain the solo voice, any added reverberation, compression, EQ or other effects, and any background vocals or doublings. Stems are the mid-point in the professional mixing process: various stems are eventually mixed down to a single track to create a final product. While vocal stems have a high sound quality, using them to locate the voice in virtual space poses two problems. First, they are difficult to obtain legally. Once a song is commercially released, it becomes nearly impossible to access the original stems because they are encompassed in the final mix's copyright. Since stems are of high interest to DJs and remix artists, however, some websites offer free and legal stems available for download.[6] Licensed under Creative Commons, the available stems could conceivably be used for research purposes.

[6] Legal stems may also be obtained through Remix Competitions and Contests. In some instances, labels will legally release stems so that they can be used by contestants. Such competitions are hosted by Splice, Kreasound, SKIO Music, and others.

Second, since stems have not yet been mixed down with other stems to a single track, some aspect of the final vocal placement may be missing. For instance, a vocal stem might lack a reverberation effect that was added to the final mix. Because of these two setbacks, I would recommend avoiding stems for analyzing the voice's location in virtual space.

A.3.2 DIY vocal separation

Because of the scarcity of available vocal stems of commercially recorded popular music, various techniques exist to "unmix" the vocals from a finished song. In recent years, there has been a proliferation of websites and YouTube channels offering isolated vocal tracks of commercially released songs.[7] Interchangeably named "acapellas," "pellas," "pells," or "stems,"[8] these audio files cater to amateur DJs and remix artists. Such isolated vocal tracks are often low-quality, containing remnants of other sound sources or damaged vocal material. They are often prepared through "DIY" techniques described in a variety of online tutorials.

For instance, the following method is often recommended as a quick and easy way to extract vocals from a finished mix:

(1) Find an instrumental version and a complete version of the song;

(2) Align the waveforms of both versions in a digital audio workstation (DAW);

(3) Invert the phase of the vocal mix;

(4) Play both tracks at the same time. Only the vocals should be audible.

The method relies on the principle of phase cancellation, in which two identical signals cancel each other out when played together while their waveforms are out of phase. While relatively easy, the method has two drawbacks: 1) the instrumental version must be identical—save for the

[7] MS Project Sound, a popular YouTube channel, regularly posts DIY acapellas of popular songs.
[8] Not to be confused with the professionally made stems discussed above.

vocals—to the vocal version; and 2) it does not perform well on reverberated sounds. A second technique, in which one removes instruments panned to either side of a stereo track, is also often suggested. This method assumes that vocals are panned in the center while other sound sources are panned to the sides. Isolating vocals with this technique might inadvertently remove side-panned components of the vocals—such as reverberated images—or retain artifacts from unwanted sound sources also panned in the center. The quality of these isolated tracks is often improved through the addition of artificial reverberation.

A.3.3 Academic & industry research on source separation

The issue of source separation in music has long been an area of research, with potential applications—among many others—in remixing and audio editing.[9] The separation of voice and accompaniment in music can draw on studies in speech isolation, but is compounded by difficulties unique to music: sound sources are constantly changing rather than static; instruments are often correlated to one another, making it difficult to separate them; and sound editing techniques such as compression and EQ can create non-linearities in the music being separated (Rafii *et al.* 2018, 1308). While a detailed discussion of the several existing techniques for isolating the voice are beyond the purposes of this Appendix, I provide below a brief overview of common methodologies.[10]

A first strand of research on source separation assumes that the voice is primarily harmonic. Such methods isolate the voice by identifying the fundamental frequency of sung pitches and subsequently reconstructing the sound using a series of sine waves (Miller 1973;

[9] Source separation would be useful, for instance, in the following two scenarios: 1) a musician wants access to an isolated bass line to use as a sample; and 2) a sound engineer has access to the finished mix of a song—not its stems—but wants to raise the volume of the vocals.
[10] For a comprehensive overview of research on voice separation, see Pardo *et al.* 2018 and Rafii *et al.* 2018.

Wang 1994, 1995; Meron and Hirose 1998; Zhang and Zhang 2005, 2006; Fujihara *et al.* 2005, 2010; Duan *et al*. 2008). Instead of reconstructing the sound, other methods filter out anything that is not closely located to the fundamental frequency of the voice and its harmonics (Li and Wang 2006, 2007; Han and Raphael 2007; Cano et al, 2009, 2012, 2013; Bosch *et al*. 2012; Vaneph *et al.* 2016). The success of these methods is contingent on the continued harmonicity of the voice and on the performance of the pitch-identification algorithm.

Rather than focusing on the voice, other methods model the accompaniment. REpeating Pattern Extraction Technique (REPET) (Rafii & Pardo 2013) assumes that the musical accompaniment is inherently repetitive. The method assumes that removing repeating portions of a sound signal would therefore isolate the voice. The REPET method has been refined in Rafii *et al.* (2014). These methods are especially successful in cases where the voice presents no redundancies, and where there are no unexpected interferences—for instance, a single hi-hat hit occurring only once—in the accompaniment. Similar methods include (Seetharaman *et al*. 2017; FitzGerald 2012; Moussallam *et al.* 2012; Lee & Kim 2015).

The models summarized above are generally meant for use on single channel (mono) tracks. In some cases, models use information proper to a two-channel recording to isolate the voice from the accompaniment. Some methods, for instance, assume that the voice is panned in the center of the stereo field (Barry *et al*. 2004; Vinyes *et al.* 2006; Sofianos *et al*. 2010, 2012a, 2012b; Kim *et al* 2011).

A recent—and especially well-performing—trend is the use of deep neural networks (DNNs) in musical source separation. As explained above, Open-Unmix is one of such models. In order to train a DNN to do source separation, one needs a database containing 1) full audio tracks; and 2) the corresponding isolated sources. As mentioned earlier, it is difficult to obtain such material legally; however, some researchers have curated such material from a variety of sources. MUSDB18 is the largest dataset publicly available for training DNNs to do source separation (Rafii *et al.* 2017; Stöter *et al.* 2017). The dataset contains 150 full stereophonic tracks, along with isolated *drums, bass, vocals,* and *others* stems. MUSDB18 is a composite of pre-existing datasets: DSD100 (Liutkus *et al.* 2017), which contains 100 tracks from the "Mixing Secrets" Free Multitrack Download Library, MedleyDB (Bittner *et al.* 2014), containing tracks from independent artists and recording studios, and miscellaneous tracks licensed under Creative Commons.

The MUSDB database was introduced as part of the SiSEC 2018 campaign. Since 2008, the yearly Signal Separation Evaluation Campaign (SiSEC) has been tasked with rating the performance of available systems for source separation.[11] The publicly available results of each year's campaign ensure continued communication between researchers working on issues of source separation. Anyone researching source separation can submit their method to be evaluated according to a set of standards defined by SiSEC.[12] The 2018 campaign, for instance, received 30 submissions. The highest-ranked method of this campaign, TAK1 (Takahashi *et al.* 2018), is not publicly available. To make state-of-the art source separation technology available to the public, Stöter *et al.* created Open-Unmix after the 2018 campaign. The UMXHQ algorithm it uses is comparable in performance to TAK1.

[11] While SiSEC was originally a speech separation and denoising component, the 2018 campaign addresses musical source separation only. See the CHiME challenge for an evaluation of speech-related tasks.

[12] The results are evaluated with the BSS Eval toolbox. This method compares the estimated isolated source (i.e., the isolated vocal track created by an algorithm) to the ground truth (the "official" isolated vocal track). The toolbox evaluates separation quality according to three criteria: 1) Source to Distortion; 2) Source to Artefact; and 3) Source to Interference Ratios (Stöter *et al.* 2018).

A.3.4 iZotope & Audionamix

Some commercially released software also allows for voice separation. Such tools are more expensive than free options like Open-Unmix, but they have the advantage of presenting user-friendly GUIs.[13] Audionamix's XTRAX STEMS, for instance, uses deep neural networks to separate a complete track into four components: voice, bass, percussion, and other. While Audionamix has not published information on the specific neural network used in XTRAX STEMS, a 2016 conference presentation by Vaneph *et al.* (2016) provides enlightening information on the type of technology developed by Audionamix. The authors outline a "separation workflow" for isolating individual sources from a finished mix (Figure A.2). A finished mix undergoes various processes—vocal isolation through pitch tracking and separation algorithms based on "state-of-the-art deep learning techniques"—to be broken down in individual sources. Figure A.3 shows XTRAX STEMS' graphical user interface (GUI).

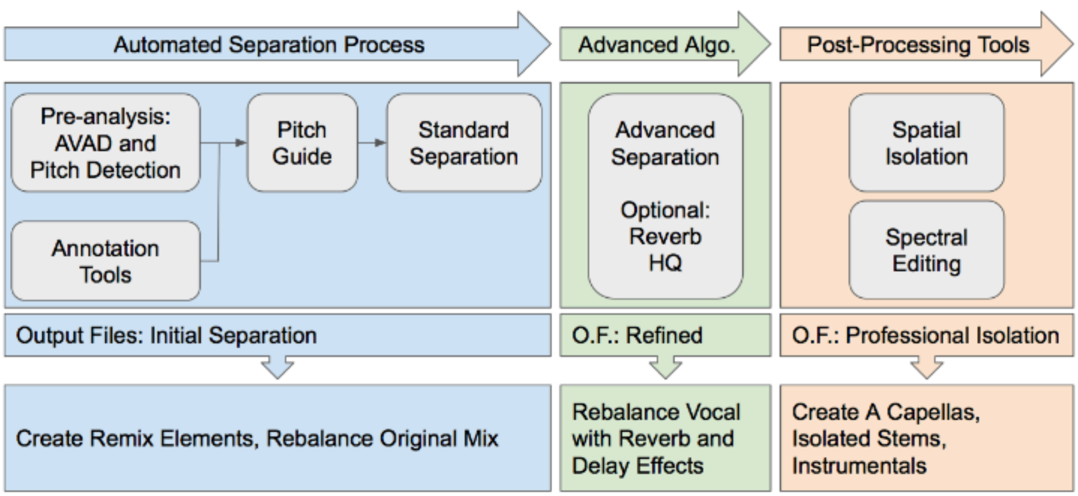

Figure A.2 Source separation workflow of Audionamix technology (Vaneph *et al.* 2016)

[13] As of July 2020, Audionamix XTRAX STEMS 2 costs USD 60. iZotope RX 7 Standard, which contains the Music Rebalance tool, costs USD 399.

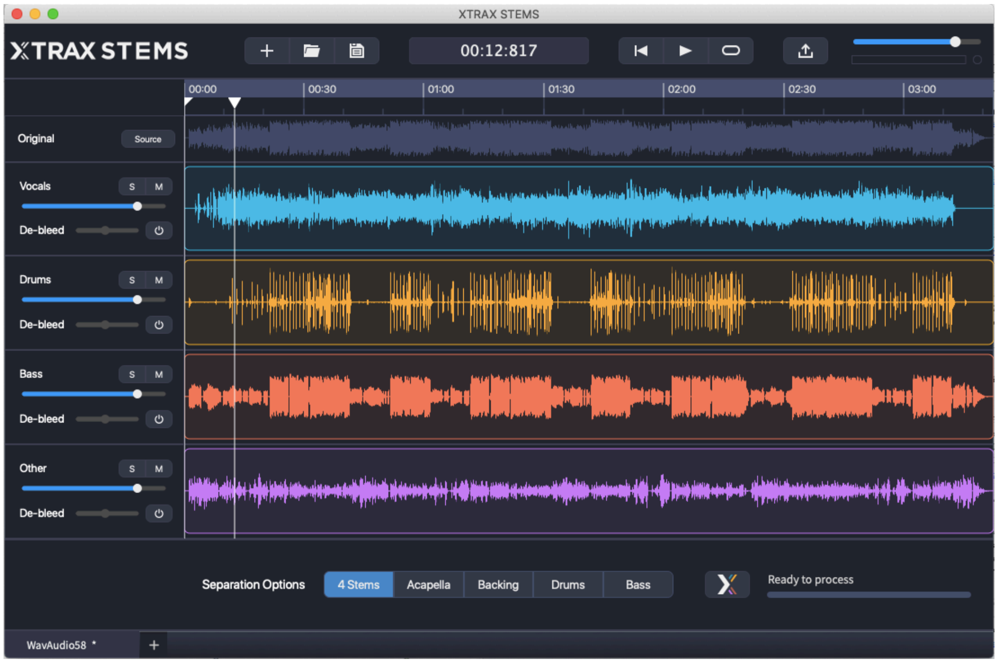

Figure A.3 Audionamix XTRAX STEMS user interface

iZotope RX 7's Music Rebalance tool may also be used to isolate the vocal components of a finished mix. Audio separation software iZotope introduced Music Rebalance in 2018. The tool uses a neural network to separate a sound file into the conventional components: voice, bass, percussion, and other.[14] With the use of sliding scales, a user can remix the four components (Figure A.4). Music Rebalance also includes three presets—"Gentle," "Medium" and "Aggressive"—for isolating the voice (Figure A.5).

[14] There is no publicly available information on the source separation model used by iZotope. Information on the tool can be found on iZotope's website: https://www.izotope.com/en/products/rx/features/music-rebalance.html

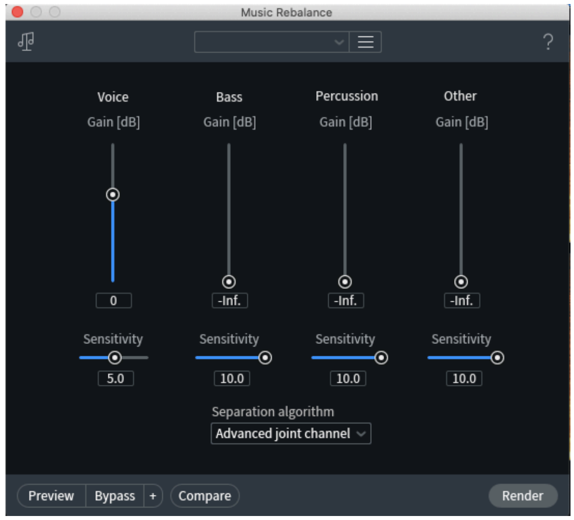

Figure A.4 Four sliding scales in iZotope RX 7 Standard's Music Rebalance tool

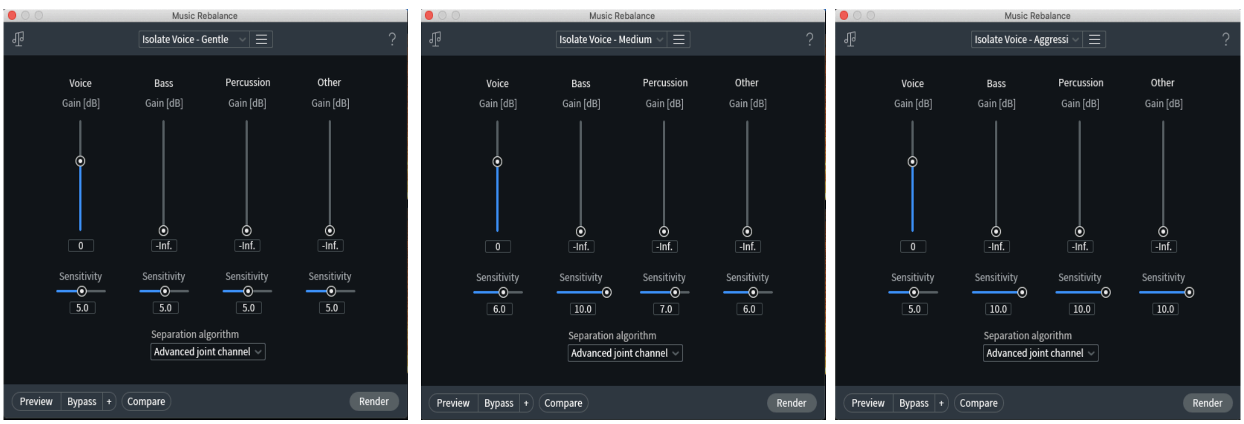

Figure A.5 Presets for isolating the voice in iZotope RX 7 Standard's Music Rebalance tool

A.4 Comparing Open-Unmix and iZotope RX 7

To isolate the vocals of a finished mix, I would recommend using one of three DNN-based approaches outlined above: Open-Unmix, iZotope RX 7's Music Rebalance tool, or Audionamix's XTRAX STEMS. Despite being based on similar technologies, the three methods perform differently. These differences in performance might be caused by variations in the DNN's architecture or by differences in the training datasets. For instance, a method trained on a dataset composed mainly of hip-hop songs in which the voice is centered, prominent, and accompanied by a sparse instrumental texture might perform poorly on an R&B track with different mixing conventions. To conclude this overview of source separation algorithms, I compare below the performance of Open-Unmix (using the algorithm's default settings) and iZotope's Music Rebalance on "Love The Way You Lie" (Eminem feat. Rihanna 2010) and "Something Just Like This" (The Chainsmokers feat. Coldplay 2017).[15]

Figure A.6 lists excerpts of "Love The Way You Lie." Rihanna sings the opening chorus, accompanied only by a piano. Figures A.6.b to A.6.d are attempts to isolate Rihanna's voice. They were made by the three iZotope pre-set voice isolation algorithms: gentle, medium, and aggressive. Notice how Music Rebalance can mask the piano to varying degrees. The tool is especially useful to remove notes in the low register. It has more difficulty, however, in detecting that some of the middle-range piano pitches are distinct from the voice. A portion of the piano track therefore remains in the isolated vocal track.

As heard in Figure A.6.e, Open-Unmix can effectively remove the piano. A new problem arises, however: the algorithm also removes most of the reverberation—which is panned to the sides of the stereo stage—added to Rihanna's voice. The reverberated images are instead placed in the "Other" category (Figure A.6.f). It therefore seems that Open-Unmix is unable to recognize the reverberated images of Rihanna's voice as a vocal component of the full track.

The isolated vocal track created by Open-Unmix would be useful for someone wanting to remix Rihanna's voice with a different type of reverberation. An analyst wanting to describe vocal placement, however, would be better served by the vocal tracks created by iZotope.

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[15] To hear to the isolated vocal tracks, visit https://hcommons.org/members/mduguay/ or contact me via email.

Despite the unwanted piano sounds, the isolated track maintains a central aspect of vocal placement: the reverberated images.

Figure A.7 shows excerpts of “Something Just Like This.” Coldplay frontman Chris Martin’s voice has a relatively similar amplitude to the other sound sources heard in the track. The vocal track in Figure A.7.b was made by iZotope’s Music Rebalance “medium” algorithm, while Figure A.7.c was made using Open-Unmix. The latter functions much better than the former. The vocals in Figure A.7.b sound damaged and distorted. Moreover, several instrumental sounds are incorporated in the track. Open-Unmix, conversely, completely removes the instruments and even manages to retain the slight delay applied to the voice.

a) Original track
b) Isolated voice – iZotope RX 7 Standard, Music Rebalance tool, “Gentle”
c) Isolated voice – iZotope RX 7 Standard, Music Rebalance tool, “Medium”
d) Isolated voice – iZotope RX 7 Standard, Music Rebalance tool, “Aggressive”
e) Isolated voice – Open-Unmix
f) Isolated “Other” – Open-Unmix

Figure A.6 Isolating Rihanna’s voice in “Love The Way You Lie,” 0:00–0:25

a) Original track
b) Isolated voice – iZotope RX 7 Standard, Music Rebalance tool, “Medium”
c) Isolated voice – Open-Unmix

Figure A.7 Isolating Chris Martin’s voice in “Something Just Like This,” 0:32–0:51

Appendix B Instructions for Analyzing Vocal Placement

B.1 Analyzing the Voice's Width

The width of a voice is determined through aural analysis supported by sound processing tool MarPanning. This tool provides a visualization of the way sounds in a .wav file are panned on the stereo stage. An analyst can place each of a song's formal sections into one of the five categories shown in Table B.1. Note that a given width rating might not be representative of the entirety of a given formal section. The analyst should choose the level that best encapsulates the overall sound of the chorus. Width categorization should not take into consideration added background vocals provided by one or more additional singers. The chosen level should therefore only represent the panning of the "lead vocals."

A voice's width rating can be obtained with the following steps:

(1) Install MarPanning (McNally *et al.* 2015). See below for more information on the tool.

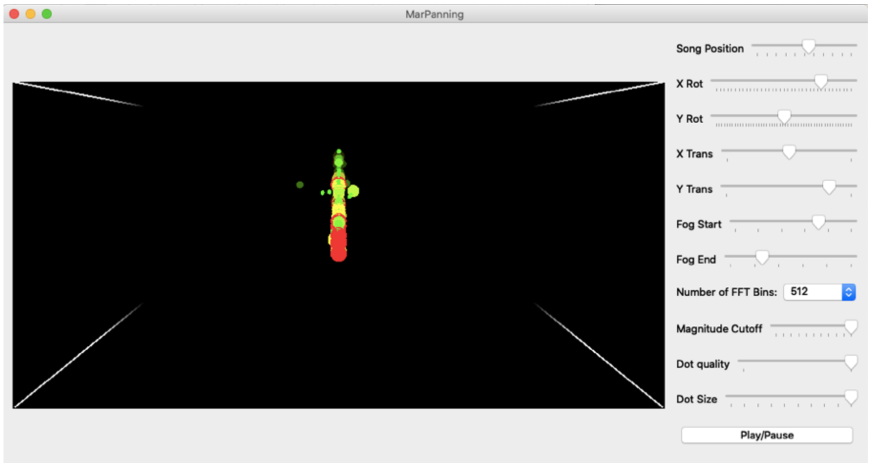
(2) Open a .wav file of the isolated vocal track under study in MarPanning. The tool will generate a visualization of the track's panning as it unfolds in time.

(3) In accordance to the panning you see and hear, categorize each formal section into one of the five categories shown above. Figure B.1 shows screen captures of each width rating as it appears in MarPanning.

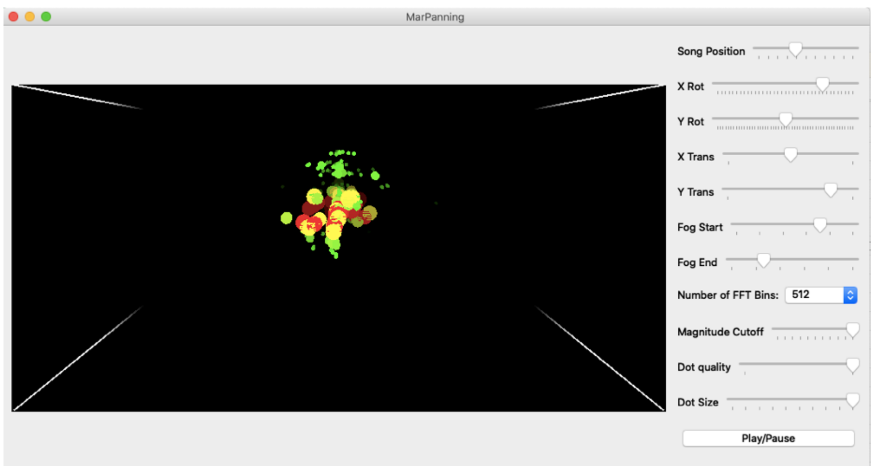
Narrow	**W1**	The voice occupies a narrow position in the center of the stereo stage.	**“Lemon,” N*E*R*D & Rihanna** Rihanna, Verse, 01:44–02:11
	W2	The voice occupies a slightly more diffuse position in the center of the stereo stage.	**“Only,” Nicki Minaj ft. Drake, Lil Wayne & Chris Brown** Drake, Verse, 01:45–2:49
	W3	The voice occupies a narrow position in the center of the stereo stage, and some of its components (echo, reverberation, and/or additional vocal tracks) are panned toward the sides. These wider components have a lower amplitude than the main voice.	**“Bartier Cardi,” Cardi B ft. 21 Savage** Cardi B, Chorus, 00:14–00:41
	W4	The voice occupies a slightly more diffuse position in the center of the stereo stage, and some of its components (echo, reverberation, and/or additional vocal tracks) are panned toward the sides. These wider components have a lower amplitude than the main voice.	**“Love Galore**,” **SZA ft. Travis Scott** SZA, Chorus, 00:14–00:29
Diffuse	**W5**	The voice and its associated components (echo, reverberation, and/or additional vocal tracks) are panned across the stereo stage.	**“Close,” Nick Jonas ft. Tove Lo** Nick Jonas, Chorus, 00:52–01:23

Table B.1 A five-point scale for analyzing a voice’s width

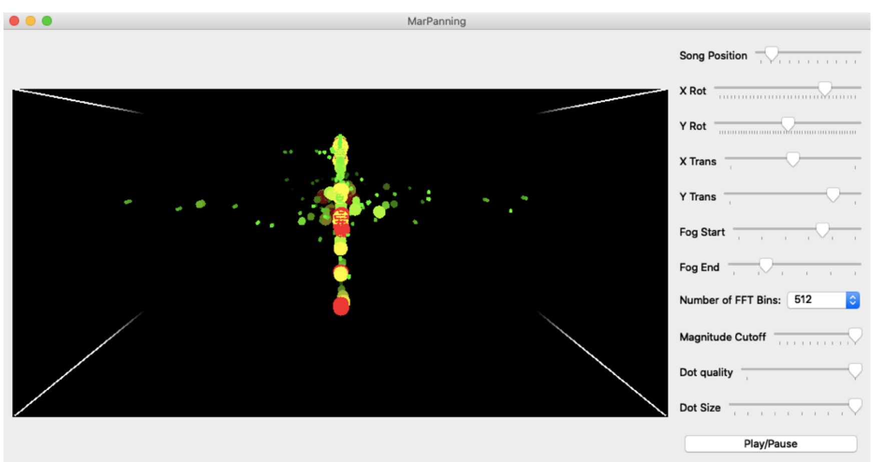
W1


MarPanning
Song Position
X Rot
Y Rot
X Trans
Y Trans
Fog Start
Fog End
Number of FFT Bins: 512
Magnitude Cutoff
Dot quality
Dot Size
Play/Pause

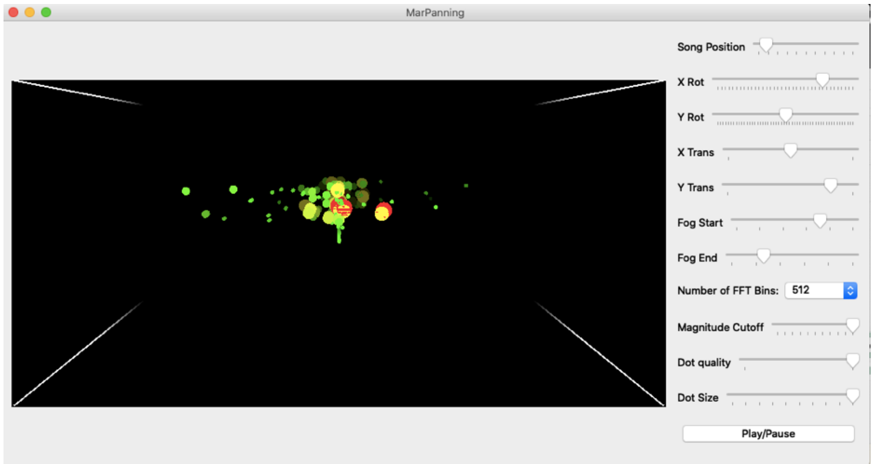
W2


MarPanning
Song Position
X Rot
Y Rot
X Trans
Y Trans
Fog Start
Fog End
Number of FFT Bins: 512
Magnitude Cutoff
Dot quality
Dot Size
Play/Pause

W3


MarPanning
Song Position
X Rot
Y Rot
X Trans
Y Trans
Fog Start
Fog End
Number of FFT Bins: 512
Magnitude Cutoff
Dot quality
Dot Size
Play/Pause

W4



W5

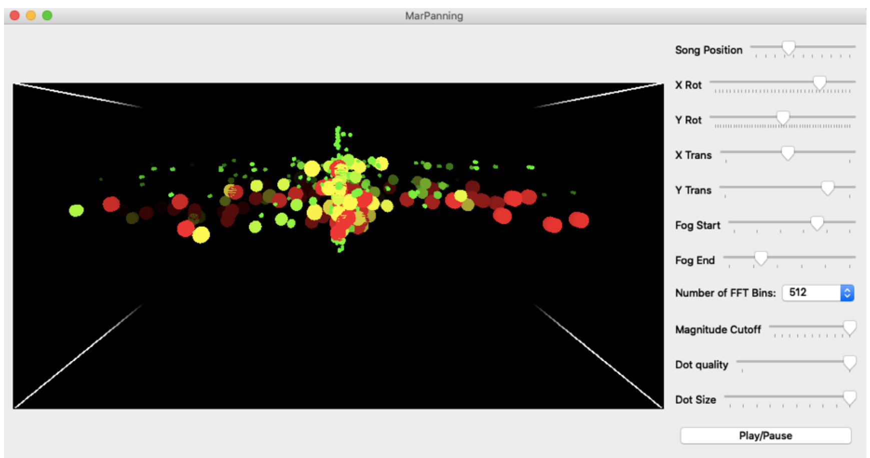


Figure B.1 Five different width categories in MarPanning's user interface

B.1.1 MarPanning

MarPanning is a visualization tool that displays the panning, magnitude, and frequency of sounds in stereo recordings. It provides a rapid, accessible, and intuitive way to display complex information about finished mixes. Developed by McNally *et al.* (2009, 2015) using the

MARSYAS programming framework,[16] MarPanning can be used for "illustra(ting) and quantify(ing) production decisions and recording practices used by engineers and producers in the record production process." While the authors originally intended to use these features for pedagogical purposes,[17] MarPanning can also be used for music analysis.[18]

The most recent version of MarPanning (2015) allows users to visualize the panning data of .wav files through a user interface. Sounds appear in the user interface as dots of various sizes and color. These dots provide the user with information on the *magnitude, panning,* and *frequency* of sound sources.

(1) Magnitude—the perceived loudness of a sound—is shown through variations in the dots' appearance. Low-level frequencies are green, mid-level frequencies are yellow, and high-level frequencies are red.[19] Magnitude is also reflected in dot size: larger dots have a higher magnitude.

(2) Panning—a sound's location in the stereo field—is mapped on the x-axis. A sound appearing toward the left of the screen, for instance, is placed toward the left of the stereo image.

(3) Frequency—the pitch height of a sound—is mapped on the y-axis.

(4) Time is mapped on the z-axis, allowing users to see changes in magnitude, panning and frequency in real-time.

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[16] MARSYAS (Music Analysis Retrieval and Synthesis for Audio Signals) is a "free software framework for audio analysis, synthesis and retrieval written by George Tzanetakis and a community of developers around the world." Users can use existing "building blocks" corresponding to published algorithms in Music Information Retrieval, or extend the framework with their own components (Tzanetakis & Cook 2002).

[17] The authors suggest using MarPanning to "providing students with a visual feedback of what they are (or are not) hearing in recordings as they develop their critical listening skills" (McNally *et al.* 2009).

[18] In a 2011 conference presentation, David Sears uses MarPanning to relate panning in Radiohead's "Paranoid Android" (1997) to the song's formal outline (Sears 2011).

[19] McNally *et al.* (2009) do not specify the magnitude threshold at which a dot changes color.

Users can make real-time changes to the 3-D visualization with a series of sliding scales (Figure B.2). I would encourage the reader to install MarPanning and experiment with the user interface.

(1) "Song Position" and "Play/Pause" control audio playback;

(2) "X Rot," "Y Rot," "X Trans," "Y Trans," "Fog Start," and "Fog End" allow the user to modify the 3D representation by rotating the X and Y axes or controlling the zoom;

(3) "Number of FFT Bins" determines the window size of the FFT;

(4) "Magnitude Cutoff" allows the user to show or mask low-magnitude frequencies;

(5) "Dot quality" allows the user to toggle between circular and triangular dots;

(6) "Dot Size" allows the user to change the size of the dots.

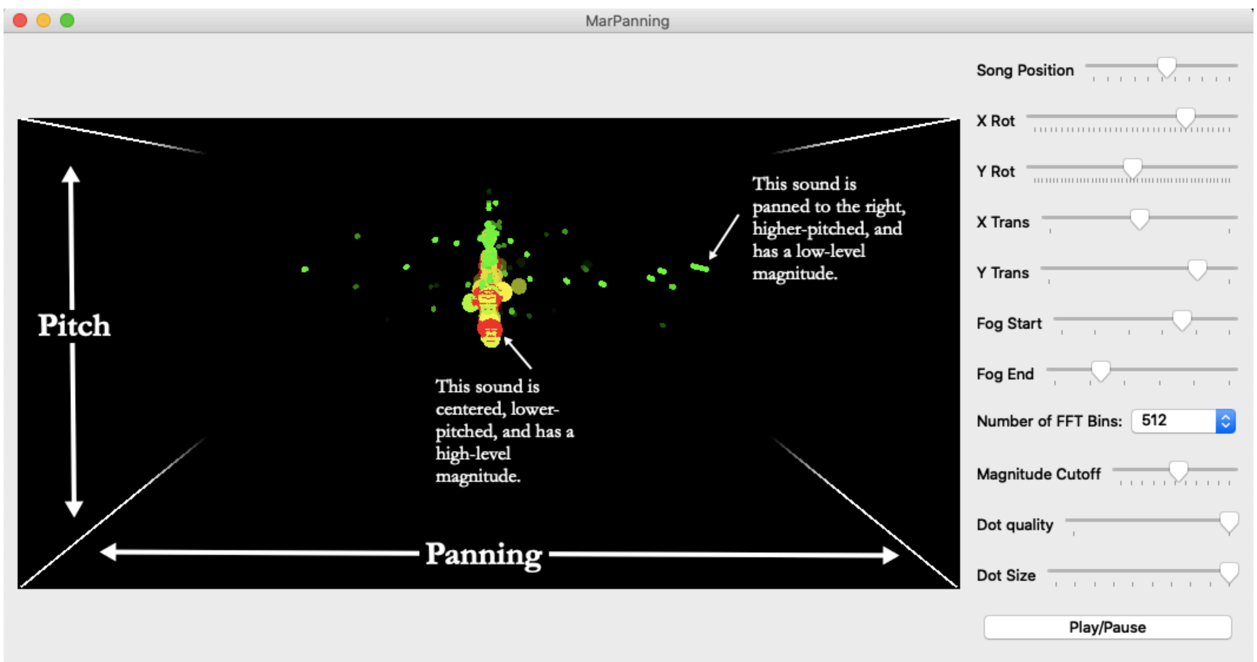

Figure B.2 MarPanning's User Interface

MarPanning is based on Avendano's algorithm for determining a sound source's "panning index" in studio-produced stereo recordings (Avendano 2003). The method assumes that panning is created through differences in amplitude between the left and right signals. Avendano determines the panning of a given frequency by comparing the Short-Term-Fourier-Transform (STFT) of both signals. If a frequency is given equal amplitude on the left and right side, it appears at the center of the stereo image. Conversely, a louder amplitude in one of the channels would result in an off-center sound.

In a precursor project to MarPanning, Tzanetakis *et al.* (2007) use Avendano's panning index, but renames it the "Stereo Panning Spectrum" (SPS). Each frequency bin is assigned an SPS value ranging from -1 (extreme left) to 1 (extreme right), with 0 in the center. The SPS values are used to create two-dimensional spectrograms in which the x-axis represents time, the y-axis frequency, and panning is shown through variations in color. Grey indicates a centered location, black indicates full left panning, and white indicates full right panning.

MarPanning uses the SPS to create the 3D visualizations. It computes the SPS of each frequency in different FFT (Fast Fourier Transform) bins. As each new FFT bin is computed, the visual representation of each frequency's panning is mapped to 0 on the z-axis (time).

While using MarPanning to visualize panning information in recorded music, some potential limitations should be kept in mind:

(1) MarPanning does not distinguish between sound sources. There is no way to establish—other than by ear—if a given dot represents, say, the voice or the guitar. If an analyst wants to determine the exact panning information of the voice in a finished mix, an isolated vocal track should be used.

(2) Since the 3D visualization is dynamic, it can be difficult to obtain precise data on a frequency's SPS. Exact panning information can be extracted from the SPS panning spectrograms created in Tzanetakis *et al.* (2007).

B.2 Analyzing the Voice's Pitch Height

The location of a voice on the *Vertical Axis* is established according to the pitch range occupied by the voice. This range can easily be determined by ear; an analyst can listen for the highest and lowest pitch of a given melody and use this data to locate the voice on the vertical axis. In some situations, however, aural analysis is inconvenient. An analyst might need to obtain specific data to make, for instance, a qualitative statement about the pitches used more frequently by a singer. Aural analysis might also be unsuitable when determining the range of a rapped verse without a clear melodic contour. Finally, a large-scale corpus study would require a more time-efficient method for determining the pitch range of several songs.

In order to easily obtain data on vocal pitch, I suggest using Sonic Visualiser and its associated plug-in "PYIN Smoothed Pitch Track." Sonic Visualiser is a free, open-source software for the visualization and analysis of audio recordings. It was developed in 2010 by Chris Cannam, Christian Landone and Mark Sandler at Queen Mary University of London's Centre for Digital Music (Cannam *et al.* 2010). Users can import, edit, and annotate audio files on its Desktop user interface, which also supports a variety of plug-ins for sound processing.[20] The PYIN algorithm, developed by Matthias Mauch and Simon Dixon, tracks the estimated frequency of a sound signal over time (2014). When used as a plug-in in Sonic Visualiser, the "PYIN Smoothed Pitch Track" function outputs an estimation of a melody's pitches.

Pitch data can be obtained with the following steps:

(1) Install Sonic Visualiser and the PYIN plug-in.

(2) Open the *isolated vocal track* of the piece under study in Sonic Visualiser.

(3) Apply the "PYIN Smoothed Pitch Track" transform to the entire track. The default

[20] See https://www.vamp-plugins.org/download.html for a list of available plug-ins.

settings can be maintained. Note that the plug-in is meant to analyze monophonic vocal tracks and can only capture one pitch per time frame. When a voice is layered with harmonies, “Smoothed Pitch Track” will only output what it estimates to be the main melodic line.

(4) Review the estimated Pitch Track, making any necessary corrections. Occasionally, the pitch estimated by PYIN appears an octave higher or lower than it sounds.

(5) Export the “Smoothed Pitch Track” layer to a .csv file. The file shows a time series in which specific time points in the audio are associated with a value in Hz.

(6) The data contained in the .csv file can be used to determine the vocal range in given sections of the song. Other data—such as the median pitch—can also be extracted from the .csv file.

B.3 Analyzing the Voice’s Prominence

The Depth axis of the virtual space corresponds to prominence. A voice’s location on the depth axis is determined via the voice’s amplitude in relationship to the full mix. A voice’s prominence is expressed as a percentage:

$$Prominence = \left(\frac{Average\ RMS\ Amplitude\ of\ the\ vocal\ track}{Average\ RMS\ Amplitue\ of\ the\ full\ track}\right) x\ 100$$

I propose to use Sonic Visualiser and its associated plug-in “RMS Amplitude” to determine the prominence of a voice in the virtual space.[21] The RMS Amplitude (root mean

[21] The RMS Amplitude plug-in is part of the “LibXtract Vamp plugins” group, which implements several functions

square amplitude) function computes the amplitude of a sound signal over time. The function first establishes the square root of the arithmetic mean of the sound signal, then squares the result. This process ensures that the amplitude of a sound signal—which has both positive and negative values—is expressed as a set of positive values only.

In order to express the prominence of a voice via a percentage, an analyst first needs to determine the RMS Amplitude of 1) the isolated vocal track and 2) the full track. RMS Amplitude data can be obtained with the following steps:

(1) Install Sonic Visualiser and its associated “RMS Amplitude” plug-in.
(2) Open the *isolated vocal trac*k and apply the RMS Amplitude transform.
(3) Export the resulting layer as a .csv file. The resulting file contains a time series in which specific time points in the audio are associated with an RMS Amplitude value.
(4) Open the *full track* and apply the RMS amplitude transform.
(5) Export the resulting layer as a .csv file.

Sonic Visualiser can be cumbersome for an analyst wishing to quickly obtain data about several audio files. Sonic Annotator, a tool that allows the user to apply installed Vamp plug-ins to batches of audio files, is a time-efficient alternative (Cannam & Bullock 2012). The resulting data can be written in a selection of formats, including .csv files.

Once the amplitude of the voice and the full track have been determined, the analyst can now determine the relative amplitude of the voice. The .csv files contain data on the RMS Amplitude of the voice and the full track at every time frame. In any given track, a voice occasionally stays silent; this can occur between phrases, sections, and during instrumental

of Jamie Bullock’s LibXtract library. The library contains various audio feature extraction functions. The plug-in can be accessed here https://code.soundsoftware.ac.uk/projects/vamp-libxtract-plugins, and the LibXtract library can be accessed here https://github.com/jamiebullock/LibXtract breaks. The .csv files should be processed to remove time frames in which the voice's amplitude is almost null—below a threshold of 0.02, for instance. This step ensures that the very low-amplitude vocal segments are not counted toward the average amplitude.

The prominence of a voice is determined with the following steps:

(1) Calculate the average RMS Amplitude of the voice for the excerpt under study.
(2) Calculate the average RMS Amplitude of the full track for the excerpt under study.
(3) Express the RMS Amplitude of the voice in relationship to the RMS Amplitude of the full track as a percentage.

A higher percentage indicates a more prominent voice, as the RMS Amplitude of this voice corresponds to a larger portion of the RMS Amplitude of the full track.

B.4 Analyzing the Voice's Environment

The environment is the apparent space in which a sound object is located. Each sound object in a recording interacts with an apparent environment through temporal effects such as reverberation or echo.

A voice's environment should be determined via aural analysis. Through close listening, an analyst can place each of a song's formal sections into one of the five categories shown in Table B.2. I have outlined the categories after conducting close listening to the corpus outlined in Chapter 3. This ranking system is meant to encompass the principal spatial "tropes" common to the *Billboard* chart repertoire. Note that there might be audible differences between songs belonging to the same category. For instance, the layer of echo found characteristic of "E3" may have a slightly higher relative amplitude to the main voice in song X than in song Y.

Nonetheless, I would group these two songs together because they have a common spatial profile in which the main voice is subtly repeated through a layer of echo.

The environment of a voice might change over time, and the analyst should choose the level that best encapsulates the overall sound of the section under study. Finally, an analyst should ensure that their categorization truly represents the *voice's* environment. Recall that every sound source in a recording might be placed in its own environment: a voice treated with a lot of reverberation, for instance, may be accompanied by a completely dry guitar. Therefore, one should ensure that they are considering the voice only and not the apparent environment of the other sound sources in the mix.

Table B.2 A five-point scale for analyzing a voice's environment

Flat ↑	**E1**	The voice's environment sounds flat. There might be minimal ambiance added the voice, but there is no audible echo or reverberation at the end of the phrase.	**"Like I'm Gonna Lose You," Meghan Trainor ft. John Legend** Meghan Trainor, Verse, 00:00–00:31
	E2	The *last word or syllable* of each musical phrase is repeated through echo or reverberation. The effect is mainly rhythmical, in that this repeated word fills a pause in the vocal line.	**"No Limit," G-Easy ft. A$AP Rocky & Cardi B** A$AP Rocky, Chorus, 00:10–00:28
	E3	The vocal line is repeated in one clear layer of echo. This added layer may be dry or slightly reverberant and has a lower amplitude than the main voice.	**"Somebody," Natalie La Rose ft. Jeremih** Jeremih, Chorus, 00:02–00:19
	E4	The main voice is accompanied by a noticeable amount of reverberation.	**"Him & I," G-Easy and Halsey** Halsey, Chorus, 00:00–00:22
↓ **Reverberant**	**E5**	The main voice is accompanied by two or more layers of echo. The echo layers may be noticeably reverberant, similar in amplitude to the main voice, and difficult to differentiate from one another.	**"The Monster," Eminem ft. Rihanna** Rihanna, Chorus, 00:00–00:18

I suggest that a voice's environment be analyzed by ear because the current state of sound processing technology does not allow for precise measurements of echo and reverberation in musical sound signals.[22] There has been few attempts to extract information about the reverberation parameters of a virtual space. Perez *et al.* (2019) establish a machine-learning based method that predicts the reverberation time (RT60) of a virtual room. The method is useful to create accurate renderings of room acoustics in virtual environment situations. Given that such virtual environments are modeled after realistic, physical rooms, however, they fundamentally differ from the virtual spaces found in popular music.

Indeed, virtual spaces have spatial characteristics that may be unattainable in real life. For instance, a sound engineer can manipulate reverberation at different points of a sung phrase, making it impossible to pinpoint consistent characteristics of the space in which this voice unfolds. Moreover, the final mix of a song is a compound of different spatial effects that combine 1) the properties of the room in which the sound source was originally recorded; 2) artificial reverberation and echo effects added to individual sound sources after recording; and 3) artificial reverberation and echo effects added to the final mix. Sound processing methods to analyze environment in recorded popular music should therefore consider that virtual spaces are created through the combination of various environments.

De Man *et al.* propose a method for analyzing the perceived amount of artificial reverberation in "mixtures of sources with varying degrees and types of reverb" (2017, 114). The paper introduces an Equivalent Impulse Response measurement, which allows for the extraction

[22] Consider, for instance, the Reverberation time. The acoustic properties of a space may be expressed with an RT60 measurement, which refers to the time required for a sound to decay by 60dB. RT60 measurements are obtained through the analysis of a carefully calibrated sound's reaction to a real space. The virtual spaces created in recorded popular music do not physically exist, and as such, cannot be "excited" by a signal for subsequent analysis. Moreover, musical signals are often too complex to generate useful RT60 measurements. Kendrick *et al.* (2006) extract reverberation parameters from music signals using a method based on artificial neural networks. They are, however, studying existing physical spaces such as concert halls and other performance venues.

of 1) relative reverb loudness and 2) early decay time of full mixes consisting of a compound of different artificial environments. The method, however, relies on a comparison of the finished mix with the original recorded sound sources. Therefore, it is unfortunately not applicable to situations in which an analyst only has access to the final mix.

B.5 Analyzing the Voice's Layering

The layering of a voice should be determined via aural analysis. By ear, the analyst can place each of a song's formal sections into one of the five categories shown in Table B.3. Note that a given layering rating might not be representative of the entirety of a given formal section. A singer might open a chorus at a layering level of L1, but quickly be joined by several added layers for a level of L4. The analyst should choose the level that best encapsulates the overall sound of the chorus.

Layering categorizations do not take into consideration added background vocals provided by one or more additional singers. The chosen layering level should only reflect vocals sung by the "lead vocals." Consider, for instance, Chris Brown's verse in "Birthday Cake" (Rihanna ft. Chris Brown, 2011). As Brown sings, Rihanna accompanies him by repeating the word "Cake." This accompaniment would not count as an added layer because it is not sung by Chris Brown.

Table B.3 A five-point scale for analyzing a voice's layering

Single ↑	**L1**	The voice is presented as solo. Occasionally, a few words may be doubled for emphasis.	**"Work," Rihanna ft. Drake** Drake, Verse, 02:13–02:24
	L2	The voice is presented as solo, but additional vocal layers are added at the ends of musical phrases for emphasis.	**"Girls Like You," Maroon 5 ft. Cardi B** Cardi B, Verse, 02:54–03:15
	L3	The voice is accompanied by one or two layers. Layers might provide minimal harmonies or double the voice. The layers have a noticeably lower amplitude than the main voice.	**"Airplanes," B.o.B Featuring Hayley Williams** Hayley Williams, Chorus, 00:09–00:30
	L4	The voice is accompanied by two or more layers. These layers are close copies of the main voice, sharing the same pitch and amplitude.	**"Feel This Moment," Pitbull ft. Christina Aguilera** Pitbull, Verse, 01:12–01:24
↓ **Layered**	**L5**	The voice is accompanied by two or more layers. These layers add harmonies to the main voice, creating a thick and multi-voiced texture.	**"Cheap Thrills," Sia ft. Sean Paul** Sia, Chorus, 00:33–01:06

B.6 Displaying Vocal Placement Data

While Chapter 2 outlines a method for visually displaying vocal placement, the data can also be stored in a .csv file (Table B.4). This format is better suited for the context of a corpus study where an analyst is interested in conducting a statistical analysis of several vocal placements.

Table B.4 .csv file with vocal placement data in “The Monster” (Eminem ft. Rihanna, 2013)

Index	Time	Form	Artist	Gender	Function	Style	PitchMin	PitchQ1	PitchMedian	PitchQ2	PitchMax	Environme	Layering	Prominence	Width
1	0	Chorus	Rihanna	F	Feat	S	165.726	328.65425	372.113	418.81525	677.941	E5	L1	89.0263179	W4
2	19.2271875	Verse1	Eminem	M	Main	R	112.998	182.339	202.215	238.143	725.299	E1	L1	62.0128366	W1
3	54.085875	Chorus	Rihanna	F	Feat	S	272.262	334.023	409.865	426.418	668.511	E5	L1	50.6056995	W4
4	71.5254792	Post-chorus	Rihanna	F	Feat	S	169.978	438.1415	557.189	745.883	947.054	E1	L3	41.2521104	W5
5	88.9275833	Verse2	Eminem	M	Main	R	88.4004	192.48175	248.3025	313.70425	496.985	E1	L3	71.5476851	W3
6	123.863375	Chorus	Rihanna	F	Feat	S	272.296	333.2805	410.2135	427.37925	669.636	E5	L1	50.9129484	W4
7	141.2965	Post-chorus	Rihanna	F	Feat	S	184.407	417.207	493.5335	728.18625	990.132	E1	L3	39.3647567	W5
8	158.776771	Verse3	Eminem	M	Main	R	136.396	232.59275	267.3	299.12675	496.756	E1	L1	65.6781243	W1
9	195.871	Chorus	Rihanna	F	Feat	S	253.148	329.9455	372.764	418.2865	669.544	E5	L1	92.31156	W4
10	213.321125	Bridge	Both												
11	230.767333	Outro	Rihanna	F	Feat	S	273.155	431.9445	552.175	732.5635	1040.3	E1	L3	38.9182194	W5
12	252.268104	End													

The “Time” and “Form” columns indicate the timestamps at which each formal section begins.

The subsequent columns provide the following data:

“Artist:” The name of the artist performing the section

“Gender:” The gender of the artist (F for women and M for men)

“Function:” The function of the artist in the track (featured artist, main artist, or neither)

“Style:” The style of vocal delivery for the section (S for sing and R for rap)

“PitchMin:” The minimum vocal pitch (Hz) of the section

“PitchQ1:” The vocal pitch (Hz) occupying the range’s first quartile

“PitchMedian:” The median vocal pitch (Hz)

“PitchQ3:” The vocal pitch (Hz) occupying the range’s third quartile

“Pitch Max:” The maximum vocal pitch (Hz)

“Environment:” The environment rating of the voice for the section

“Layering:” The layering rating of the voice for the section

“Prominence:” The prominence of the voice, expressed as a percentage, for the section

“Width:” The width rating of the voice for the section

Appendix C List of Songs in the Collaborative Song (CS) Corpus

Index #	Chart year	Position	Type	Title	Artists
1	2018	47	Duet	All the Stars	Kendrick Lamar & SZA
2	2018	61	W ft. M	Bartier Cardi	Cardi B Ft. 21 Savage
3	2018	63	M ft. W	Big Bank	YG Ft. 2 Chainz, Big Sean & Nicki Minaj
4	2018	77	Duet	Eastside	benny blanco, Halsey & Khalid
5	2018	31	M ft. W	FEFE	6ix9ine Ft. Nicki Minaj & Murda Beatz
6	2018	14	M ft. W	Finesse	Bruno Mars Ft. Cardi B
7	2018	10	M ft. W	Girls Like You	Maroon 5 Ft. Cardi B
8	2018	4	W ft. M	Havana	Camilla Cabello Ft. Young Thug
9	2018	45	Duet	Him & I	G-Easy & Halsey
10	2018	7	W ft. M	I Like it	Cardi B, Bad Bunny & J Balvin
11	2018	83	Duet	Lemon	N*E*R*D & Rihanna
12	2018	19	Duet	Love Lies	Khalid & Normani
13	2018	34	M ft. W	MotorSport	Migos, Nicki Minaj & Cardi B
14	2018	30	M ft. W	No Limit	G-Easy Ft. A$AP Rocky & Cardi B
15	2018	74	M ft. W	Plain Jane	A$AP Ferg Ft. Nicki Minaj
16	2018	89	M ft. W	What Lovers Do	Maroon 5 Ft. SZA
17	2017	31	M ft. W	1-800-273-8255	Logic Ft. Alessia Cara & Khalid
18	2017	41	Duet	Bad Things	Machine Gun Kelly & Camilla Cabello
19	2017	73	W ft. M	Chained to the Rhythm	Katy Perry Ft. Skip Marley
20	2017	74	M ft. W	Feels	Calvin Harris Ft. Pharrell Williams & Katy Perry
21	2017	26	Duet	I Don't Want to Live Forever	Zayn & Taylor Swift
22	2017	80	W ft. M	Love Galore	SZA Ft. Travis Scott
23	2017	66	M ft. W	Loyalty.	Kendrick Lamar Ft. Rihanna
24	2017	91	M ft. NB	No Promises	Cheat Code Ft. Demi Lovato

25	2017	53	M ft. W	Rake It Up	Yo Gotti Ft. Nicki Minaj
26	2017	44	M ft. W	Rockabye	Clean Bandit Ft. Sean Paul & Anne-Marie
27	2017	85	M ft. W	Swalla	Jason Derulo Ft. Nicki Minaj & Ty Dolla $ign
28	2017	18	M ft. W	Wild Thoughts	DJ Khaled Ft. Rihanna & Bryson Tiller
29	2016	11	W ft. M	Cheap Thrills	Sia Ft. Sean Paul
30	2016	66	M ft. W	Close	Nick Jonas Ft. Tove Lo
31	2016	25	M ft. W	Cold Water	Major Lazer Ft. Justin Bieber & MO
32	2016	69	M ft. W	Down in the DM	Yo Gotti Ft. Nicki Minaj
33	2016	38	M ft. W	I Hate U I Love U	Gnash Ft. Olivia O'brien
34	2016	86	Duet	I Know What You Did Last Summer	Shawn Mendes & Camila Cabello
35	2016	19	Duet	Me, Myself & I	G-Eazy & Bebe Rexha
36	2016	46	Duet	Never Forget You	Zara Larsson & MNEK
37	2016	3	M ft. W	One Dance	Drake Ft. WizKid & Kyla
38	2016	29	M ft. W	Too Good	Drake Ft. Rihanna
39	2016	50	M ft. W	We Don't Talk Anymore	Charlie Puth Ft. Selena Gomez
40	2016	4	W ft. M	Work	Rihanna Ft. Drake
41	2015	42	Duet	FourFiveSeconds	Rihanna & Kanye West & Paul McCartney
42	2015	69	M ft. W	All Eyes on You	Meek Mill Ft. Chris Brown & Nicki Minaj
43	2015	15	W ft. M	Bad Blood	Taylor Swift Ft. Kendrick Lamar
44	2015	27	W ft. M	Good For You	Selena Gomez Ft. A$AP Rocky
45	2015	16	Duet	Lean On	Major Lazer & DJ Snake Ft. MO
46	2015	76	W ft. M	Like I'm Gonna Lose You	Meghan Trainor Ft. John Legend
47	2015	56	Duet	Love Me Harder	Ariana Grande & The Weekend
48	2015	75	M ft. W	Marvin Gaye	Charlie Puth Ft. Meghan Trainor
49	2015	51	W ft. M	Only	Nicki Minaj Ft. Drake, Lil Wayne & Chris Brown
50	2015	24	M ft. W	Post to Be	Omarion Ft. Chris Brown & Jhene Aiko
51	2015	41	W ft. M	Somebody	Natalie La Rose Ft. Jeremih

52	2015	66	W ft. M	Truffle Butter	Nicki Minaj Ft. Drake & Little Wayne
53	2014	65	W ft. M	2 On	Tinashe Ft. ScHoolboy Q
54	2014	90	M ft. W	23	Mike WiLL Made-It Ft. Miley Cyrus, Wiz Khalifa & Juicy J
55	2014	2	W ft. M	Dark Horse	Katy Perry Ft. Juicy J
56	2014	84	W ft. M	Do What U Want	Lady Gaga Ft. R. Kelly
57	2014	35	W ft. M	Drunk In Love	Beyonce Ft. Jay Z
58	2014	87	M ft. W	No Mediocre	T.I. Ft. Iggy Azalea
59	2014	16	M ft. W	The Monster	Eminem Ft. Rihanna
60	2014	11	M ft. W	Timber	Pitbull Ft. Ke$ha
61	2013	81	M ft. W	#Beautiful	Mariah Carey Ft. Miguel
62	2013	59	W ft. M	Bad	Wale Ft. Tiara Thomas Or Rihanna
63	2013	42	M ft. W	Beauty And A Beat	Justin Bieber Ft. Nicki Minaj
64	2013	36	M ft. W	Feel This Moment	Pitbull Ft. Christina Aguilera
65	2013	77	M ft. W	Highway Don't Care	Tim McGraw & Taylor Swift
66	2013	7	W ft. M	Just Give Me A Reason	P!nk Ft. Nate Ruess
67	2013	43	M ft. W	Same Love	Macklemore & Ryan Lewis Ft. Mary Lambert
68	2013	23	Duet	Scream & Shout	Will.i.am & Britney Spears
69	2013	13	W ft. M	Stay	Rihanna Ft. Mikky Ekko
70	2013	31	W ft. M	The Way	Ariana Grande Ft. Mac Miller
71	2012	86	M ft. W	5 O'Clock	T-Pain Ft. Wiz Khalifa & Lily Allen
72	2012	51	M ft. W	Ass Back Home	Gym Class Heroes Ft. Neon Hitch
73	2012	79	W ft. M	Birthday Cake	Rihanna Ft. Chris Brown
74	2012	57	M ft. W	Dance (A$$)	Big Sean Ft. Nicki Minaj
75	2012	38	Duet	Good Time	Owl City & Carly Rae Jepsen
76	2012	1	M ft. W	Somebody That I Used To Know	Gotye Ft. Kimbra
77	2012	23	M ft. W	Take Care	Drake Ft. Rihanna
78	2012	3	M ft. W	We Are Young	Fun. Ft. Janelle Monae

79	2012	90	W ft. M	We Run The Night	Havana Brown Ft. Pitbull
80	2012	11	M ft. W	Wild Ones	Flo Rida Ft. Sia
81	2011	64	M ft. W	Bottoms Up	Trey Songz Ft. Nicki Minaj
82	2011	72	Duet	Like A G6	Far*East Movement Ft. Cataracs & Dev
83	2011	38	M ft. W	Coming Home	Diddy - Dirty Money Ft. Skylar Grey
84	2011	68	M ft. W	Don't You Wanna Stay	Jason Aldean & Kelly Clarkson
85	2011	4	W ft. M	E.T.	Katy Perry Ft. Kanye West
86	2011	51	M ft. W	I Need A Doctor	Dr. Dre Ft. Eminem & Skylar Grey
87	2011	50	W ft. M	Moment 4 Life	Nicki Minaj Ft. Drake
88	2011	53	W ft. M	Motivation	Kelly Rowland Ft. Lil Wayne
89	2011	9	M ft. W	Moves Like Jagger	Maroon 5 Ft. Christina Aguilera
90	2011	11	W ft. M	On The Floor	Jennifer Lopez Ft. Pitbull
91	2011	93	W ft. M	Price Tag	Jessie J Ft. B.o.B
92	2011	54	Duet	Stereo Love	Edward Maya & Vika Jigulina
93	2011	20	W ft. M	What's My Name?	Rihanna Ft. Drake
94	2011	88	M ft. W	Where Them Girls At	David Guetta Ft. Flo Rida & Nicki Minaj
95	2011	48	M ft. W	You Make Me Feel...	Cobra Starship Ft. Sabi
96	2010	6	M ft. W	Airplanes	B.o.B Ft. Hayley Williams
97	2010	51	W ft. M	Blah Blah Blah	Ke$ha Ft. 3OH!3
98	2010	4	W ft. M	California Gurls	Katy Perry Ft. Snoop Dogg
99	2010	49	W ft. M	Hard	Rihanna Ft. Jeezy
100	2010	7	M ft. W	Love The Way You Lie	Eminem Ft. Rihanna
101	2010	56	M ft. W	My Chick Bad	Ludacris Ft. Nicki Minaj
102	2009	62	Duet	Empire State Of Mind	Jay-Z + Alicia Keys
103	2009	43	M ft. W	Good Girls Go Bad	Cobra Starship Ft. Leighton Meester
104	2009	3	W ft. M	Just Dance	Lady Gaga Ft. Colby O'Donis
105	2009	15	W ft. M	Knock You Down	Keri Hilson Ft. Kanye West & Ne-Yo

106	2009	58	M ft. W	Sugar	Flo Rida Ft. Wynter
107	2009	49	W ft. M	Turnin Me On	Keri Hilson Ft. Lil Wayne
108	2008	39	W ft. M	American Boy	Estelle Ft. Kanye West
109	2008	61	W ft. M	Hate That I Love You	Rihanna Ft. Ne-Yo
110	2008	37	M ft. W	Live Your Life	T.I. Ft. Rihanna
111	2008	72	W ft. M	Love Like This	Natasha Bedingfield Ft. Sean Kingston
112	2009	31	Duet	Run This Town	Jay-Z, Rihanna & Kanye West
113	2008	96	M ft. W	The Way I Are	Timbaland Ft. Keri Hilson

Appendix D Vocal Placement Data in the CS (Collaborative Song) Corpus

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
1	1	0	Intro													
1	2	20.5343	Pre-chorus	Kendrick Lamar	M	Neither	S	87.3	155	174	197	480	E4	L3	25.2	W4
1	3	40.4091	Chorus	SZA	F	Neither	S	169	290	365	483	598	E3	L1	37.1	W5
1	4	60.2931	Verse1	Kendrick Lamar	M	Neither	R	143	187	195	203	268	E2	L1	34.3	W3
1	5	99.8909	Pre-chorus	Kendrick Lamar	M	Neither	S	131	149	173	196	480	E4	L3	19	W3
1	6	119.751	Chorus	SZA	F	Neither	S	169	308	392	486	597	E3	L1	39.5	W5
1	7	139.602	Bridge	SZA	F	Neither	S	192	291	346	354	557	E4	L1	34.8	W4
1	8	179.271	Pre-chorus	Both												
1	9	199.079	Chorus	SZA	F	Neither	S	174	311	391	484	601	E5	L1	39.7	W5
1	10	218.937	Outro													
1	11	236.537	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
2	1	0	Intro	Both												
2	2	14.099	Chorus	Cardi B	F	Main	R	168	214	252	286	462	E2	L1	24.5	W3
2	3	41.989	Verse1	Cardi B	F	Main	R	159	295	329	361	459	E3	L2	27.6	W3
2	4	69.7837	Chorus	Cardi B	F	Main	R	93.6	217	252	285	371	E2	L1	25.6	W3
2	5	97.631	Verse2	21 Savage	M	Feat	R	61.9	98.8	108	111	240	E1	L1	23.4	W1
2	6	125.488	Chorus	Cardi B	F	Main	R	172	210	250	285	474	E2	L1	24.8	W3
2	7	153.311	Verse3	Cardi B	F	Main	R	167	263	313	353	439	E3	L1	23.4	W3
2	8	181.092	Chorus	Cardi B	F	Main	R	173	219	253	286	495	E2	L1	24.4	W3
2	9	208.955	Outro													
2	10	224.64	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
3	1	0	Verse1	YG	M	Main	R	122	208	224	242	324	E2	L2	23.7	W1
3	2	38.3709	Chorus	YG	M	Main	R	117	134	142	168	190	E2	L4	21.8	W5
3	3	57.2829	Verse2	2 Chainz	M	Feat	R	109	189	200	215	289	E2	L1	29.2	W3
3	4	94.8214	Chorus	YG	M	Main	R	117	131	137	142	172	E2	L4	21.9	W5
3	5	113.73	Verse3	Big Sean	M	Feat	R	96.3	130	140	156	219	E2	L1	28.2	W3
3	6	151.38	Chorus	YG	M	Main	R	117	124	136	145	243	E2	L4	22	W5
3	7	170.177	Verse4	Nicki Minaj	F	Feat	R	146	236	261	287	378	E2	L2	30.8	W3
3	8	207.767	Chorus	YG	M	Main	R	117	132	138	144	173	E2	L4	21.4	W5
3	9	226.709	Outro													
3	10	236.92	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
4	1	0	Intro													
4	2	11.1536	Verse1	Khalid	M	Neither	S	148	220	246	273	343	E4	L1	84.6	W4
4	3	32.4706	Pre-chorus	Khalid	M	Neither	S	153	188	223	249	332	E4	L3	43.6	W4
4	4	53.7752	Chorus	Khalid	M	Neither	S	176	219	247	278	441	E4	L3	42.7	W5
4	5	75.1054	Verse2	Halsey	F	Neither	S	186	220	242	251	334	E1	L1	82.4	W2
4	6	96.4548	Pre-chorus	Halsey	F	Neither	S	138	206	221	250	332	E4	L1	38.3	W4
4	7	117.867	Chorus	Both												
4	8	139.14	Bridge	Both												
4	9	149.836	Outro	Both												
4	10	174.017	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
5	1	0	Intro	Both												
5	2	15.4075	Verse1	6ix9ine	M	Main	R	158	182	185	186	208	E1	L1	44.3	W1
5	3	36.2921	Chorus	6ix9ine	M	Main	S	173	185	189	216	240	E2	L1	23.8	W3
5	4	42.0333	Verse2	6ix9ine	M	Main	R	174	176	184	185	192	E1	L1	38.1	W1
5	5	59.1171	Chorus	6ix9ine	M	Main	S	168	184	186	207	236	E2	L1	27.7	W3
5	6	64.857	Verse3	Nicki Minaj	F	Feat	R	153	181	187	196	454	E4	L1	43.1	W3
5	7	97.2638	Chorus	6ix9ine	M	Main	S	157	185	189	207	237	E2	L1	29.7	W3
5	8	102.962	Verse4	Nicki Minaj	F	Feat	R	130	169	184	189	211	E1	L1	46.3	W1
5	9	120.094	Chorus	Both												
5	10	125.763	Bridge	6ix9ine	M	Main	R	152	184	185	185	393	E3	L1	42.2	W3
5	11	148.71	Outro	Nicki Minaj	F	Feat	R	129	186	207	242	375	E2	L1	36.4	W3
5	12	179.392	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
6	1	0	Intro													
6	2	4.7711	Verse1	Cardi B	F	Feat	R	193	270	309	342	796	E2	L1	47.5	W4
6	3	32.1892	Verse2	Bruno Mars	M	Main	S	230	310	345	353	471	E2	L1	55.5	W4
6	4	50.5428	Pre-chorus	Bruno Mars	M	Main	S	154	248	313	391	526	E1	L5	47.2	W4
6	5	68.8002	Chorus	Bruno Mars	M	Main	S	172	213	233	261	333	E1	L5	35.1	W5
6	6	87.0391	Verse3	Bruno Mars	M	Main	S	216	329	355	411	544	E2	L1	55.6	W4
6	7	105.384	Pre-chorus	Bruno Mars	M	Main	S	151	254	334	413	556	E1	L5	48	W4
6	8	123.644	Chorus	Bruno Mars	M	Main	S	169	210	231	239	348	E1	L5	37.7	W5
6	9	141.941	Bridge1	Bruno Mars	M	Main	S	211	350	414	620	1621	E1	L5	35.6	W5
6	10	160.249	Bridge2	Both												
6	11	178.475	Chorus	Bruno Mars	M	Main	S	174	257	306	346	531	E1	L5	65.4	W5
6	12	196.821	Outro	Both												
6	13	222.988	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
7	1	0	Intro													
7	2	8.67725	Verse1	Maroon 5	M	Main	S	159	257	267	311	394	E3	L1	77.2	W3
7	3	39.3773	Chorus	Maroon 5	M	Main	S	162	239	261	267	332	E1	L3	63.1	W5
7	4	54.7094	Post-chorus	Maroon 5	M	Main	S	193	231	260	268	346	E1	L3	36.8	W5
7	5	70.1548	Verse2	Maroon 5	M	Main	S	173	259	286	323	444	E3	L2	52.4	W3
7	6	100.936	Chorus	Maroon 5	M	Main	S	209	223	261	265	332	E1	L3	49.8	W5
7	7	116.163	Post-chorus	Maroon 5	M	Main	S	124	223	261	265	336	E1	L5	33.8	W5
7	8	146.927	Bridge	Maroon 5	M	Main	S	98.2	131	148	165	270	E1	L3	75.2	W2
7	9	164.262	Chorus	Maroon 5	M	Main	S	197	223	260	264	333	E1	L1	86.7	W2
7	10	173.729	Verse3	Cardi B	F	Feat	R	172	315	338	355	446	E1	L2	54.8	W4
7	11	204.547	Chorus	Maroon 5	M	Main	S	194	222	261	284	335	E1	L5	44.2	W5
7	12	219.798	Post-chorus	Maroon 5	M	Main	S	180	249	263	294	969	E4	L5	27.8	W5
7	13	242.899	Outro													
7	14	270.786	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
8	1	0	Intro													
8	2	10.0482	Chorus	Camilla Cabello	F	Main	S	160	233	262	294	342	E1	L1	77.2	W1
8	3	28.3273	Verse1	Camilla Cabello	F	Main	S	179	264	292	355	472	E2	L2	38.2	W3
8	4	46.6177	Pre-chorus	Camilla Cabello	F	Main	S	209	346	369	400	593	E4	L5	71.5	W5
8	5	64.8792	Chorus	Camilla Cabello	F	Main	S	172	231	262	293	348	E2	L1	40	W1
8	6	83.7974	Verse2	Young Thug	M	Feat	R	146	223	235	263	389	E2	L1	47.9	W3
8	7	119.755	Chorus	Camilla Cabello	F	Main	S	191	233	265	295	525	E2	L1	40.2	W1
8	8	138.064	Bridge	Camilla Cabello	F	Main	S	194	283	355	465	628	E4	L5	25.5	W5
8	9	174.611	Chorus	Camilla Cabello	F	Main	S	178	233	264	294	472	E2	L5	39.9	W4
8	10	192.836	Outro	Camilla Cabello	F	Main	S	137	220	233	309	443	E4	L5	28.5	W5
8	11	218.518	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
9	1	0	Chorus	Halsey	F	Neither	S	187	249	266	296	395	E4	L1	42.2	W4
9	2	23.3095	Verse1	G-Eazy	M	Neither	R	125	182	191	203	297	E1	L1	45.4	W1
9	3	66.93	Chorus	Halsey	F	Neither	S	176	249	265	296	395	E4	L1	39.8	W4
9	4	88.8053	Post-chorus	Halsey	F	Neither	S	156	246	260	441	536	E4	L5	31.7	W5
9	5	111.918	Verse2	G-Eazy	M	Neither	R	131	173	182	189	297	E1	L1	45.4	W1
9	6	154.136	Chorus	Halsey	F	Neither	S	188	249	265	296	396	E4	L1	39.4	W4
9	7	176.105	Post-chorus	Halsey	F	Neither	S	187	247	261	442	532	E4	L5	30.5	W5
9	8	197.867	Bridge	Both												
9	9	219.615	Chorus	Halsey	F	Neither	S	192	249	265	296	395	E4	L1	38.8	W4
9	10	241.578	Post-chorus	Halsey	F	Neither	S	185	246	258	440	531	E4	L5	31.6	W5
9	11	280.155	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
10	1	0	Intro													
10	2	14.7415	Verse1	Cardi B	F	Main	R	170	266	321	350	502	E1	L3	68.5	W2
10	3	57.1624	Chorus	Cardi B	F	Main	R	171	305	346	415	904	E1	L3	46.6	W4
10	4	85.329	Verse2	Bad Bunny	M	Feat	R	160	251	260	262	644	E1	L1	73.7	W1
10	5	141.892	Chorus	Cardi B	F	Main	R	214	289	341	415	901	E1	L3	47.5	W4
10	6	169.959	Verse3	J Balvin	M	Feat	R	117	220	232	234	525	E1	L1	66.3	W1
10	7	212.36	Bridge	Both												
10	8	226.468	Chorus	Cardi B	F	Main	R	204	234	350	394	823	E1	L3	44	W4
10	9	240.627	Outro													
10	10	256.68	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
11	1	0	Intro	Pharrell Williams	M	Neither	R	131	149	175	199	294			96.4	
11	2	2.84006	Verse1	Pharrell Williams	M	Neither	R	125	301	327	346	419	E1	L1	32	W1
11	3	23.1867	Chorus1	Pharrell Williams	M	Neither	R	200	237	247	310	395	E1	L1	44.6	W1
11	4	33.1263	Verse2	Pharrell Williams	M	Neither	R	201	313	331	358	412	E1	L1	34.3	W1
11	5	53.4052	Chorus1	Pharrell Williams	M	Neither	R	140	240	250	301	398	E1	L1	31.6	W1
11	6	63.591	Interlude	Pharrell Williams	M	Neither	R	168	205	228	257	349	E1	L2	46	W1
11	7	73.645	Chorus2	Rihanna	F	Neither	R	151	236	261	281	362	E1	L1	29.4	W1
11	8	104.009	Verse3	Rihanna	F	Neither	R	146	245	264	279	578	E2	L1	33.8	W1
11	9	131.833	Bridge	Pharrell Williams	M	Neither	R	126	182	228	262	367	E1	L1	27.7	W1
11	10	154.484	Chorus2	Pharrell Williams	M	Neither	R	155	232	259	283	368	E1	L1	27.8	W1
11	11	184.92	Chorus1	Pharrell Williams	M	Neither	R	151	242	250	297	394	E1	L1	99.7	W1
11	12	193.771	Outro	Pharrell Williams	M	Neither	R	179	230	243	264	308	E1	L1	24.1	W1
11	13	219.904	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
12	1	0	Intro													
12	2	14.2538	Verse1	Khalid	M	Neither	S	124	154	174	208	316	E1	L1	49.6	W1
12	3	41.1505	Pre-chorus	Khalid	M	Neither	S	148	174	178	203	237	E2	L1	28.9	W3
12	4	54.5224	Chorus	Both												
12	5	67.8876	Verse2	Normani	F	Neither	S	187	310	372	418	557	E2	L1	69.3	W3
12	6	94.4292	Pre-chorus	Normani	F	Neither	S	172	207	209	252	352	E2	L1	28.3	W3
12	7	107.866	Chorus	Both												
12	8	134.527	Bridge	Both												
12	9	161.202	Chorus	Both												
12	10	187.87	Outro													
12	11	203.309	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
13	1	0	Intro												93.5	
13	2	6.911	Chorus	Quavo	M	Main	S	127	166	197	220	234	E1	L1	45.9	W1
13	3	34.8703	Verse1	Quavo	M	Main	R	130	146	147	175	242	E4	L3	42.9	W2
13	4	76.5478	Verse2	Offset	M	Main	R	105	153	173	192	337	E1	L1	61.8	W1
13	5	104.43	Verse3	Cardi B	F	Feat	R	188	274	301	317	895	E2	L2	53.5	W3
13	6	146.204	Chorus	Quavo	M	Main	S	186	215	896	925	951	E1	L1	47.3	W2
13	7	160.03	Verse4	Nicki Minaj	F	Feat	R	126	197	213	226	429	E2	L2	58.1	W3
13	8	229.621	Verse5	Takeoff	M	Main	R	123	222	238	249	348	E1	L1	53.2	W1
13	9	257.501	Chorus	Quavo	M	Main	S	128	176	219	224	403	E1	L1	46	W2
13	10	285.305	Outro	Quavo	M	Main	R	131	195	196	220	224	E1	L1	38.8	W2
13	11	303.113	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
14	1	0	Intro													
14	2	10.9797	Chorus	A$AP Rocky	M	Feat	R	142	191	206	214	241	E2	L1	37.9	W4
14	3	32.7705	Post-chorus	G-Eazy	M	Main	R	137	166	181	193	237	E2	L1	35.3	W3
14	4	43.7258	Verse1	G-Eazy	M	Main	R	130	168	189	201	227	E2	L1	34.5	W3
14	5	76.4266	Chorus	A$AP Rocky	M	Feat	R	124	190	205	215	308	E2	L1	38.5	W4
14	6	98.2612	Post-chorus	Cardi B	F	Feat	R	188	243	269	301	355	E2	L1	36.4	W3
14	7	109.187	Verse2	Cardi B	F	Feat	R	133	269	307	341	457	E1	L2	42.9	W4
14	8	141.897	Chorus	A$AP Rocky	M	Feat	R	141	190	205	214	241	E1	L1	37.7	W3
14	9	163.685	Post-chorus	G-Eazy	M	Main	R	152	167	182	193	237	E2	L1	35.3	W3
14	10	174.63	Chorus	A$AP Rocky	M	Feat	R	141	191	204	215	242	E2	L1	39.8	W4
14	11	196.424	Post-chorus	G-Eazy	M	Main	R	148	167	182	194	237	E2	L1	35.5	W3
14	12	212.481	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
15	1	0	Intro	Both												
15	2	12.1513	Chorus	A$AP Ferg	M	Main	R	97.5	129	139	149	160	E2	L1	97.6	W3
15	3	23.3931	Verse1	A$AP Ferg	M	Main	R	99.6	166	215	254	344	E1	L1	39.3	W1
15	4	68.6584	Chorus	A$AP Ferg	M	Main	R	96.6	131	140	149	166	E1	L1	38.5	W3
15	5	91.283	Post-chorus	A$AP Ferg	M	Main	R	111	145	189	248	332	E2	L1	35.6	W3
15	6	102.527	Verse2	Nicki Minaj	F	Feat	R	146	240	267	292	383	E2	L1	42.6	W3
15	7	147.655	Chorus	Nicki Minaj	F	Feat	R	147	201	228	242	265	E2	L1	38.3	W3
15	8	170.228	Post-chorus	Nicki Minaj	F	Feat	R	112	220	228	233	265	E2	L4	29.8	W5
15	9	181.637	Outro													
15	10	204.052	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
16	1	0	Intro													
16	2	8.67598	Verse1	Maroon 5	M	Main	S	138	233	235	291	300	E3	L1	93.7	W3
16	3	26.2176	Pre-chorus	Maroon 5	M	Main	S	221	234	261	291	352	E2	L3	64	W5
16	4	43.6268	Chorus	Maroon 5	M	Main	S	224	351	465	522	597	E3	L3	37	W5
16	5	61.1528	Verse2	SZA	F	Feat	S	192	233	235	294	396	E4	L1	32.1	W4
16	6	78.6215	Pre-chorus	Maroon 5	M	Main	S	212	234	261	292	351	E2	L3	43.6	W5
16	7	96.0359	Chorus	Maroon 5	M	Main	S	225	353	465	525	605	E3	L1	33.1	W4
16	8	113.504	Post-chorus	Both												
16	9	130.949	Bridge	Both												
16	10	159.349	Chorus	Both												
16	11	194.245	Outro													
16	12	213.247	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
17	1	0	Intro													
17	2	19.1984	Pre-chorus	Logic	M	Main	S	148	232	234	258	693	E2	L1	74.7	W4
17	3	38.4265	Chorus	Logic	M	Main	S	170	224	234	261	314	E1	L1	48.9	W2
17	4	57.6502	Verse1	Logic	M	Main	R	170	212	232	236	274	E1	L1	52.7	W2
17	5	76.7956	Pre-chorus	Logic	M	Main	S	150	215	233	253	693	E2	L1	37.3	W4
17	6	96.0103	Chorus	Both												
17	7	115.268	Verse2	Alessia Cara	F	Feat	S	196	236	260	315	417	E3	L2	42.4	W4
17	8	134.529	Verse3	Logic	M	Main	S	191	231	233	236	317	E1	L1	52.9	W2
17	9	153.716	Pre-chorus	Logic	M	Main	S	152	231	234	258	693	E2	L1	41.5	W4
17	10	172.873	Chorus	Both												
17	11	194.458	Outro													
17	12	250.178	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
18	1	0	Intro													
18	2	14.0157	Chorus	Camila Cabello	F	Neither	S	213	300	371	442	607	E2	L1	60.3	W4
18	3	41.8451	Verse1	Machine Gun Kelly	M	Neither	R	162	223	236	246	331	E2	L1	39.8	W2
18	4	69.7302	Pre-chorus	Machine Gun Kelly	M	Neither	S	122	163	184	195	292	E1	L3	41.6	W2
18	5	83.5232	Chorus	Camila Cabello	F	Neither	S	213	299	371	440	606	E2	L1	46.9	W4
18	6	111.389	Verse2	Machine Gun Kelly	M	Neither	R	119	213	231	250	438	E2	L2	41.4	W4
18	7	139.202	Pre-chorus	Machine Gun Kelly	M	Neither	S	123	162	184	198	294	E1	L3	42.3	W5
18	8	153.114	Chorus	Camila Cabello	F	Neither	S	208	300	373	440	607	E2	L1	47.1	W4
18	9	181.003	Bridge	Camila Cabello	F	Neither	S	199	322	332	371	532	E4	L2	57.2	W4
18	10	194.83	Pre-chorus	Both												
18	11	208.818	Chorus	Camila Cabello	F	Neither	S	161	293	333	393	608	E2	L5	37.7	W4
18	12	238.696	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
19	1	0	Intro													
19	2	5.09963	Verse1	Katy Perry	F	Main	S	239	298	329	335	565	E3	L1	46.2	W4
19	3	45.5886	Pre-chorus	Katy Perry	F	Main	S	211	255	327	333	440	E4	L3	46.2	W4
19	4	55.627	Chorus	Katy Perry	F	Main	S	291	364	401	440	524	E2	L3	39.3	W5
19	5	98.6176	Verse2	Katy Perry	F	Main	S	237	296	329	335	534	E3	L1	43.3	W4
19	6	118.868	Pre-chorus	Katy Perry	F	Main	S	221	277	328	332	399	E4	L3	51.6	W4
19	7	128.882	Chorus	Katy Perry	F	Main	S	177	355	412	440	595	E2	L3	40.9	W5
19	8	170.617	Bridge	Skip Marley	M	Feat	S	187	218	223	323	441	E4	L2	58.8	W3
19	9	192.003	Chorus	Katy Perry	F	Main	S	243	351	432	446	596	E2	L5	42.6	W5
19	10	212.31	Outro	Katy Perry	F	Main	S	202	270	294	327	511	E4	L5	64.3	W5
19	11	240.856	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
20	1	0	Intro													
20	2	31.1173	Verse1	Pharrell Williams	M	Neither	S	214	300	331	406	593	E1	L3	59	W2
20	3	50.1386	Pre-chorus	Pharrell Williams	M	Neither	S	206	258	337	372	443	E1	L3	58.3	W2
20	4	69.1076	Chorus	Katy Perry	F	Neither	S	242	309	368	390	503	E1	L1	47.5	W1
20	5	88.1033	Verse2	Pharrell Williams	M	Neither	S	143	288	310	333	514	E1	L3	61.4	W2
20	6	107.166	Pre-chorus	Pharrell Williams	M	Neither	S	206	269	337	372	444	E1	L3	58.5	W2
20	7	126.216	Chorus	Katy Perry	F	Neither	S	127	304	365	387	503	E1	L1	51.3	W1
20	8	145.213	Verse3	Big Sean	M	Neither	R	100	149	163	174	377	E1	L1	62.2	W1
20	9	183.48	Chorus	Both												
20	10	222.674	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
21	1	0	Intro													
21	2	18.4195	Verse1	Zayn	M	Neither	S	195	278	293	296	538	E2	L1	63	W4
21	3	34.6309	Pre-chorus	Zayn	M	Neither	S	243	441	513	529	675	E3	L1	50.2	W4
21	4	48.9289	Chorus	Zayn	M	Neither	S	218	304	455	504	686	E2	L4	31.3	W5
21	5	83.471	Verse2	Taylor Swift	F	Neither	S	193	287	293	296	354	E1	L3	53.7	W4
21	6	97.7692	Pre-chorus	Taylor Swift	F	Neither	S	248	444	521	537	663	E3	L1	48.7	W4
21	7	114.025	Chorus	Both												
21	8	146.463	Bridge	Both												
21	9	179.098	Chorus	Both												
21	10	227.872	Outro	Both												
21	11	245.279	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
22	1	0	Intro	Travis Scott	M	Feat	S	97	109	125	163	438	E3	L1	20	W2
22	2	14.8437	Chorus	SZA	F	Main	S	191	246	295	350	487	E4	L1	47.2	W4
22	3	29.1141	Verse1	SZA	F	Main	S	172	222	255	294	410	E1	L1	47.4	W2
22	4	71.7932	Bridge	SZA	F	Main	S	193	294	374	397	538	E1	L2	51.6	W4
22	5	114.553	Chorus	SZA	F	Main	S	186	247	293	355	488	E1	L2	53.8	W4
22	6	128.669	Verse2	SZA	F	Main	S	179	219	244	263	395	E2	L2	46.1	W4
22	7	157.139	Verse3	Travis Scott	M	Feat	S	91.4	193	253	284	394	E3	L1	43.5	W3
22	8	199.792	Chorus	SZA	F	Main	S	192	247	294	357	488	E1	L2	53.7	W4
22	9	214.082	Outro	SZA	F	Main	S	185	254	293	330	495	E1	L2	62.3	W4
22	10	283.836	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
23	1	0	Intro													
23	2	17.4009	Pre-chorus	DJ Dahi	M											
23	3	34.6974	Chorus	Both												
23	4	51.9591	Verse1	Kendrick Lamar	M	Main	R	145	159	166	171	260	E1	L1	67.3	W1
23	5	69.2059	Verse2	Rihanna	F	Feat	R	134	195	199	225	274	E1	L3	65	W3
23	6	86.579	Verse3	Kendrick Lamar	M	Main	R	102	145	151	161	221	E1	L2	28.8	W1
23	7	103.843	Pre-chorus	DJ Dahi	M											
23	8	112.571	Chorus	Both												
23	9	138.443	Verse4	Kendrick Lamar	M	Main	R	140	186	195	198	263	E2	L4	30.9	W3
23	10	155.885	Verse5	Rihanna	F	Feat	R	152	173	197	218	264	E1	L4	34.6	W3
23	11	173.026	Pre-chorus	DJ Dahi												
23	12	181.69	Chorus	Both												
23	13	207.647	Outro	Both												
23	14	227.434	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
24	1	0	Intro													
24	2	9.46127	Verse1	Demi Lovato	NB	Feat	S	386	464	511	523	598	E3	L2	69.5	W4
24	3	26.5486	Pre-chorus	Demi Lovato	NB	Feat	S	207	293	311	352	502	E1	L3	50.4	W5
24	4	43.5653	Chorus	Trevor Dahl	M	Main	S	193	229	233	260	467	E3	L2	62.8	W4
24	5	60.5326	Post-chorus													
24	6	77.4814	Verse2	Demi Lovato	NB	Feat	S	231	465	517	524	594	E3	L2	46.2	W4
24	7	94.4694	Pre-chorus	Demi Lovato	NB	Feat	S	209	294	311	351	507	E1	L3	50.6	W5
24	8	111.449	Chorus	Both												
24	9	128.511	Post-chorus													
24	10	145.468	Bridge	Both												
24	11	162.398	Chorus	Both												
24	12	179.509	Post-chorus													
24	13	213.471	Outro													
24	14	224.532	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
25	1	0	Intro	Both												
25	2	12.9087	Chorus	Yo Gotti	M	Main	R	130	168	178	187	224	E3	L1	38.4	W3
25	3	38.4806	Verse1	Yo Gotti	M	Main	R	105	168	183	205	284	E3	L1	34.6	W3
25	4	76.9337	Chorus	Yo Gotti	M	Main	R	119	168	177	188	256	E3	L1	38.3	W3
25	5	102.51	Verse2	Nicki Minaj	F	Feat	R	112	188	208	227	335	E4	L2	39.7	W3
25	6	153.71	Chorus	Yo Gotti	M	Main	R	130	168	177	187	237	E3	L1	39	W3
25	7	179.28	Verse3	Yo Gotti	M	Main	R	122	183	208	228	352	E3	L1	45.9	W3
25	8	230.533	Chorus	Yo Gotti	M	Main	R	143	169	178	187	221	E2	L1	23.5	W3
25	9	256.125	Outro													
25	10	275.535	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
26	1	0	Intro	Sean Paul	M	Neither	R	162	261	297	337	505	E3	L1	66.5	W3
26	2	19.4653	Verse1	Anne-Marie	F	Neither	S	177	221	259	269	384	E4	L1	87.4	W4
26	3	38.367	Pre-chorus	Anne-Marie	F	Neither	S	213	272	309	347	496	E1	L3	47.3	W3
26	4	57.1812	Chorus	Anne-Marie	F	Neither	S	401	492	514	525	661	E4	L5	78.5	W4
26	5	76.0695	Post-chorus	Both												
26	6	85.4473	Verse2	Sean Paul	M	Neither	R	161	216	220	242	363	E1	L2	45.5	W3
26	7	113.663	Bridge	Anne-Marie	F	Neither	S	240	261	292	320	393	E1	L3	45	W3
26	8	123.014	Pre-chorus	Anne-Marie	F	Neither	S	237	292	328	350	505	E1	L5	39.3	W4
26	9	132.431	Chorus	Anne-Marie	F	Neither	S	412	493	514	525	665	E4	L5	77.7	W5
26	10	151.354	Post-chorus	Both												
26	11	170.143	Bridge	Anne-Marie	F	Neither	S	197	262	291	324	373	E4	L1	86.9	W3
26	12	182.402	Pre-chorus	Anne-Marie	F	Neither	S	199	266	298	347	529	E3	L1	77.3	W2
26	13	201.145	Chorus	Anne-Marie	F	Neither	S	164	441	509	524	664	E4	L5	56.2	W5
26	14	220.015	Post-chorus	Both												
26	15	238.853	Outro													
26	16	253.894	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
27	1	0	Intro	Nicki Minaj	F	Feat	R	81.3	91.2	207	222	238	E2	L1	40.8	W3
27	2	8.40677	Verse1	Jason Derulo	M	Main	S	152	191	209	245	452	E2	L1	43.5	W3
27	3	27.9863	Pre-chorus	Jason Derulo	M	Main	S	190	410	487	517	744	E1	L2	81.2	W3
27	4	37.8886	Chorus	Jason Derulo	M	Main	S	68.6	182	185	188	428	E1	L5	50.3	W5
27	5	57.3946	Post-chorus	Jason Derulo	M	Main	S	182	189	201	208	299	E1	L1	37.5	W1
27	6	67.2036	Verse2	Ty Dolla $ign	M	Feat	R	61.8	140	245	275	414	E2	L1	55.9	W3
27	7	96.5727	Pre-chorus	Jason Derulo	M	Main	S	190	410	492	545	749	E1	L2	81.5	W3
27	8	106.376	Chorus	Jason Derulo	M	Main	S	79.8	183	185	190	423	E1	L5	48.9	W5
27	9	125.941	Post-chorus	Jason Derulo	M	Main	S	122	184	197	208	416	E1	L1	36.8	W1
27	10	135.751	Verse3	Nicki Minaj	F	Feat	R	146	177	193	215	422	E4	L2	56.5	W3
27	11	165.164	Pre-chorus	Jason Derulo	M	Main	S	208	413	495	555	828	E1	L2	83.4	W3
27	12	175.03	Chorus	Both												
27	13	194.57	Post-chorus	Both												
27	14	218.483	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
28	1	0	Intro	DJ Khaled	M	Neither	R	113	317	361	381	430	E2	L1	48.2	W3
28	2	9.91423	Verse1	Rihanna	F	Neither	S	128	175	194	206	317	E2	L1	56.4	W2
28	3	29.5204	Chorus	Rihanna	F	Neither	S	128	232	251	313	396	E4	L2	62.2	W4
28	4	44.156	Post-chorus													
28	5	53.9487	Verse2	Rihanna	F	Neither	S	146	188	205	234	317	E4	L1	54.4	W4
28	6	73.5224	Chorus	Rihanna	F	Neither	S	188	234	258	313	396	E4	L3	60.3	W4
28	7	88.256	Post-chorus													
28	8	97.9861	Verse3	Bryson Tiller	M	Neither	R	114	190	196	212	554	E3	L1	53.4	W3
28	9	151.955	Chorus	Rihanna	F	Neither	S	193	234	259	315	396	E4	L3	58.5	W4
28	10	166.647	Outro	All												
28	11	204.176	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
29	1	0	Intro	Sean Paul	M	Feat	R	172	212	219	245	426	E4	L1	69.2	W3
29	2	11.7849	Verse1	Sia	F	Main	S	208	272	327	332	438	E1	L3	58.9	W4
29	3	22.5579	Pre-chorus	Sia	F	Main	S	241	328	410	433	490	E1	L5	54.6	W5
29	4	33.0597	Chorus	Both												
29	5	65.0729	Verse2	Sia	F	Main	S	232	277	328	335	419	E1	L5	55.8	W5
29	6	75.7387	Pre-chorus	Sia	F	Main	S	246	329	408	433	553	E1	L5	55.5	W5
29	7	86.4193	Chorus	Both												
29	8	118.423	Verse3	Sean Paul	M	Feat	R	136	210	220	275	749	E1	L2	65	W3
29	9	139.773	Bridge	Both												
29	10	161.031	Chorus	Both												
29	11	193.047	Outro	Sia	F	Main	S	244	276	290	327	351	E1	L5	35.2	W5
29	12	226.053	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
30	1	0	Intro													
30	2	7.80792	Verse1	Nick Jonas	M	Main	S	167	225	266	323	446	E2	L1	58.2	W4
30	3	38.8465	Pre-chorus	Nick Jonas	M	Main	S	149	222	281	410	503	E4	L1	92.9	W4
30	4	52.232	Chorus	Nick Jonas	M	Main	S	251	430	441	491	564	E4	L4	48.8	W5
30	5	83.3686	Verse2	Tove Lo	F	Feat	S	171	220	245	276	483	E4	L1	43	W4
30	6	114.35	Pre-chorus	Tove Lo	F	Feat	S	175	220	268	378	498	E4	L1	84.6	W4
30	7	127.832	Chorus	Both												
30	8	158.866	Bridge	Both												
30	9	183.608	Chorus	Both												
30	10	230.095	Outro													
30	11	237.674	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
31	1	0	Intro													
31	2	2.67131	Verse1	Justin Bieber	M	Neither	S	133	223	264	280	375	E2	L1	67.3	W3
31	3	23.422	Pre-chorus	Justin Bieber	M	Neither	S	147	222	248	279	418	E1	L1	56.8	W1
31	4	46.6249	Chorus	Justin Bieber	M	Neither	S	162	219	246	251	287	E1	L3	46.3	W2
31	5	67.3007	Verse2	Justin Bieber	M	Neither	S	163	249	277	284	376	E2	L1	43.6	W3
31	6	87.9352	Pre-chorus	Justin Bieber	M	Neither	S	162	224	249	328	420	E1	L3	68.6	W3
31	7	111.149	Chorus	Justin Bieber	M	Neither	S	182	220	246	276	337	E1	L5	49.4	W2
31	8	131.769	Bridge	MO	F	Neither	S	177	272	281	367	559	L4	L3	45.7	W5
31	9	152.406	Chorus	Both												
31	10	173.102	Outro	Justin Bieber	M	Neither	S	176	218	220	221	281	E2	L1	64.2	W4
31	11	184.907	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
32	1	0	Intro	Yo Gotti	M	Main	R	118	173	183	190	235	E2	L1	70	W3
32	2	18.8009	Chorus	Yo Gotti	M	Main	R	139	175	187	195	331	E2	L1	37.8	W3
32	3	31.3983	Verse1	Yo Gotti	M	Main	R	103	176	189	212	585	E2	L1	38.2	W1
32	4	57.2386	Chorus	Yo Gotti	M	Main	R	146	179	185	192	204	E2	L1	36.3	W3
32	5	80.1604	Verse2	Nicki Minaj	F	Feat	R	113	163	176	184	231	E1	L1	46.3	W1
32	6	131.742	Chorus	Yo Gotti	M	Main	R	138	178	188	197	213	E2	L1	40.1	W3
32	7	144.284	Verse3	Nicki Minaj	F	Feat	R	116	164	196	217	338	E2	L1	32	W3
32	8	207.032	Chorus	Yo Gotti	M	Main	R	150	177	187	195	213	E2	L1	38.6	W3
32	9	219.607	Outro	Yo Gotti	M	Main	R	131	178	186	195	264	E2	L1	36.4	W3
32	10	259.079	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
33	1	0	Verse1	Olivia O'Brien	F	Feat	S	180	227	248	271	335	E4	L1	82.9	W4
33	2	23.5922	Chorus	Olivia O'Brien	F	Feat	S	102	246	261	288	337	E4	L1	45	W4
33	3	46.8082	Verse2	Gnash	M	Main	S	96.5	123	135	139	284	E1	L1	35.7	W1
33	4	130.492	Chorus	Both												
33	5	153.896	Bridge	Both												
33	6	198.229	Chorus	Olivia O'Brien	F	Feat	S	179	246	262	286	337	E4	L1	81.2	W4
33	7	227.028	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
34	1	0	Intro	Both												
34	2	17.2531	Verse1	Camila Cabello	F	Neither	S	194	247	264	294	350	E3	L1	69.2	W3
34	3	36.2367	Pre-chorus	Both												
34	4	50.8726	Chorus	Both												
34	5	67.8431	Post-chorus	Both												
34	6	86.7276	Verse2	Shawn Mendes	M	Neither	S	191	260	289	297	395	E3	L1	68.6	W3
34	7	103.565	Pre-chorus	Both												
34	8	118.298	Chorus	Both												
34	9	135.135	Bridge	Both												
34	10	185.703	Chorus	Both												
34	11	228.247	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
35	1	0	Intro													
35	2	9.60583	Chorus	Bebe Rexha	F	Neither	S	139	352	391	439	631	E4	L1	74.5	W4
35	3	26.6645	Verse1	G-Eazy	M	Neither	R	139	210	220	229	586	E1	L1	41.8	W1
35	4	61.1041	Chorus	Bebe Rexha	F	Neither	S	294	353	390	434	639	E4	L1	74.5	W4
35	5	78.0632	Post-chorus	Bebe Rexha	F	Neither	S	142	310	343	387	639	E4	L1	32.7	W4
35	6	95.1938	Verse2	G-Eazy	M	Neither	R	129	200	208	216	495	E1	L1	42.9	W1
35	7	129.554	Chorus	Bebe Rexha	F	Neither	S	296	353	390	424	643	E4	L1	76.7	W4
35	8	146.649	Post-chorus	Bebe Rexha	F	Neither	S	111	310	350	395	647	E4	L1	30.9	W4
35	9	183.185	Bridge	G-Eazy	M	Neither	R	111	188	200	210	448	E1	L1	33.7	W1
35	10	198.101	Chorus	Bebe Rexha	F	Neither	S	294	352	390	425	648	E4	L1	83.9	W4
35	11	215.211	Post-chorus	Bebe Rexha	F	Neither	S	206	310	351	396	746	E4	L1	31.2	W4
35	12	254.428	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
36	1	0	Verse1	Zara Larsson	F	Neither	S	170	248	300	340	458	E2	L1	73.4	W4
36	2	28.7289	Chorus	Zara Larsson	F	Neither	S	168	294	332	440	507	E1	L4	38.1	W5
36	3	54.9826	Post-chorus	Zara Larsson	F	Neither	S	166	304	339	604	717	E4	L3	19.3	W3
36	4	81.3816	Verse2	MNEK	M	Neither	S	166	255	333	375	559	E3	L2	44.9	W4
36	5	107.555	Chorus	Zara Larsson	F	Neither	S	217	296	337	443	508	E1	L5	37.4	W5
36	6	133.896	Bridge	Both												
36	7	160.164	Chorus	Zara Larsson	F	Neither	S	147	330	376	448	599	E1	L5	50.7	W5
36	8	186.468	Post-chorus	Both												
36	9	218.158	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
37	1	0	Intro	Kyla	F	Feat	S	182	231	276	315	397	E3	L2	41.6	W4
37	2	11.6168	Verse1	Drake	M	Main	S	113	155	157	185	216	E1	L1	39.9	W2
37	3	30.0693	Chorus	Drake	M	Main	S	135	153	173	175	236	E1	L1	33.9	W2
37	4	48.5044	Post-chorus	Kyla	F	Feat	S	155	230	276	319	396	E3	L2	42.8	W4
37	5	57.7345	Verse2	Drake	M	Main	S	116	139	143	156	210	E1	L1	35.7	W2
37	6	76.196	Chorus	Drake	M	Main	S	130	153	172	175	249	E1	L1	36.4	W2
37	7	94.6805	Bridge	Wizkid	M	Feat	S	231	260	263	275	311	E1	L1	12.3	W2
37	8	113.127	Bridge2	Both												
37	9	150.011	Chorus	Drake	M	Main	S	131	155	174	175	237	E1	L1	37.8	W2
37	10	175.015	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
38	1	0	Intro	Drake	M	Main	S	139	145	149	165	189	E4	L1	27.5	W3
38	2	24.5023	Verse1	Drake	M	Main	S	112	148	165	181	221	E1	L1	37.1	W2
38	3	56.9866	Pre-chorus	Drake	M	Main	S	108	137	146	166	207	E2	L1	35.8	W2
38	4	73.3352	Chorus	Drake	M	Main	S	104	124	138	164	323	E1	L1	35.8	W2
38	5	89.567	Verse2	Rihanna	F	Feat	S	206	296	334	366	408	E1	L1	35.3	W2
38	6	105.875	Pre-chorus	Rihanna	F	Feat	S	209	276	294	333	411	E2	L1	35.3	W2
38	7	122.156	Chorus	Both												
38	8	138.442	Verse3	Drake	M	Main	S	108	147	165	186	297	E1	L1	37.8	W2
38	9	187.176	Chorus	Both												
38	10	203.563	Outro	Popcaan	M											
38	11	263.681	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
39	1	0	Chorus	Charlie Puth	M	Main	S	259	323	369	412	559	E1	L1	75	W1
39	2	21.0519	Verse1	Charlie Puth	M	Main	S	205	332	369	376	495	E3	L1	40	W3
39	3	40.2773	Pre-chorus	Charlie Puth	M	Main	S	185	269	314	367	444	E2	L2	52.3	W3
39	4	59.4319	Chorus	Charlie Puth	M	Main	S	264	318	369	412	564	E1	L3	38	W3
39	5	78.6439	Verse2	Selena Gomez	F	Feat	S	240	336	370	389	559	E4	L3	46.9	W3
39	6	97.8447	Pre-chorus	Selena Gomez	F	Feat	S	186	276	325	364	556	E3	L2	50.8	W3
39	7	117.045	Chorus	Both												
39	8	136.278	Bridge													
39	9	155.471	Pre-chorus	Both												
39	10	174.724	Chorus	Both												
39	11	193.873	Outro	Both												
39	12	217.713	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
40	1	0	Intro													
40	2	10.8507	Chorus	Rihanna	F	Main	S	190	249	276	308	376	E4	L1	60.2	W3
40	3	26.5158	Verse1	Rihanna	F	Main	S	175	248	278	311	422	E4	L1	57.7	W3
40	4	68.257	Chorus	Rihanna	F	Main	S	190	249	276	308	376	E4	L1	53.3	W3
40	5	86.6034	Verse2	Rihanna	F	Main	S	186	276	313	364	428	E4	L1	59	W3
40	6	115.334	Chorus	Rihanna	F	Main	S	139	248	276	308	379	E4	L3	65.5	W4
40	7	130.828	Verse3	Drake	M	Feat	S	112	138	154	165	216	E1	L1	56.3	W1
40	8	183.009	Chorus	Both												
40	9	198.652	Outro	Rihanna	F	Main	S	183	247	274	277	313	E4	L2	26.3	W3
40	10	216.138	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
41	1	0	Verse1	Rihanna	F	Neither	S	173	297	337	370	1317	E3	L1	78.1	W3
41	2	28.0024	Chorus	Rihanna	F	Neither	S	207	293	329	361	484	E1	L5	64.9	W5
41	3	46.7632	Verse2	Kanye West	M	Neither	S	144	219	225	291	418	E1	L3	73.1	W3
41	4	65.2834	Chorus	Both												
41	5	84.0191	Bridge	Rihanna	F	Neither	S	182	290	339	441	692	E1	L1	73.7	W2
41	6	121.889	Verse3	Both												
41	7	149.187	Chorus	Both												
41	8	191.745	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
42	1	0	Intro													
42	2	12.423	Chorus	Chris Brown	M	Feat	S	144	187	296	368	741	E2	L1	50	W4
42	3	49.7083	Verse1	Meek Mill	M	Main	R	184	277	292	309	401	E2	L2	59.1	W3
42	4	86.7752	Chorus	Chris Brown	M	Feat	S	138	185	288	332	741	E2	L1	38.3	W4
42	5	124.019	Verse2	Nicki Minaj	F	Feat	R	166	237	268	299	742	E1	L2	48.5	W3
42	6	173.57	Chorus	Both												
42	7	198.267	Outro	Both												
42	8	234.366	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
43	1	0	Intro													
43	2	38.0894	Chorus	Taylor Swift	F	Main	S	226	249	330	433	603	E4	L4	90	W5
43	3	48.685	Verse1	Kendrick Lamar	M	Feat	R	140	252	276	298	596	E1	L2	31.9	W4
43	4	71.2858	Pre-chorus	Taylor Swift	F	Main	S	303	391	437	491	609	E4	L1	52.7	W4
43	5	83.2949	Chorus	Taylor Swift	F	Main	S	222	267	331	448	645	E4	L5	31	W5
43	6	105.112	Verse2	Kendrick Lamar	M	Feat	R	153	263	276	293	397	E1	L3	41.1	W4
43	7	127.757	Pre-chorus	Taylor Swift	F	Main	S	308	393	442	507	639	E4	L1	45.2	W4
43	8	139.769	Chorus	Taylor Swift	F	Main	S	224	296	390	451	599	E4	L5	31.6	W5
43	9	161.57	Bridge	Taylor Swift	F	Main	S	241	377	393	440	511	E1	L3	77.3	W5
43	10	187.788	Chorus	Taylor Swift	F	Main	S	223	315	439	494	663	E4	L5	32.8	W5
43	11	244.896	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
44	1	0	Intro													
44	2	11.7685	Verse1	Selena Gomez	F	Main	S	172	299	312	348	462	E4	L1	87.9	W4
44	3	33.3134	Pre-chorus	Selena Gomez	F	Main	S	256	311	323	350	406	E2	L1	86.9	W4
44	4	44.0758	Chorus	Selena Gomez	F	Main	S	256	315	348	351	431	E4	L3	79.6	W4
44	5	65.6724	Verse2	Selena Gomez	F	Main	S	178	296	311	322	443	E4	L1	51.8	W4
44	6	87.2405	Pre-chorus	Selena Gomez	F	Main	S	230	310	318	350	407	E4	L1	62.7	W4
44	7	97.9728	Chorus	Selena Gomez	F	Main	S	230	311	321	350	425	E4	L3	48.4	W4
44	8	130.383	Bridge	Selena Gomez	F	Main	S	192	310	312	340	625	E4	L1	76.1	W4
44	9	141.073	Verse3	A$AP Rocky	M	Feat	R	111	174	191	201	315	E1	L1	37.1	W2
44	10	184.301	Chorus	Selena Gomez	F	Main	S	230	312	342	350	417	E4	L4	50.7	W4
44	11	205.949	Outro													
44	12	220.701	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
45	1	0	Intro													
45	2	10.0568	Verse1	Ty Dolla $ign	M	Neither	R	142	193	231	265	479	E1	L3	42.1	W4
45	3	68.8319	Verse2	MO	F	Neither	S	215	275	351	394	482	E4	L2	55.5	W4
45	4	88.3714	Chorus	MO	F	Neither	S	280	351	389	442	565	E1	L5	36.2	W5
45	5	107.995	Post-chorus													
45	6	132.441	Bridge													
45	7	152.049	Chorus	MO	F	Neither	S	229	386	411	463	569	E1	L5	36.9	W5
45	8	171.797	Outro	MO	F	Neither	S	260	351	392	465	537	E4	L1	98.3	W5
45	9	179.056	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
46	1	0	Verse1	Meghan Trainor	F	Neither	S	176	261	293	326	531	E1	L2	71.3	W1
46	2	44.0315	Chorus	Meghan Trainor	F	Neither	S	151	302	339	411	542	E1	L2	51.2	W3
46	3	84.0449	Verse2	John Legend	M	Neither	S	128	265	295	327	540	E1	L2	64	W1
46	4	123.984	Chorus	Both												
46	5	163.967	Bridge	Both												
46	6	190.623	Chorus	Both												
46	7	228.677	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
47	1	0	Verse1	Ariana Grande	F	Neither	S	222	302	332	370	504	E3	L1	54.5	W4
47	2	42.1492	Chorus	Ariana Grande	F	Neither	S	269	334	371	492	674	E3	L3	38.3	W5
47	3	71.3068	Verse2	The Weeknd	M	Neither	S	231	284	331	370	550	E4	L1	43.6	W4
47	4	110.061	Chorus	Ariana Grande	F	Neither	S	264	334	370	490	688	E3	L3	42.7	W5
47	5	148.889	Bridge	Both												
47	6	168.223	Chorus	Ariana Grande	F	Neither	S	164	332	369	412	561	E3	L5	44.3	W5
47	7	207.023	Outro	Ariana Grande	F	Neither	S	275	363	371	414	664	E1	L5	44.5	W5
47	8	236.095	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
48	1	0	Chorus	Charlie Puth	M	Main	S	188	329	366	391	441	E1	L1	69.1	W2
48	2	20.2175	Verse1	Charlie Puth	M	Main	S	136	185	205	237	280	E1	L1	46	W2
48	3	37.6214	Pre-chorus	Charlie Puth	M	Main	S	225	328	367	373	444	E1	L2	50.7	W4
48	4	55.0608	Chorus	Both												
48	5	87.795	Verse2	Meghan Trainor	F	Feat	S	82.5	339	410	492	718	E2	L1	42.1	W4
48	6	107.433	Pre-chorus	Both												
48	7	124.931	Bridge	Both												
48	8	142.437	Chorus	Both												
48	9	172.906	Outro	Both												
48	10	190.46	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
49	1	0	Intro													
49	2	9.04431	Verse1	Nicki Minaj	F	Main	R	130	206	221	239	369	E2	L1	46.1	W4
49	3	73.0853	Chorus	Chris Brown	M	Feat	S	142	272	286	311	372	E2	L2	87	W4
49	4	105.15	Verse2	Drake	M	Feat	R	110	170	190	209	328	E1	L1	50.2	W2
49	5	169.113	Chorus	Chris Brown	M	Feat	S	119	273	293	311	372	E2	L2	86.2	W4
49	6	201.141	Verse3	Lil Wayne	M	Feat	R	82.4	184	209	234	465	E2	L1	50.9	W4
49	7	265.111	Chorus	Chris Brown	M	Feat	S	200	275	301	312	496	E2	L1	77.1	W4
49	8	310.33	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
50	1	0	Intro	All												
50	2	10.1326	Chorus	Omarion	M	Main	S	82.2	155	174	205	235	E2	L1	54.6	W3
50	3	39.5202	Verse1	Omarion	M	Main	S	68.7	155	173	180	621	E3	L2	55.1	W3
50	4	69.124	Chorus	Omarion	M	Main	S	62.8	155	174	206	238	E2	L3	48.7	W5
50	5	98.6498	Verse2	Chris Brown	M	Feat	S	104	175	279	312	426	E2	L2	56	W3
50	6	128.165	Verse3	Jhene Aiko	F	Feat	S	151	278	347	409	508	E5	L2	50	W3
50	7	157.741	Chorus	All												
50	8	187.319	Bridge	All												
50	9	206.988	Outro	All												
50	10	226.575	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
51	1	0	Intro													
51	2	4.62169	Chorus	Jeremih	M	Main	S	166	261	289	327	399	E3	L1	39.7	W3
51	3	22.8789	Verse1	Natalie La Rose	F	Main	S	252	293	297	332	445	E3	L1	36.8	W3
51	4	41.1813	Pre-chorus	Natalie La Rose	F	Main	S	195	261	290	299	353	E3	L4	34.9	W5
51	5	59.5005	Chorus	Jeremih	M	Feat	S	166	261	293	328	582	E3	L1	33.3	W3
51	6	77.7517	Verse2	Natalie La Rose	F	Main	S	243	293	299	358	446	E3	L1	35.8	W3
51	7	95.99	Pre-chorus	Natalie La Rose	F	Main	S	211	261	291	310	352	E3	L4	33.8	W5
51	8	114.283	Chorus	Jeremih	M	Feat	S	166	261	292	328	583	E3	L2	33.8	W3
51	9	132.562	Bridge	Natalie La Rose	F	Main	S	216	277	292	298	336	E1	L3	29.7	W5
51	10	150.912	Pre-chorus	Natalie La Rose	f	Main	S	202	260	291	312	353	E3	L4	34.8	W5
51	11	169.13	Chorus	Jeremih	M	Feat	S	194	261	292	328	398	E3	L2	34.3	W3
51	12	199.524	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
52	1	0	Chorus													
52	2	18.281	Verse1	Drake	M	Feat	R	122	172	184	193	288	E1	L1	45.1	W1
52	3	63.9378	Chorus													
52	4	82.2325	Verse2	Nicki Minaj	F	Main	R	135	239	257	278	350	E1	L1	39.9	W1
52	5	123.309	Chorus													
52	6	141.654	Verse3	Lil Wayne	M	Feat	R	150	229	263	285	427	E1	L1	51.4	W1
52	7	187.199	Chorus													
52	8	218.657	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
53	1	0	Intro													
53	2	5.63585	Verse1	Tinashe	F	Main	S	178	228	276	330	427	E3	L1	86.3	W4
53	3	24.6143	Pre-chorus	Tinashe	F	Main	S	143	247	271	337	672	E3	L2	62.6	W4
53	4	43.6232	Chorus	Tinashe	F	Main	S	181	247	274	285	669	E3	L3	35.5	W4
53	5	81.7046	Verse2	Tinashe	F	Main	S	181	227	276	328	455	E3	L1	45.2	W4
53	6	100.639	Pre-chorus	Tinase	F	Main	S	181	246	261	356	664	E3	L2	46.3	W4
53	7	119.727	Chorus	Tinashe	F	Main	S	145	247	255	284	597	E3	L3	43	W4
53	8	148.87	Verse3	ScHoolboy Q	M	Feat	R	136	178	193	203	273	E2	L3	50.2	W4
53	9	176.72	Bridge	Tinashe	F	Main	S	172	247	276	279	375	E3	L5	53.3	W4
53	10	195.731	Chorus	Tinashe	F	Main	S	181	247	261	286	382	E3	L3	39.4	W4
53	11	231.695	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
54	1	0	Intro													
54	2	13.8804	Chorus	Miley Cyrus	F	Neither	R	105	111	118	124	307	E2	L4	25.9	W5
54	3	27.5567	Post-chorus	Juicy J	M	Neither	R	176	272	313	325	338	E1	L4	23.8	W5
54	4	41.3019	Verse1	Miley Cyrus	F	Neither	R	156	220	251	292	587	E2	L3	36.7	W4
54	5	68.7144	Pre-chorus	Miley Cyrus	F	Neither	S	108	217	221	232	253	E1	L4	29.9	W5
54	6	82.4464	Chorus	Miley Cyrus	F	Neither	R	106	114	118	124	184	E2	L4	26.7	W5
54	7	96.1308	Post-chorus	Juicy J	M	Neither	R	172	184	190	209	361	E1	L4	26.8	W5
54	8	109.817	Verse2	Wiz Khalifa	M	Neither	R	101	200	208	213	332	E1	L1	36.2	W3
54	9	137.268	Pre-chorus	Miley Cyrus	F	Neither	S	110	216	220	232	267	E1	L4	31.1	W5
54	10	151.027	Chorus	Miley Cyrus	F	Neither	R	103	112	118	124	336	E2	L4	26.3	W5
54	11	164.707	Post-chorus	Juicy J	M	Neither	R	152	181	189	315	338	E1	L4	27.2	W5
54	12	178.424	Verse3	Juicy J	M	Neither	R	148	184	190	196	338	E1	L3	36.6	W5
54	13	205.863	Pre-chorus	Miley Cyrus	F	Neither	S	108	216	221	232	266	E1	L4	28.7	W5
54	14	219.569	Chorus	Miley Cyrus	F	Neither	R	105	112	118	124	296	E2	L4	26.2	W5
54	15	233.292	Post-chorus	Juicy J	M	Neither	R	61.6	208	216	304	338	E1	L3	25.1	W5
54	16	252.527	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
55	1	0	Intro	Juicy J	M	Feat	R	114	198	253	261	324	E1	L1	88	W1
55	2	19.8621	Verse1	Katy Perry	F	Main	S	205	272	312	339	478	E2	L2	33	W4
55	3	48.9226	Pre-chorus	Katy Perry	F	Main	S	226	269	337	402	460	E4	L1	60	W4
55	4	65.3184	Chorus	Katy Perry	F	Main	S	210	464	472	529	621	E1	L4	55.1	W5
55	5	77.938	Verse2	Katy Perry	F	Main	S	160	253	311	334	472	E2	L2	32.5	W4
55	6	114.431	Pre-chorus	Katy Perry	F	Main	S	128	260	283	411	425	E4	L3	55.5	W4
55	7	130.723	Chorus	Katy Perry	F	Main	S	208	463	474	536	912	E1	L4	52	W5
55	8	143.429	Verse3	Juicy J	M	Feat	R	135	193	199	205	571	E2	L3	35.3	W4
55	9	187.151	Pre-chorus	Katy Perry	F	Main	S	177	276	348	413	547	E4	L5	45.3	W4
55	10	203.457	Chorus	Katy Perry	F	Main	S	113	348	459	472	561	E1	L5	38.3	W5
55	11	224.996	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
56	1	0	Intro	Both												
56	2	19.8841	Verse1	Lady Gaga	F	Main	S	175	330	369	416	581	E3	L1	55.4	W4
56	3	39.6147	Pre-chorus	Lady Gaga	F	Main	S	176	287	371	418	662	E1	L3	79.2	W5
56	4	59.2968	Chorus	Lady Gaga	F	Main	S	246	329	369	415	578	E1	L2	46.4	W5
56	5	79.0034	Verse2	R. Kelly	M	Feat	S	109	244	251	279	505	E2	L1	71.2	W4
56	6	108.504	Pre-chorus	R. Kelly	M	Feat	S	207	271	326	366	575	E1	L3	74.5	W5
56	7	128.163	Chorus	Lady Gaga	F	Main	S	246	367	423	449	675	E1	L5	61.3	W5
56	8	147.954	Bridge	Lady Gaga	F	Main	S	176	307	362	437	732	E1	L3	77.2	W4
56	9	172.477	Chorus	Lady Gaga	F	Main	S	123	332	376	445	675	E1	L5	61.5	W5
56	10	192.215	Outro	Lady Gaga	F	Main	S	235	331	483	524	667	E1	L5	58.5	W4
56	11	224.903	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
57	1	0	Intro													
57	2	69.935	Verse1	Beyoncé	F	Main	S	144	216	243	262	415	E3	L1	45	W3
57	3	125.696	Pre-chorus	Beyoncé	F	Main	S	175	312	396	464	565	E3	L1	51.5	W3
57	4	153.001	Chorus	Beyoncé	F	Main	S	245	518	528	546	564	E3	L1	31	W3
57	5	166.765	Verse2	Beyoncé	F	Main	R	171	246	261	273	340	E3	L2	44.1	W3
57	6	207.876	Pre-chorus	Beyoncé	F	Main	S	219	312	409	475	559	E3	L2	42.1	W3
57	7	235.485	Chorus	Beyoncé	F	Main	S	273	475	527	544	565	E3	L1	31.2	W3
57	8	248.977	Verse3	Jay-Z	M	Feat	R	170	237	248	258	523	E1	L1	28.4	W1
57	9	303.951	Chorus	Beyoncé	F	Main	S	179	468	526	544	598	E3	L1	31.1	W3
57	10	317.657	Bridge	Beyoncé	F	Main	S	128	235	261	303	503	E3	L1	59.1	W3
57	11	351.86	Chorus	Beyoncé	F	Main	S	300	465	526	546	622	E3	L1	26	W3
57	12	372.509	Outro													
57	13	381.522	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
58	1	0	Intro													
58	2	11.323	Chorus	T.I.	M	Main	R	115	154	165	169	212	E1	L4	41.9	W5
58	3	31.3895	Verse1	T.I.	M	Main	R	84	140	149	159	213	E1	L3	34	W3
58	4	61.5683	Chorus	T.I.	M	Main	R	111	153	165	169	262	E1	L4	42.8	W5
58	5	81.6435	Verse2	Iggy Azalea	F	Feat	R	148	239	250	261	357	E2	L1	36.2	W3
58	6	111.814	Chorus	T.I.	M	Main	R	115	154	165	169	211	E1	L4	42.4	W5
58	7	131.916	Verse3	T.I.	M	Main	R	83.6	134	140	145	187	E1	L3	34.9	W3
58	8	172.141	Chorus	T.I.	M	Main	R	115	153	165	168	207	E1	L4	41.4	W5
58	9	192.272	Outro													
58	10	202.38	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
59	1	0	Chorus	Rihanna	F	Feat	S	166	329	372	419	678	E5	L1	89	W4
59	2	19.2272	Verse1	Eminem	M	Main	R	113	182	202	238	725	E1	L1	62	W1
59	3	54.0859	Chorus	Rihanna	F	Feat	S	272	334	410	426	669	E5	L1	50.6	W4
59	4	71.5255	Post-chorus	Rihanna	F	Feat	S	170	438	557	746	947	E1	L3	41.3	W5
59	5	88.9276	Verse2	Eminem	M	Main	R	88.4	192	248	314	497	E1	L3	71.5	W3
59	6	123.863	Chorus	Rihanna	F	Feat	S	272	333	410	427	670	E5	L1	50.9	W4
59	7	141.297	Post-chorus	Rihanna	F	Feat	S	184	417	494	728	990	E1	L3	39.4	W5
59	8	158.777	Verse3	Eminem	M	Main	R	136	233	267	299	497	E1	L1	65.7	W1
59	9	195.871	Chorus	Rihanna	F	Feat	S	253	330	373	418	670	E5	L1	92.3	W4
59	10	213.321	Bridge	Both												
59	11	230.767	Outro	Rihanna	F	Feat	S	273	432	552	733	1040	E1	L3	38.9	W5
59	12	252.268	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
60	1	0	Intro													
60	2	9.20653	Chorus	Ke$ha	F	Feat	S	203	248	278	311	498	E1	L3	81.6	W1
60	3	24.0213	Post-chorus	Ke$ha	F	Feat	S	242	281	369	417	501	E1	L3	80.5	W1
60	4	38.7059	Verse1	Pitbull	M	Main	R	176	245	261	270	315	E1	L3	43.7	W1
60	5	53.4703	Pre-chorus	Pitbull	M	Main	R	128	179	198	373	589	E1	L4	43.4	W1
60	6	68.2184	Chorus	Ke$ha	F	Feat	S	135	249	284	370	634	E1	L3	65.2	W1
60	7	97.7936	Post-chorus	Ke$ha	F	Feat	S	239	281	373	490	824	E1	L3	45.3	W1
60	8	112.544	Verse2	Pitbull	M	Main	R	178	250	263	276	549	E1	L3	40.5	W1
60	9	127.256	Pre-chorus	Pitbull	M	Main	R	149	181	245	417	645	E1	L4	42.6	W1
60	10	142.084	Chorus	Ke$ha	F	Feat	S	204	250	296	372	647	E1	L5	68.1	W1
60	11	171.719	Outro	Both												
60	12	214.088	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
61	1	0	Intro	Both												
61	2	18.6509	Verse1	Miguel	M	Feat	S	137	201	247	260	324	E4	L1	57	W3
61	3	54.5718	Chorus	Miguel	M	Feat	S	151	189	207	246	317	E1	L3	58.1	W4
61	4	90.4861	Verse2	Mariah Carey	F	Main	S	161	266	328	367	455	E1	L2	64.7	W4
61	5	108.38	Chorus	Both												
61	6	162.236	Outro	Both												
61	7	214.988	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
62	1	0	Intro	Wale	M	Main	R	101	120	221	275	308	E2	L1	66.7	W3
62	2	33.7662	Chorus	Rihanna	F	Feat	S	140	242	250	268	304	E3	L2	59.2	W4
62	3	75.8624	Verse1	Wale	M	Main	R	118	196	217	233	292	E3	L1	69.9	W3
62	4	117.858	Chorus	Rihanna	F	Feat	S	80.2	243	249	260	306	E3	L2	53	W4
62	5	152.203	Verse1	Wale	M	Main	R	97.9	166	190	200	296	E2	L2	70.9	W3
62	6	202.142	Chorus	Rihanna	F	Feat	S	165	245	250	273	359	E3	L2	64.2	W4
62	7	238.847	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
63	1	0	Intro	Nicki Minaj	F	Feat	R	192	274	289	291	332	E2	L1	45.6	W3
63	2	15.6808	Verse1	Justin Bieber	M	Main	S	214	258	261	263	337	E2	L1	39.1	W3
63	3	30.6063	Pre-chorus	Justin Bieber	M	Main	S	250	288	294	328	362	E1	L2	37.7	W4
63	4	45.6186	Chorus	Justin Bieber	M	Main	S	222	294	331	386	405	E3	L3	42.5	W4
63	5	77.4791	Post-chorus													
63	6	90.5926	Verse2	Justin Bieber	M	Main	S	220	259	262	286	349	E2	L1	35.2	W3
63	7	105.581	Pre-chorus	Justin Bieber	M	Main	S	226	290	294	328	400	E1	L3	35.9	W4
63	8	120.579	Chorus	Justin Bieber	M	Main	S	223	293	331	386	405	E3	L3	43.8	W4
63	9	150.613	Bridge	Nicki Minaj	F	Feat	R	159	263	285	319	447	E1	L2	46.7	W3
63	10	180.692	Chorus	Justin Bieber	M	Main	S	161	293	330	365	523	E1	L5	33.5	W4
63	11	210.663	Outro													
63	12	228.328	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
64	1	0	Intro	Pitbull	M	Main	R	128	152	158	166	291	E1	L1	78.9	W1
64	2	14.0661	Chorus	Christina Aguilera	F	Feat	S	248	328	380	441	680	E3	L2	81.2	W4
64	3	42.4245	Post-chorus													
64	4	70.64	Verse1	Pitbull	M	Main	R	161	238	246	253	628	E1	L4	44.6	W5
64	5	98.7812	Chorus	Christina Aguilera	F	Feat	S	252	328	375	441	704	E3	L3	79.5	W4
64	6	127.073	Post-chorus													
64	7	141.208	Verse2	Pitbull	M	Main	R	133	218	238	252	691	E1	L4	43.5	W5
64	8	169.413	Chorus	Christina Aguilera	F	Feat	S	233	328	386	441	639	E3	L3	77.8	W4
64	9	197.716	Post-chorus													
64	10	211.787	Outro	Christina Aguilera	F	Feat	S	264	307	389	441	531	E3	L3	54.7	W4
64	11	229.513	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
65	1	0	Intro													
65	2	27.8577	Verse1	Tim McGraw	M	Main	S	105	148	166	185	331	E1	L1	63.8	W2
65	3	52.1914	Pre-chorus	Taylor Swift	F	Feat	S	273	342	369	373	466	E3	L1	50.6	W4
65	4	64.2785	Chorus	Tim McGraw	M	Main	S	189	324	332	369	490	E1	L3	52.3	W5
65	5	91.6314	Verse2	Both												
65	6	115.971	Pre-chorus	Taylor Swift	F	Feat	S	268	357	370	375	459	E3	L1	51.2	W4
65	7	128.11	Chorus	Tim McGraw	M	Main	S	200	327	333	369	494	E1	L3	49.7	W5
65	8	152.459	Solo													
65	9	176.666	Pre-chorus	Taylor Swift	F	Feat	S	263	364	371	437	498	E3	L1	52.3	W4
65	10	188.857	Bridge	Both												
65	11	237.44	Solo													
65	12	261.757	Outro													
65	13	275.616	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
66	1	0	Intro													
66	2	10.3762	Verse1	P!nk	F	Main	S	105	244	287	366	459	E1	L1	83.5	W2
66	3	50.7298	Chorus	P!nk	F	Main	S	226	336	390	439	530	E1	L1	43.1	W2
66	4	73.4676	Verse2	Nate Ruess	M	Feat	S	172	239	279	345	607	E1	L2	47.7	W2
66	5	118.893	Chorus	Both												
66	6	139.337	Bridge	Both												
66	7	164.364	Chorus	Both												
66	8	204.9	Outro													
66	9	242.504	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
67	1	0	Intro													
67	2	42.4558	Verse1	Macklemore	M	Main	R	98.1	127	137	146	471	E1	L1	62.5	W1
67	3	90.4477	Chorus	Mary Lambert	F	Feat	S	126	265	352	391	503	E1	L1	48.2	W1
67	4	124.395	Verse2	Macklemore	M	Main	R	67	137	147	155	321	E1	L1	59.4	W1
67	5	180.81	Solo													
67	6	192.154	Chorus	Mary Lambert	F	Feat	S	129	252	317	391	481	E1	L1	44.1	W1
67	7	214.729	Verse3	Macklemore	M	Main	R	97.3	127	135	142	471	E1	L1	67.4	W1
67	8	248.596	Chorus	Mary Lambert	F	Feat	S	130	265	346	391	515	E1	L1	50.8	W1
67	9	282.48	Outro	Mary Lambert	F	Feat	S	76.4	301	321	393	473	E1	L3	52	W5
67	10	318.532	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
68	1	0	Intro													
68	2	15.0356	Verse1	Britney Spears	F	Feat	S	101	151	161	179	346	E3	L4	47.3	W5
68	3	44.6283	Chorus	Both												
68	4	74.123	Post-chorus	Will.i.am	M	Main	S	61.9	247	294	327	350	E2	L1	32.7	W4
68	5	88.8588	Verse2	Will.i.am	M	Main	S	62.7	180	195	196	262	E3	L1	37.4	W5
68	6	118.362	Verse3	Both												
68	7	147.955	Chorus	Both												
68	8	177.466	Post-chorus	Will.i.am	M	Main	S	219	290	294	323	348	E2	L1	30.1	W4
68	9	192.317	Bridge	Will.i.am	M	Main	S	129	196	220	233	297	E1	L1	68.9	W2
68	10	221.762	Chorus	Both												
68	11	266.094	Outro	Both												
68	12	291.359	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
69	1	0	Intro													
69	2	17.1245	Verse1	Rihanna	F	Main	S	205	268	319	386	489	E2	L1	74.3	W4
69	3	51.4718	Pre-chorus	Rihanna	F	Main	S	169	263	291	296	349	E3	L1	79.6	W4
69	4	68.5741	Chorus	Rihanna	F	Main	S	178	262	299	329	480	E1	L1	68.2	W4
69	5	94.2838	Verse2	Mikky Ekko	M	Feat	S	204	289	319	336	444	E1	L1	74.6	W2
69	6	111.472	Pre-chorus	Mikky Ekko	M	Feat	S	191	264	291	298	340	E1	L1	77	W2
69	7	128.464	Chorus	Mikky Ekko	M	Feat	S	187	265	299	329	440	E1	L1	61.6	W2
69	8	154.214	Bridge	Both												
69	9	188.546	Chorus	Both												
69	10	222.902	Outro	Both												
69	11	247.52	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
70	1	0	Intro													
70	2	10.9952	Chorus	Ariana Grande	F	Main	S	200	207	211	214	221	E1	L3	56.5	W5
70	3	22.5675	Verse1	Mac Miller	M	Feat	R	172	209	214	221	379	E2	L1	46.7	W4
70	4	34.2084	Verse2	Ariana Grande	F	Main	S	204	408	418	469	632	E2	L1	64.6	W4
70	5	57.4671	Pre-chorus	Ariana Grande	F	Main	S	226	409	420	471	554	E2	L3	55.1	W5
70	6	74.9033	Chorus	Ariana Grande	F	Main	S	352	419	461	473	558	E1	L5	64.3	W5
70	7	86.5507	Verse3	Ariana Grande	F	Main	S	293	413	419	468	711	E2	L2	59.8	W4
70	8	109.799	Pre-chorus	Ariana Grande	F	Main	S	269	411	421	472	629	E1	L3	56.4	W5
70	9	127.281	Chorus	Ariana Grande	F	Main	S	177	420	464	481	711	E1	L5	66.5	W5
70	10	138.915	Verse4	Mac Miller	M	Feat	R	131	205	210	216	345	E1	L1	58.9	W2
70	11	162.121	Pre-chorus	Ariana Grande	F	Main	S	200	311	361	469	749	E1	L5	53.7	W5
70	12	179.663	Chorus	Ariana Grande	F	Main	S	308	451	469	529	1417	E1	L5	70.9	W5
70	13	202.95	Outro	Ariana Grande	F	Main	S	384	422	465	492	562	E2	L3	47.3	W4
70	14	231.73	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
71	1	0	Intro													
71	2	7.95206	Chorus	Lily Allen	F	Feat	S	174	229	256	262	338	E1	L1	60.9	W1
71	3	30.9059	Verse1	T-Pain	M	Main	S	149	220	233	262	350	E2	L2	59.6	W3
71	4	65.1524	Pre-chorus	T-Pain	M	Main	S	182	220	233	262	350	E2	L2	58.4	W3
71	5	76.6549	Chorus	Both												
71	6	122.333	Verse2	T-Pain	M	Main	S	168	220	236	262	440	E2	L2	53.3	W3
71	7	156.517	Pre-chorus	T-Pain	M	Main	S	194	234	262	349	612	E2	L2	44.7	W3
71	8	167.956	Chorus	Both												
71	9	213.728	Verse3	Wiz Khalifa	M	Feat	R	131	195	212	223	271	E3	L1	58.5	W3
71	10	259.437	Chorus	Both												
71	11	286.866	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
72	1	0	Intro													
72	2	9.39238	Chorus	Neon Hitch	F	Feat	S	190	234	264	337	476	E1	L3	49.5	W5
72	3	39.0187	Verse1	Travie McCoy	M	Main	R	143	199	206	213	274	E1	L2	58.3	W3
72	4	68.491	Chorus	Neon Hitch	F	Feat	S	156	233	262	307	471	E1	L3	46.1	W5
72	5	98.0081	Verse1	Travie McCoy	M	Main	R	161	201	209	216	257	E1	L2	54.3	W3
72	6	127.566	Chorus	Neon Hitch	F	Feat	S	186	234	277	345	474	E1	L3	36.7	W5
72	7	157.111	Bridge1	Travie McCoy	M	Main	R	122	171	191	234	634	E2	L1	46.4	W3
72	8	171.882	Bridge2	Neon Hitch	F	Feat	S	187	233	261	292	729	E1	L3	37.8	W4
72	9	186.625	Chorus	Neon Hitch	F	Feat	S	176	248	293	343	476	E1	L3	32.3	W5
72	10	222.22	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
73	1	0	Intro	Rihanna	F	Main	S	165	229	233	238	354	E5	L1	76.4	W4
73	2	24.3655	Verse1	Rihanna	F	Main	S	190	262	291	295	324	E5	L2	52.6	W4
73	3	36.3156	Chorus	Rihanna	F	Main	S	214	267	291	294	363	E1	L3	54.1	W5
73	4	60.3788	Verse2	Rihanna	F	Main	S	169	258	290	295	323	E5	L2	40.6	W4
73	5	72.3849	Verse3	Chris Brown	M	Feat	S	186	263	291	294	337	E5	L2	62.8	W4
73	6	96.3105	Chorus	Both												
73	7	120.377	Verse4	Chris Brown	M	Feat	R	158	171	174	175	292	E3	L3	50.4	W4
73	8	132.326	Verse5	Rihanna	F	Main	S	180	228	265	291	396	E3	L3	60.6	W4
73	9	171.338	Verse6	Chris Brown	M	Feat	S	174	262	290	293	362	E1	L2	58.4	W4
73	10	183.381	Chorus	Rihanna	F	Main	S	162	264	291	294	396	E5	L3	57	W5
73	11	207.41	Outro	Rihanna	F	Main	S	215	288	292	294	317	E5	L3	71.6	W4
73	12	218.843	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
74	1	0	Chorus	Big Sean	M	Main	R	62.7	82.7	94	103	179	E1	L2	29.9	W4
74	2	24.1568	Verse1	Big Sean	M	Main	R	79.4	99.9	120	138	615	E1	L1	30.4	W2
74	3	61.649	Chorus	Big Sean	M	Main	R	62.7	69.3	94.6	107	205	E1	L2	32.1	W4
74	4	84.143	Verse2	Nicki Minaj	F	Feat	R	157	216	237	260	881	E3	L1	47.2	W3
74	5	141.883	Chorus	Both												
74	6	165.15	Bridge	Big Sean	M	Main	R	86.1	95.8	99.3	106	128	E1	L3	31.5	W4
74	7	190.614	Chorus	Big Sean	M	Main	R	62.7	68.3	92.1	105	120	E1	L2	35.1	W4
74	8	230.859	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
75	1	0	Intro	Both												
75	2	15.3687	Verse1	Adam Young	M	Neither	S	109	169	182	230	267	E1	L2	35.5	W2
75	3	45.8489	Pre-chorus	Both												
75	4	61.053	Chorus	Both												
75	5	83.9063	Verse2	Carly Rae Jepsen	F	Neither	S	218	306	349	404	534	E1	L2	42.5	W2
75	6	99.1489	Pre-chorus	Both												
75	7	114.411	Chorus	Both												
75	8	144.883	Bridge	Both												
75	9	160.109	Chorus	Both												
75	10	190.582	Outro													
75	11	207.535	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
76	1	0	Intro													
76	2	18.654	Verse1	Gotye	M	Main	S	92.1	145	170	195	272	E1	L1	77.4	W1
76	3	48.4715	Interlude													
76	4	63.3501	Verse2	Gotye	M	Main	S	98.8	144	154	192	277	E1	L1	79.4	W1
76	5	93.1381	Chorus	Gotye	M	Main	S	251	341	384	432	538	E1	L1	57.6	W2
76	6	137.763	Interlude													
76	7	152.661	Verse3	Kimbra	F	Feat	S	269	346	386	432	527	E1	L1	72.2	W1
76	8	182.503	Chorus	Gotye	M	Main	S	110	338	382	431	529	E1	L5	65.9	W4
76	9	227.055	Outro	Both												
76	10	243.897	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
77	1	0	Intro													
77	2	15.7968	Verse1	Drake	M	Main	S	113	174	178	196	239	E2	L1	32	W3
77	3	78.6373	Chorus	Rihanna	F	Feat	S	155	197	232	237	318	E3	L1	31.9	W3
77	4	110.068	Verse2	Drake	M	Main	S	96.9	168	176	196	264	E2	L1	31.5	W3
77	5	157.199	Bridge	Gil Scott-Heron	M											
77	6	188.709	Chorus	Rihanna	F	Feat	S	163	208	233	236	317	E3	L1	30.8	W3
77	7	220.166	Outro													
77	8	248.657	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
78	1	0	Intro													
78	2	8.55844	Verse1	Nate Ruess	M	Main	S	124	175	221	236	352	E1	L1	76.4	W2
78	3	49.437	Chorus	Nate Ruess	M	Main	S	162	295	349	442	487	E1	L3	45.3	W5
78	4	90.9806	Verse2	Nate Ruess	M	Main	S	162	235	287	354	524	E1	L3	42.6	W5
78	5	111.176	Chorus	Nate Ruess	M	Main	S	190	295	349	442	488	E1	L3	36.2	W5
78	6	152.955	Bridge1	Janelle Monae	F	Feat	S	175	288	350	358	596	E1	L1	52.4	W2 (right)
78	7	173.879	Bridge2	Nate Ruess	M	Main	S	215	263	323	352	497	E1	L3	54.6	W5
78	8	194.789	Chorus	Nate Ruess	M	Main	S	160	295	349	442	489	E1	L3	46.4	W5
78	9	236.435	Outro	Nate Ruess	M	Main	S	118	146	151	174	224	E1	L1	84.4	W2
78	10	252.256	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
79	1	0	Intro	Both												
79	2	30.9332	Verse1	Havana Brown	F	Main	S	194	246	248	262	353	E1	L3	30.4	W4
79	3	61.1483	Chorus	Havana Brown	F	Main	S	186	218	219	221	286	E1	L1	35.5	W2
79	4	87.5751	Post-chorus													
79	5	102.768	Verse2	Pitbull	M	Feat	R	115	237	253	265	552	E1	L3	42	W4
79	6	132.823	Chorus	Havana Brown	F	Main	S	184	218	220	570	729	E1	L1	35.2	W2
79	7	159.384	Post-chorus													
79	8	174.54	Verse3	Havana Brown	F	Main	S	186	245	248	262	349	E1	L3	29.8	W4
79	9	204.781	Chorus	Havana Brown	F	Main	S	184	217	219	221	241	E1	L2	38.8	W2
79	10	237.872	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
80	1	0	Chorus	Sia	F	Feat	S	185	349	391	410	657	E2	L1	70	W4
80	2	31.2908	Verse1	Flo Rida	M	Main	R	162	230	237	244	399	E1	L3	41.8	W5
80	3	61.5918	Chorus	Sia	F	Feat	S	235	350	391	409	633	E2	L3	49.8	W4
80	4	91.7666	Verse2	Flo Rida	M	Main	R	122	206	215	241	312	E1	L3	45.6	W5
80	5	123.923	Chorus	Sia	F	Feat	S	183	350	391	399	616	E2	L5	34.9	W4
80	6	154.198	Bridge1	Sia	F	Feat	S	132	260	268	311	421	E1	L3	55.9	W4
80	7	169.263	Bridge2	Flo Rida	M	Main	S	155	197	208	209	265	E1	L4	51.2	W5
80	8	184.322	Chorus	Sia	F	Feat	S	148	195	278	391	565	E2	L5	33.5	W4
80	9	214.623	Outro	Sia	F	Feat	S	132	230	262	309	363	E1	L3	61.8	W4
80	10	234.842	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
81	1	0	Intro	Trey Songz	M	Main	S	160	261	264	311	396	E1	L3	81.9	W5
81	2	16.3214	Chorus	Trey Songz	M	Main	S	152	256	259	287	549	E1	L5	34.6	W5
81	3	42.2313	Verse1	Trey Songz	M	Main	S	187	260	287	298	332	E1	L1	78.5	W2
81	4	55.2359	Pre-chorus	Trey Songz	M	Main	S	172	257	292	324	411	E2	L2	54.5	W4
81	5	68.2198	Chorus	Trey Songz	M	Main	S	152	255	259	262	392	E1	L5	37.7	W5
81	6	94.1675	Verse2	Trey Songz	M	Main	S	226	277	303	312	410	E2	L1	78.9	W2
81	7	107.115	Pre-chorus	Trey Songz	M	Main	S	173	261	296	363	554	E2	L2	65.4	W4
81	8	120.127	Chorus	Trey Songz	M	Main	S	152	255	259	288	581	E1	L5	37.1	W5
81	9	146.066	Verse3	Nicki Minaj	F	Feat	R	170	238	259	296	464	E1	L1	46.1	W2
81	10	197.961	Chorus	Trey Songz	M	Main	S	173	258	276	353	420	E1	L5	46.3	W5
81	11	223.877	Outro	Both												
81	12	242.02	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
82	1	0	Chorus	Dev	F	Neither	R	147	228	233	235	301	E1	L4	41.1	W5
82	2	31.7902	Verse1	The Cataracs	M	Neither	R	99	148	151	158	221	E1	L1	49.7	W2
82	3	47.0304	Pre-chorus	The Cataracs	M	Neither	R	150	162	174	175	234	E1	L3	33.6	W4
82	4	62.4118	Chorus	Dev	F	Neither	R	102	232	233	235	459	E1	L4	33.7	W5
82	5	93.096	Verse2	The Cataracs	M	Neither	R	101	154	158	171	209	E2	L2	54.6	W4
82	6	108.463	Pre-chorus	The Cataracs	M	Neither	R	150	163	174	175	234	E1	L3	34.5	W4
82	7	123.875	Chorus	Dev	F	Neither	R	87.3	231	233	234	486	E1	L4	33.6	W5
82	8	154.593	Bridge	The Cataracs	M	Neither	R	87.2	196	233	236	313	E1	L1	43.7	W4
82	9	185.268	Chorus	Dev	F	Neither	R	159	232	233	234	300	E1	L4	34	W5
82	10	218.286	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
83	1	0	Chorus	Skylar Grey	F	Feat	S	128	246	276	291	371	E3	L1	69.2	W3
83	2	30.9865	Intro	Diddy	M	Main	R	113	145	155	178	245	E1	L4	69.1	W2
83	3	54.0162	Verse1	Diddy	M	Main	R	125	209	228	251	332	E1	L3	55.9	W3
83	4	99.7118	Chorus	Skylar Grey	F	Feat	S	154	246	268	292	372	E1	L3	51.5	W5
83	5	122.503	Verse2	Diddy	M	Main	R	117	223	243	261	429	E1	L3	61.2	W3
83	6	156.758	Chorus	Skylar Grey	F	Feat	S	162	246	274	298	405	E1	L5	54.6	W5
83	7	179.687	Verse3	Diddy	M	Main	R	146	205	216	231	347	E1	L2	65.5	W3
83	8	213.961	Chorus	Skylar Grey	F	Feat	S	144	247	281	323	478	E1	L5	58	W5
83	9	250.074	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
84	1	0	Intro													
84	2	17.2767	Verse1	Jason Aldean	M	Main	S	117	185	203	220	284	E1	L1	76.3	W2
84	3	37.2396	Chorus	Both												
84	4	63.9456	Post-chorus													
84	5	77.2299	Verse2	Kelly Clarkson	F	Feat	S	263	380	420	496	666	E1	L1	62.1	W2
84	6	97.3092	Chorus	Both												
84	7	123.981	Bridge	Both												
84	8	150.601	Chorus	Both												
84	9	180.543	Outro	Both												
84	10	254.277	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
85	1	0	Intro	Kanye West	M	Feat	R	90.2	185	219	243	482	E1	L1	58.6	W1
85	2	32.2415	Verse1	Katy Perry	F	Main	S	256	353	401	415	496	E3	L2	51	W3
85	3	57.4897	Pre-chorus	Katy Perry	F	Main	S	267	350	393	470	563	E3	L1	50	W2
85	4	70.1479	Chorus	Katy Perry	F	Main	S	270	350	399	418	607	E1	L3	46.6	W5
85	5	98.5299	Verse2	Katy Perry	F	Main	S	298	356	404	415	463	E3	L2	50.4	W3
85	6	111.344	Pre-chorus	Katy Perry	F	Main	S	266	349	390	413	550	E3	L5	49.1	W4
85	7	123.972	Chorus	Katy Perry	F	Main	S	274	350	394	417	616	E1	L3	45.2	W5
85	8	149.434	Bridge	Kanye West	M	Feat	R	97.4	175	193	214	421	E1	L3	78.3	W4
85	9	177.859	Chorus	Katy Perry	F	Main	S	250	349	359	416	632	E1	L4	43.2	W5
85	10	231.242	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
86	1	0	Chorus	Skylar Grey	F	Feat	S	223	390	433	450	494	E5	L1	70	W3
86	2	30.6365	Verse1	Eminem	M	Feat	R	190	286	304	338	446	E1	L3	55.8	W2
86	3	79.9433	Chorus	Skylar Grey	F	Feat	S	233	307	314	384	465	E1	L5	21.5	W5
86	4	104.43	Verse2	Eminem	M	Feat	R	190	289	326	369	494	E1	L3	55.5	W2
86	5	153.581	Chorus	Skylar Grey	F	Feat	S	145	302	315	390	469	E1	L5	19.7	W5
86	6	202.844	Verse3	Dr. Dre	M	Main	R	127	172	184	202	303	E1	L1	54.8	W1
86	7	252.083	Chorus	Skylar Grey	F	Feat	S	260	303	344	394	478	E1	L5	26.3	W5
86	8	283.74	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
87	1	0	Intro													
87	2	9.76008	Verse1	Nicki Minaj	F	Main	R	145	240	261	281	358	E1	L1	65.9	W1
87	3	78.5802	Chorus	Nicki Minaj	F	Main	S	123	245	247	251	375	E4	L1	47.5	W4
87	4	117.783	Verse2	Drake	M	Feat	R	93.3	159	166	178	519	E1	L1	59.9	W1
87	5	176.585	Chorus	Nicki Minaj	F	Main	S	163	245	247	250	375	E4	L1	46.8	W4
87	6	215.793	Bridge	Nicki Minaj	F	Main	S	137	247	270	311	376	E5	L1	86.8	W4
87	7	235.341	Chorus	Nicki Minaj	F	Main	S	150	244	247	249	373	E4	L1	58.6	W4
87	8	279.313	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
88	1	0	Intro													
88	2	6.83819	Verse1	Kelly Rowland	F	Main	S	194	392	439	517	671	E2	L1	49.8	W3
88	3	34.0509	Pre-chorus	Kelly Rowland	F	Main	S	184	296	438	569	676	E1	L2	49.7	W3
88	4	47.8298	Chorus	Kelly Rowland	F	Main	S	167	303	387	439	593	E1	L1	58.6	W3
88	5	88.5347	Verse2	Lil Wayne	M	Feat	R	105	134	142	149	541	E2	L1	47.1	W1
88	6	129.439	Chorus	Kelly Rowland	F	Main	S	120	303	349	439	596	E1	L3	58.7	W3
88	7	156.622	Verse3	Kelly Rowland	F	Main	S	196	390	408	471	710	E2	L1	60.2	W3
88	8	183.859	Pre-chorus	Kelly Rowland	F	Main	S	193	297	437	571	679	E1	L1	53.5	W3
88	9	197.567	Chorus	Kelly Rowland	F	Main	S	171	299	385	439	593	E1	L1	55.3	W3
88	10	230.567	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
89	1	0	Intro													
89	2	15.3124	Verse1	Adam Levine	M	Main	S	123	248	295	334	375	E4	L1	42.6	W4
89	3	45.3074	Chorus	Adam Levine	M	Main	S	152	251	294	329	522	E1	L3	49.4	W5
89	4	75.3042	Verse2	Adam Levine	M	Main	S	159	250	302	362	537	E4	L1	42.8	W4
89	5	105.329	Chorus	Adam Levine	M	Main	S	152	254	294	330	529	E1	L3	52.4	W5
89	6	135.357	Verse3	Christina Aguilera	F	Feat	S	177	296	341	371	668	E1	L3	45	W4
89	7	167.209	Chorus	Both												
89	8	197.217	Outro													
89	9	202.032	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
90	1	0	Intro	Both												
90	2	26.432	Verse1	Pitbull	M	Feat	R	61.8	230	251	267	311	E1	L3	54	W5
90	3	44.8284	Verse2	Jennifer Lopez	F	Main	S	194	308	311	314	723	E5	L3	40.4	W5
90	4	81.8009	Chorus	Jennifer Lopez	F	Main	S	202	235	311	350	477	E5	L2	42.4	W4
90	5	115.136	Verse3	Jennifer Lopez	F	Main	S	196	308	311	314	625	E5	L3	43.6	W5
90	6	151.989	Chorus	Jennifer Lopez	F	Main	S	197	276	312	351	478	E5	L2	41.1	W4
90	7	200.022	Verse4	Pitbull	M	Feat	R	146	226	248	261	367	E1	L3	44.4	W4
90	8	218.444	Chorus	Jennifer Lopez	F	Main	S	152	278	312	351	686	E5	L3	37.5	W4
90	9	284.873	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
91	1	0	Intro	Jessie J	F	Main	R	185	287	315	353	598	E2	L1	37.7	W2
91	2	12.0832	Verse1	Jessie J	F	Main	S	215	346	355	394	489	E1	L1	41.6	W4
91	3	35.4222	Pre-chorus	Jessie J	F	Main	S	335	393	441	467	756	E1	L3	51.7	W5
91	4	44.9455	Chorus	Jessie J	F	Main	S	282	331	348	350	444	E1	L3	42.9	W5
91	5	66.9892	Verse2	Jessie J	F	Main	S	237	346	352	394	480	E1	L3	43.9	W4
91	6	90.293	Pre-chorus	Jessie J	F	Main	S	328	404	445	471	621	E1	L3	49.4	W5
91	7	99.7956	Chorus	Jessie J	F	Main	S	253	330	348	350	444	E1	L5	44.1	W5
91	8	121.835	Verse3	B.o.B	M	Feat	R	140	224	243	258	367	E1	L1	53.6	W2
91	9	154.66	Chorus	Jessie J	F	Main	S	165	320	332	349	657	E1	L5	38	W5
91	10	198.593	Outro	Jessie J	F	Main	S	178	260	327	333	444	E1	L5	49.2	W5
91	11	223.06	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
92	1	0	Intro	Vika Jigulina	F	Feat	S	231	330	373	413	493	E5	L1	58.4	W3
92	2	49.19	Verse1	Vika Jigulina	F	Feat	S	231	275	280	316	394	E3	L1	37.2	W3
92	3	64.3235	Pre-chorus	Vika Jigulina	F	Feat	S	134	185	210	297	442	E1	L3	40.1	W1
92	4	94.6428	Chorus	Edward Maya	M	Main	S	101	186	219	373	492	E1	L1	33.3	W1
92	5	124.804	Verse2	Vika Jigulina	F	Feat	S	108	139	276	303	371	E3	L1	38.4	W3
92	6	139.866	Pre-chorus	Vika Jigulina	F	Feat	S	122	185	206	250	414	E1	L3	42	W1
92	7	155.001	Bridge	Vika Jigulina	F	Feat	S	203	330	411	415	443	E5	L1	51.8	W3
92	8	185.25	Chorus	Edward Maya	M	Main	S	133	186	213	328	494	E1	L1	33.3	W1
92	9	252.563	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
93	1	0	Chorus	Rihanna	F	Main	S	139	277	290	329	443	E3	L1	46.9	W4
93	2	20.0661	Verse1	Drake	M	Feat	R	104	137	143	159	442	E1	L1	55	W2
93	3	58.4733	Chorus	Rihanna	F	Main	S	249	277	293	330	443	E3	L1	46.6	W4
93	4	68.0169	Verse2	Rihanna	F	Main	S	178	251	274	278	378	E3	L1	52.7	W4
93	5	87.2431	Refrain	Rihanna	F	Main	S	272	329	332	370	666	E1	L1	57.7	W2
93	6	125.596	Chorus	Rihanna	F	Main	S	247	277	291	329	442	E3	L1	52.6	W4
93	7	135.197	Verse3	Rihanna	F	Main	S	212	247	271	277	375	E3	L1	54	W4
93	8	154.342	Refrain	Rihanna	F	Main	S	244	328	331	370	506	E1	L1	56.9	W2
93	9	173.53	Bridge	Rihanna	F	Main	S	302	377	436	492	563	E3	L1	59.8	W2
93	10	192.752	Chorus	Rihanna	F	Main	S	242	277	293	330	443	E3	L1	46.5	W4
93	11	211.94	Refrain	Rihanna	F	Main	S	186	308	331	370	564	E1	L1	51.5	W2
93	12	263.193	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
94	1	0	Chorus	Flo Rida	M	Neither	S	155	297	311	313	647	E2	L4	63.9	W5
94	2	32.3202	Verse1	Flo Rida	M	Neither	R	186	232	239	249	311	E1	L2	53.4	W4
94	3	61.9319	Chorus	Both												
94	4	91.4079	Verse2	Nicki Minaj	F	Neither	R	150	296	324	339	541	E1	L2	54.9	W4
94	5	121.059	Chorus	Both												
94	6	150.475	Bridge	Nicki Minaj	F	Neither	S	229	311	328	393	478	E1	L3	38.8	W5
94	7	180.092	Chorus	Both												
94	8	213.487	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
95	1	0	Intro	Sabi	F	Feat	S	194	220	232	293	355	E1	L4	53.9	W5
95	2	14.6109	Verse1	Gabe Saporta	M	Main	S	142	259	291	299	484	E3	L1	54.8	W4
95	3	43.8261	Pre-chorus	Sabi	F	Feat	S	292	454	465	467	574	E1	L3	56.5	W5
95	4	56.5406	Chorus	Both												
95	5	72.9068	Verse2	Gabe Saporta	M	Main	S	148	240	287	296	473	E5	L1	51.7	W4
95	6	101.971	Pre-chorus	Sabi	F	Feat	S	292	443	464	467	689	E1	L3	36.2	W5
95	7	129.225	Chorus	Both												
95	8	160.123	Bridge	Both												
95	9	178.458	Chorus	Both												
95	10	216.242	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
96	1	0	Intro													
96	2	10.6711	Chorus	Hayley Williams	F	Feat	S	121	224	247	268	373	E1	L3	54	W3
96	3	31.3046	Verse1	B.o.B	M	Main	R	180	242	258	270	339	E1	L1	54.5	W1
96	4	72.5299	Chorus	Hayley Wiliams	F	Feat	S	169	225	247	274	391	E1	L3	51.4	W3
96	5	93.1774	Verse2	B.o.B	M	Main	R	150	235	254	274	354	E1	L1	53.7	W1
96	6	134.478	Chorus	Hayley Williams	F	Feat	S	157	222	247	267	380	E1	L3	51.3	W3
96	7	155.204	Outro	Both												
96	8	191.827	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
97	1	0	Verse1	Ke$ha	F	Main	R	194	237	273	319	543	E1	L4	81.3	W4
97	2	18.1889	Pre-chorus	Ke$ha	F	Main	S	543	543	543	543	543	E1	L5	29.6	W5
97	3	32.2115	Chorus	Ke$ha	F	Main	R	228	285	324	371	602	E1	L4	59.4	W5
97	4	50.1519	Verse2	Ke$ha	F	Main	R	204	254	287	344	828	E1	L3	63	W4
97	5	66.1641	Pre-chorus	Ke$ha	F	Main	S	599	599	599	599	599	E1	L5	28.8	W5
97	6	80.1819	Chorus	Ke$ha	F	Main	R	190	263	309	365	601	E1	L4	59.4	W5
97	7	98.1752	Bridge	3OH!3	M	Feat	R	129	147	190	201	503	E1	L3	83.6	W1
97	8	121.643	Chorus	Ke$ha	F	Main	R	228	264	314	388	602	E1	L4	56.6	W5
97	9	155.602	Outro	Ke$ha	F	Main	R	206	290	371	473	722	E1	L1	37.4	W1
97	10	172.06	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
98	1	0	Intro	Snoop Dogg	M	Feat	R	93.8	98.3	110	392	392	E2	L3	79.2	W3
98	2	7.78835	Verse1	Katy Perry	F	Main	S	233	343	355	475	475	E2	L1	55.2	W3
98	3	38.6869	Pre-chorus	Katy Perry	F	Main	S	228	414	444	639	639	E2	L1	58.5	W3
98	4	54.0146	Chorus	Katy Perry	F	Main	S	235	347	351	532	532	E1	L3	47.2	W5
98	5	84.7864	Verse2	Katy Perry	F	Main	S	266	340	363	530	530	E2	L2	53.8	W3
98	6	100.086	Pre-chorus	Katy Perry	F	Main	S	228	399	444	606	606	E1	L3	56.6	W3
98	7	115.418	Chorus	Katy Perry	F	Main	S	148	344	349	482	482	E1	L3	46.5	W5
98	8	146.213	Verse3	Snoop Dogg	M	Feat	R	77.3	118	133	481	481	E1	L2	52.7	W3
98	9	184.599	Chorus	Katy Perry	F	Main	S	164	347	350	885	885	E1	L5	48.8	W5
98	10	215.276	Outro	Both												
98	11	234.203	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
99	1	0	Intro	Both												
99	2	21.6553	Verse1	Rihanna	F	Main	S	203	247	275	280	375	E2	L2	44.3	W3
99	3	63.9618	Chorus	Rihanna	F	Main	S	244	329	340	376	525	E1	L4	41	W5
99	4	84.9848	Post-chorus	Rihanna	F	Main	S	204	277	285	370	449	E1	L3	34.6	W4
99	5	106.079	Verse2	Rihanna	F	Main	S	162	250	279	365	501	E2	L2	46.2	W3
99	6	148.371	Chorus	Rihanna	F	Main	S	237	329	332	374	523	E1	L4	43.1	W5
99	7	169.415	Verse3	Jeezy	M	Feat	R	196	250	266	283	600	E1	L4	49.9	W4
99	8	211.597	Bridge	Rihanna	F	Main	S	210	249	292	329	564	E3	L3	53	W4
99	9	232.671	Chorus	Rihanna	F	Main	S	183	329	331	371	526	E1	L3	41.2	W5
99	10	250.724	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
100	1	0	Chorus	Rihanna	F	Feat	S	189	295	312	389	596	E2	L1	85.2	W3
100	2	27.3185	Verse1	Eminem	M	Main	R	167	275	293	320	444	E1	L1	67.2	W1
100	3	71.461	Chorus	Rihanna	F	Feat	S	196	286	308	347	589	E2	L3	65.5	W3
100	4	104.58	Verse2	Eminem	M	Main	R	210	285	293	304	445	E1	L1	64.8	W1
100	5	148.66	Chorus	Rihanna	F	Feat	S	159	286	308	347	593	E2	L3	64.3	W3
100	6	181.785	Verse3	Eminem	M	Main	R	195	286	321	345	460	E1	L1	70.7	W1
100	7	228.62	Chorus	Rihanna	F	Feat	S	195	291	309	348	593	E2	L3	64	W3
100	8	266.943	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
101	1	0	Chorus	Ludacris	M	Main	R	109	140	147	156	220	E5	L1	52.1	W3
101	2	25.056	Verse1	Ludacris	M	Main	R	110	188	206	225	394	E3	L2	66.3	W3
101	3	58.8482	Chorus	Ludacris	M	Main	R	113	141	150	158	228	E5	L1	52	W3
101	4	81.4963	Verse2	Ludacris	M	Main	R	116	207	225	247	804	E3	L1	64.6	W3
101	5	115.285	Chorus	Ludacris	M	Main	R	119	141	150	158	359	E5	L1	50.2	W3
101	6	137.875	Verse3	Nicki Minaj	F	Feat	R	203	267	280	297	432	E3	L2	47.6	W3
101	7	171.786	Chorus	Ludacris	M	Main	R	121	143	153	225	402	E5	L1	52.3	W3
101	8	194.413	Outro	Ludacris	M	Main	R	100	168	184	195	209	E2	L1	37.3	W3
101	9	219.772	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
102	1	0	Intro													
102	2	11.7159	Verse1	Jay-Z	M	Main	R	133	196	204	209	408	E1	L1	48.2	W1
102	3	56.0534	Chorus	Alicia Keys	F	Feat	S	200	413	455	466	561	E1	L4	52.1	W5
102	4	83.7486	Verse2	Jay-Z	M	Main	R	134	206	213	218	424	E1	L1	48.9	W1
102	5	128.101	Chorus	Alicia Keys	F	Feat	S	183	415	456	466	561	E1	L4	51.4	W5
102	6	155.739	Verse3	Jay-Z	M	Main	R	132	185	195	203	418	E1	L1	49	W1
102	7	200.074	Chorus	Alicia Keys	F	Feat	S	222	414	455	466	564	E1	L4	51.5	W5
102	8	227.76	Bridge	Alicia Keys	F	Feat	S	208	276	342	421	483	E1	L3	56.2	W2
102	9	244.437	Chorus	Alicia Keys	F	Feat	S	231	410	460	467	559	E1	L4	45.8	W5
102	10	280.701	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
103	1	0	Intro	Gabe Saporta	M	Main	S	164	257	295	329	394	E2	L4	71.1	W5
103	2	33.3153	Verse1	Gabe Saporta	M	Main	S	214	261	297	358	446	E3	L2	61.1	W4
103	3	49.2673	Pre-chorus	Gabe Saporta	M	Main	S	206	247	294	390	711	E1	L2	58.8	W4
103	4	57.2322	Chorus	Gabe Saporta	M	Main	S	215	285	303	351	469	E1	L4	40.6	W5
103	5	89.236	Verse2	Leighton Meester	F	Feat	S	146	250	289	323	443	E3	L2	61	W3
103	6	105.188	Pre-chorus	Gabe Saporta	M	Main	S	171	248	262	294	806	E1	L2	63.1	W4
103	7	113.169	Chorus	Both												
103	8	145.202	Bridge	Both												
103	9	163.172	Chorus	Both												
103	10	218.228	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
104	1	0	Intro	Lady Gaga	F	Main	S	213	311	328	330	380	E2	L1	36.6	W4
104	2	16.4788	Verse1	Lady Gaga	F	Main	S	165	277	323	377	556	E3	L1	54.8	W4
104	3	32.6005	Pre-chorus	Lady Gaga	F	Main	S	234	369	415	424	563	E2	L3	54.1	W4
104	4	48.7026	Chorus	Lady Gaga	F	Main	S	221	315	330	369	513	E1	L3	37.3	W5
104	5	66.8502	Verse2	Lady Gaga	F	Main	S	238	280	329	413	520	E3	L1	53.8	W4
104	6	83.0101	Pre-chorus	Lady Gaga	F	Main	S	206	368	415	425	660	E2	L3	54.6	W4
104	7	99.1186	Chorus	Lady Gaga	F	Main	S	216	316	330	370	499	E1	L3	37.2	W5
104	8	115.32	Verse3	Colby O'Donis	M	Feat	S	239	329	369	415	457	E3	L3	57.1	W4
104	9	147.488	Chorus	Lady Gaga	F	Main	S	273	329	369	415	500	E1	L3	53.1	W5
104	10	171.785	Bridge	Lady Gaga	F	Main	S	187	259	293	338	562	E2	L2	46	W5
104	11	212.064	Chorus	Lady Gaga	F	Main	S	232	324	331	418	605	E1	L3	51	W5
104	12	242.365	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
105	1	0	Intro	Both												
105	2	18.5923	Verse1	Keri Hilson	F	Main	S	157	231	259	284	397	E2	L1	44.3	W4
105	3	67.9953	Chorus	Keri Hilson	F	Main	S	177	239	292	328	478	E1	L5	32.7	W5
105	4	92.8991	Verse2	Ne-Yo	M	Feat	S	155	231	262	293	397	E2	L2	50.3	W4
105	5	142.445	Chorus	Both												
105	6	167.167	Verse3	Kanye West	M	Feat	R	128	193	207	223	381	E1	L1	62.6	W1
105	7	229.138	Bridge	Keri Hilson	F	Main	S	215	262	296	342	524	E1	L3	57.2	W4
105	8	253.851	Chorus	Both												
105	9	278.656	Outro	Both												
105	10	326.193	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
106	1	0	Intro	Diana Gordon	F	Feat	S	172	277	414	416	526	E1	L4	54.6	W5
106	2	19.5956	Chorus	Diana Gordon	F	Feat	S	183	262	310	314	422	E1	L5	32.7	W5
106	3	49.1643	Verse1	Flo Rida	M	Main	R	191	246	252	259	323	E1	L4	41.1	W4
106	4	78.6215	Chorus	Diana Gordon	F	Feat	S	154	261	310	313	421	E1	L5	33	W5
106	5	108.142	Verse2	Flo Rida	M	Main	R	208	253	259	267	317	E1	L4	41.3	W4
106	6	137.77	Chorus	Diana Gordon	F	Feat	S	156	234	310	312	419	E1	L5	31.5	W5
106	7	167.299	Bridge	Flo Rida	M	Main	R	163	208	231	236	313	E1	L4	43	W5
106	8	196.876	Chorus	Diana Gordon	F	Feat	S	207	303	311	341	459	E1	L5	29.8	W5
106	9	226.385	Outro													
106	10	259.373	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
107	1	0	Intro												79.8	
107	2	15.515	Verse1	Keri Hilson	F	Main	S	250	307	310	314	350	E1	L1	77.7	W2
107	3	40.4408	Chorus	Keri Hilson	F	Main	S	260	365	397	418	556	E2	L2	72.4	W3
107	4	64.7063	Verse2	Keri Hilson	F	Main	S	248	266	313	321	476	E1	L1	76	W3
107	5	89.0075	Pre-chorus	Keri Hilson	F	Main	S	261	348	366	391	464	E2	L1	72.6	W3
107	6	101.168	Chorus	Keri Hilson	F	Main	S	200	369	400	431	570	E2	L2	72.5	W3
107	7	125.421	Verse3	Lil Wayne	M	Feat	R	200	200	200	200	200	E2	L1	73.7	W1
107	8	186.193	Bridge	Both												
107	9	198.368	Chorus	Keri Hilson	F	Main	S	148	359	394	410	536	E2	L3	73.6	W3
107	10	222.67	Outro	Lil Wayne	M	Feat	R	148	175	191	200	214	E2	L1	73	W3
107	11	246.428	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
108	1	0	Intro	Kanye West	M	Feat	R	113	162	177	204	465	E1	L1	51.2	W1
108	2	24.6367	Chorus	Estelle	F	Main	S	252	368	425	465	510	E1	L2	57.9	W3
108	3	40.9721	Verse1	Estelle	f	Main	S	188	327	363	387	527	E4	L1	48.8	W3
108	4	73.4138	Chorus	Estelle	F	Main	S	222	364	412	463	510	E1	L2	58	W3
108	5	89.7467	Verse2	Estelle	F	Main	S	232	341	370	393	512	E4	L1	47.6	W3
108	6	122.228	Chorus	Estelle	F	Main	S	197	358	408	460	510	E1	L2	59.4	W3
108	7	138.559	Verse3	Kanye West	M	Feat	R	109	163	179	206	275	E1	L1	52.6	W1
108	8	195.557	Bridge	Estelle	F	Main	S	152	370	394	436	578	E1	L3	47.7	W3
108	9	211.759	Chorus	Estelle	F	Main	S	218	363	430	466	507	E1	L2	62.7	W3
108	10	228.035	Outro	Estelle	F	Main	S	241	329	393	488	592	E1	L3	46.6	W3
108	11	241.842	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
109	1	0	Intro	Both												
109	2	20.5922	Verse1	Both												
109	3	66.536	Chorus	Rihanna	F	Main	S	159	260	308	387	519	E1	L4	64.5	W5
109	4	92.1353	Verse2	Both												
109	5	112.5	Chorus	Ne-Yo	M	Feat	S	196	241	300	365	495	E1	L4	67.8	W5
109	6	135.545	Bridge	Both												
109	7	168.735	Chorus	Both												
109	8	207.053	Outro	Both												
109	9	218.953	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
110	1	0	Intro													
110	2	24.828	Chorus	Rihanna	F	Feat	S	163	277	294	331	798	E1	L3	61.4	W5
110	3	72.9481	Verse1	T.I.	M	Main	R	117	186	213	226	502	E1	L3	49.6	W2
110	4	121.056	Chorus	Rihanna	F	Feat	S	159	277	293	321	774	E1	L3	60.9	W5
110	5	168.972	Verse2	T.I.	M	Main	R	99.6	162	176	190	500	E1	L3	57.6	W4
110	6	217.047	Chorus	Rihanna	F	Feat	S	217	278	294	331	639	E1	L3	60	W5
110	7	264.965	Bridge	Rihanna	F	Feat	S	239	294	336	372	545	E3	L2	61.8	W4
110	8	312.965	Outro													
110	9	338.86	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
111	1	0	Intro	Natasha Bedingfield	F	Main	S	165	198	350	426	793	E2	L5	45.7	W5
111	2	18.6975	Verse1	Natasha Bedingfield	F	Main	S	240	341	394	443	598	E2	L1	56.4	W3
111	3	31.2063	Pre-chorus	Natasha Bedingfield	F	Main	S	247	345	368	421	599	E2	L1	59	W3
111	4	43.6856	Chorus	Natasha Bedingfield	F	Main	S	253	351	387	436	600	E1	L5	60.6	W5
111	5	68.6603	Verse2	Natasha Bedingfield	F	Main	S	238	328	391	440	635	E2	L1	56.8	W3
111	6	81.0764	Pre-chorus	Natasha Badingfield	F	Main	S	240	346	390	470	715	E1	L3	65.1	W3
111	7	93.5539	Chorus	Natasha Bedingfield	F	Main	S	170	350	390	439	589	E1	L5	65.4	W5
111	8	118.428	Verse3	Sean Kingston	M	Feat	S	131	174	179	217	429	E1	L2	58	W3
111	9	143.451	Chorus	Natasha Bedingfield	F	Main	S	170	345	379	439	793	E1	L5	65.7	W5
111	10	222.3	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
112	1	0	Chorus	Rihanna	F	Feat	S	159	280	316	357	446	E5	L1	68.4	W3
112	2	33.3139	Verse1	Jay-Z	M	Main	R	134	233	258	269	558	E1	L2	53.7	W3
112	3	66.5136	Chorus	Rihanna	F	Feat	S	145	275	318	361	539	E1	L1	64.2	W3
112	4	99.7227	Verse2	Jay-Z	M	Main	R	135	252	261	270	424	E1	L2	58.9	W3
112	5	132.868	Chorus	Rihanna	F	Feat	S	185	279	318	361	537	E1	L1	65.9	W3
112	6	166.117	Verse3	Kanye West	M	Feat	R	134	205	220	239	539	E1	L1	56.7	W1
112	7	233.194	Chorus	Rihanna	F	Feat	S	211	290	360	404	495	E3	L1	75.6	W3
112	8	267.563	End													

Ind#	TS#	Time (s)	Form	Artist	Gen	F(x)	Style	PMin	PQ1	PMed	PQ3	PMax	Env	Lay	Prom	Wid
113	1	0	Intro												41.4	
113	2	25.0174	Verse1	Timbaland	M	Main	S	61.8	92.5	105	207	309	E1	L4	43.7	W5
113	3	42.765	Pre-chorus	Keri Hilson	F	Feat	S	202	246	311	434	595	E1	L4	50.2	W5
113	4	59.5359	Chorus	Both												
113	5	75.2342	Verse2	Timbaland	M	Main	S	61.8	182	184	186	312	E1	L4	42.9	W5
113	6	92.8928	Pre-chorus	Keri Hilson	F	Feat	S	181	238	306	429	596	E1	L4	47	W5
113	7	109.682	Chorus	Both												
113	8	126.486	Verse3	D.O.E	M	Feat	R	136	168	175	180	336	E2	L2	60	W3
113	9	143.25	Verse4	Sebastian	M	Feat	R	133	165	172	184	263	E1	L2	64.4	W3
113	10	160.006	Pre-chorus	Keri Hilson	F	Feat	S	180	234	306	421	595	E1	L4	56.8	W5
113	11	176.662	Chorus	Both												
113	12	213.096	End													

Appendix E Updated Descriptive Statistical Analysis of the CS Corpus, June 2021

On May 19, 2021, singer Demi Lovato came out as non-binary. This updated descriptive statistical analysis of the CS corpus accurately represents their gender identity. The figures contained in this Appendix are therefore meant as an updated version of the ones presented throughout Chapter 4.

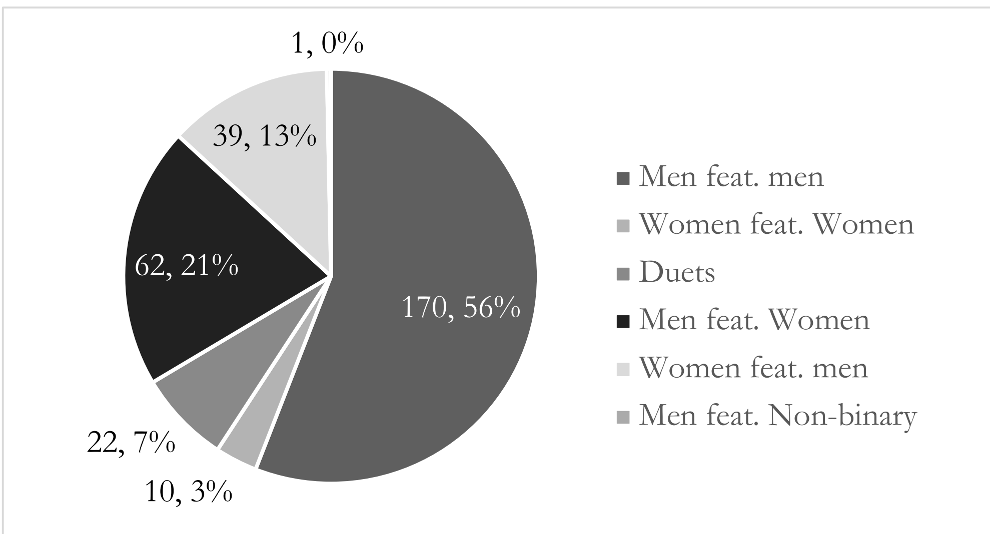

Figure E.1 All collaborations in the 2008–18 *Billboard* Hot 100 year-end charts

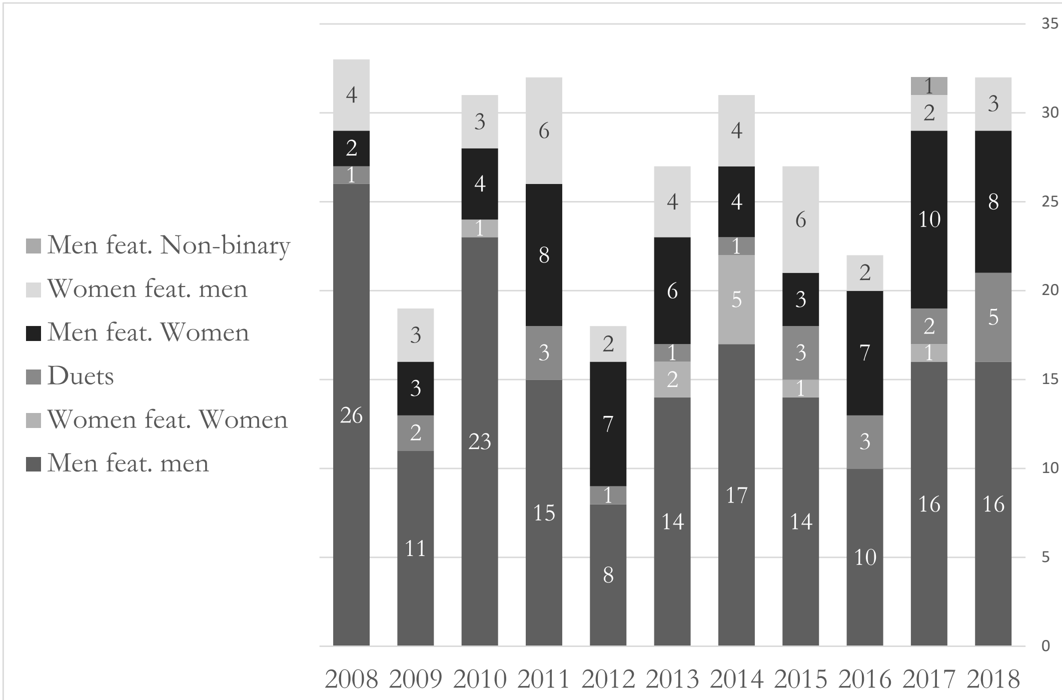

Figure E.2 All Collaborations in the 2008–18 *Billboard* Hot 100 year-end charts, separated by year

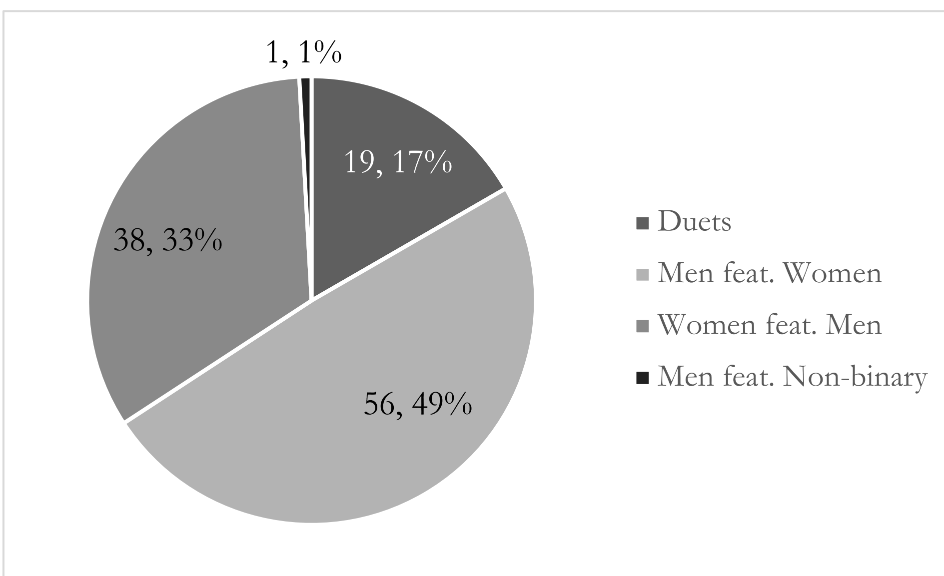

Figure E.3 Types of Collaborations in the CS corpus

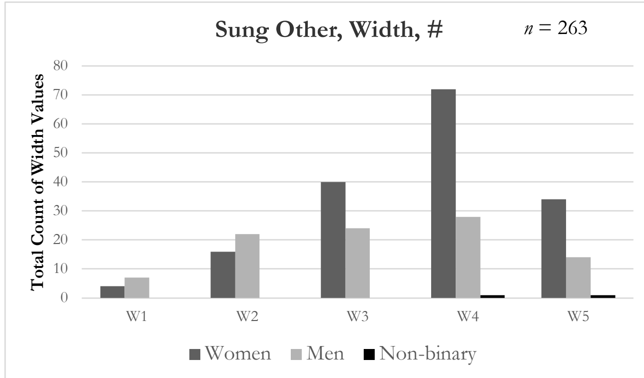

Figure E.4 Total Count of width values in "Sung Other" Sections, in the CS corpus

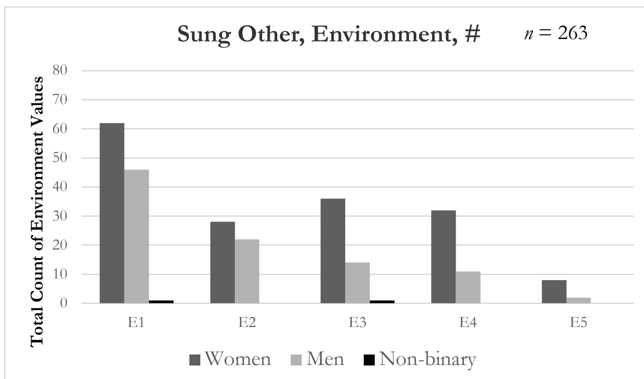

Figure E.5 Total Count of environment values in "Sung Other" Sections, in the CS corpus

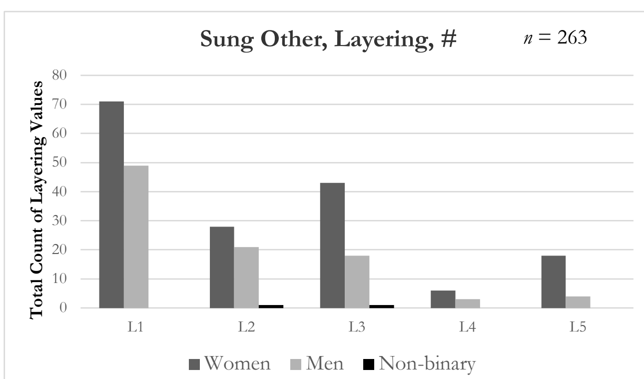

Figure E.6 Total Count of layering values in "Sung Other" Sections, in the CS corpus

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