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Musical Minds: Exploring the Connection Between Music and Emotions

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Abstract

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This honors thesis explores the multifaceted relationship between music and emotions, weaving together insights from psychology, neuroscience, and music cognition. The first part delves into theoretical models and neurobiological mechanisms underlying music-evoked emotions, discussing the discrete and dimensional models, the Geneva Emotional Music Scale (GEMS), and cross-cultural perspectives on emotional perception in music. It also examines the role of the amygdala and the impact of neurotransmitters, particularly dopamine, in shaping our emotional responses to music.

The second part of the thesis shifts focus to the practical application of these concepts through the detailed analysis of *Imọlara*, a string quartet I composed for this thesis. It highlights the use of harmony, timbre, and texture to evoke emotions in each of the four movements, demonstrating the process of translating emotion into music. By bridging the gap between abstract principles and their application in composition, this thesis aims to deepen the current understanding of the emotional power of music and its universal connection with the human experience.

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Chapter 1: Theory of Music-Evoked Emotions

In the field of music-evoked emotions, various models and theories contribute to our understanding of how music influences our emotions. At the forefront are the discrete and dimensional models, each offering distinct insights into the emotions induced by music. A new model, named The Geneva Emotional Music Scale (GEMS) represents a significant advancement in this area, specifically designed to capture the range of emotions elicited by music in a way distinct from its discrete and emotional predecessors. Empirical research delves into the debate over whether music genuinely evokes emotional responses or simply conveys emotions that listeners recognize. Complementing these studies is cross-cultural research, which probes the universality of musical emotions across diverse cultural backgrounds. In this chapter, I will synthesize these diverse perspectives to illuminate the current landscape of the study of music-evoked emotions.

1.1 Current Models of Music-Evoked Emotions

The discrete emotion model is a prominent framework in the study of music-evoked emotions, stating that all emotions can be derived from a limited number of universal and innate basic emotions, such as fear, anger, disgust, sadness, and happiness. This model is based on the assumption that each discrete basic emotion is underpinned by an independent neural system. However, despite its widespread use in research on music and emotion, some neuroimaging and physiological studies have struggled to find consistent evidence supporting distinct neural substrates for each emotion (Barrett & Wager, 2006). In the context of music, this model is often adapted, replacing emotions less commonly expressed by music, like disgust, with more accurate concepts like tenderness or peacefulness. This adaptation highlights an ongoing debate about whether models designed for simple emotions can effectively capture the full range of emotional experiences in aesthetic contexts like music.

The dimensional model contrasts with this discrete emotion model and has a few notable variations. Russell's Circumplex Model (Russel, 1980), is a foundational two-dimensional framework in emotion research. It graphs emotions onto a plane defined by two axes: valence, ranging from pleasant to unpleasant, and arousal, ranging from calm to excited. This model is particularly useful in music research to understand how different pieces or genres elicit varying degrees of pleasure/displeasure and calmness/excitement in listeners. Thayer's Model (Thayer, 1989), offers an alternative two-dimensional perspective, focusing on energetic arousal, from tiredness to wakefulness, and tense arousal, from calmness to nervousness. This model highlights that arousal in emotional experiences can have different sources and qualities, which is crucial for understanding the diverse emotional effects of music. Schimmack & Grob's Model, developed in 2000, expands on the dimensional approach by introducing a three-dimensional model. This model is supported by evidence indicating that arousal–calmness, and tension–relaxation are distinct dimensions, not reducible to a single arousal dimension (Schimmack & Grob, 2000; Schimmack & Reisenzein, 2002). Factors such as circadian rhythms affect energetic arousal differently than tense arousal, and these arousal dimensions have been shown to change in opposite directions under specific manipulations (Gold et al. 1995). This model offers a comprehensive framework for dissecting nuanced emotional responses to music, acknowledging the multifaceted nature of these experiences (Figure 1.1)(Eerola and Vuoskoski, 2011).

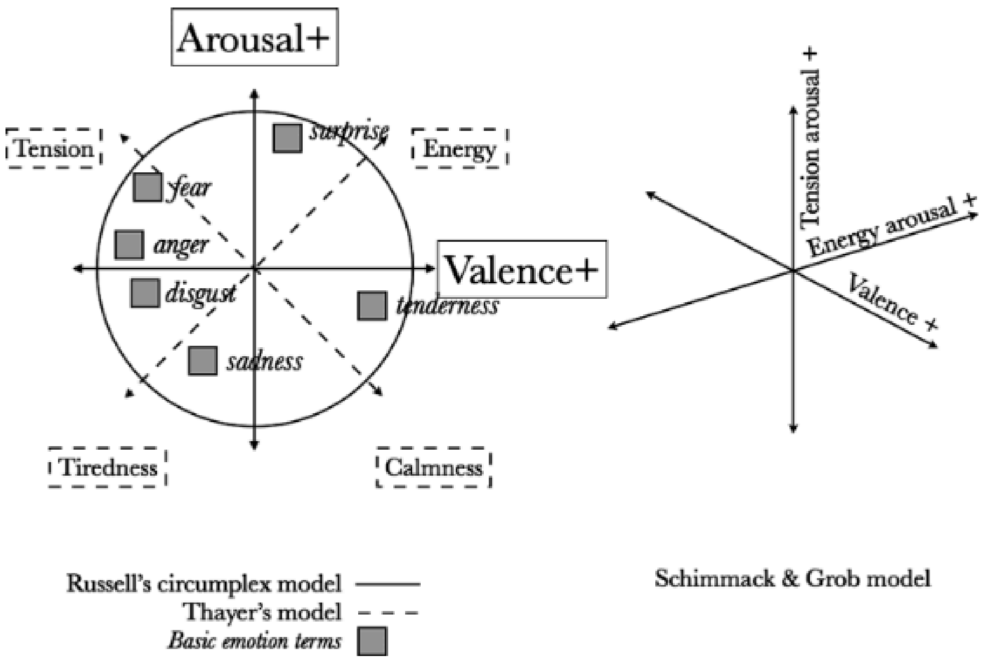

Figure 1.1 Dimensional Models of Music-Evoked Emotions Visual descriptions of different dimensional models of music-evoked emotions[1]

The discrete and dimensional models of music-evoked emotions are well-established and extensively discussed in the literature. However, the groundbreaking work of Zentner, Grandjean, and Scherer in 2008 introduced a novel approach, providing fresh perspectives on the intricate relationship between music and emotion. Their research diverges from traditional models by proposing a unique framework that uncovers the distinct emotional rewards offered by music, thereby enriching our understanding of this complex interplay.

The study by Zetner et al. begins by acknowledging the universal presence of music in human culture and its substantial role in our everyday lives. Drawing from the rich historical

[1] Figure 1 Adapted from 'A comparison of the discrete and dimensional models of emotion in music' by T. Eerola and J. K. Vuoskoski, 2011, Psychology of Music, 39(1), p.21. © T. Eerola and J. K. Vuoskoski 2011. Reprinted with permission from SAGE Publications.

context, the researchers highlight how the emotive qualities of music have long been a source of intrigue, dating back to ancient philosophical musings. This historical perspective sets the stage for their investigation, underlining the need for a more refined understanding of the emotional dimensions of music.

Zentner, Grandjean, and Scherer argue that both the discrete and dimensional models discussed previously are inadequate for encapsulating the broad emotional palette that music can paint. This gap in knowledge lays the foundation for their hypothesis that a new, music-specific approach is necessary—one that can more accurately depict the diverse emotional experiences elicited by music.

A key point of Zentner, Grandjean, and Scherer's research was the development of the Geneva Emotional Music Scale (GEMS), an innovative tool for assessing emotions elicited by music. The GEMS project began with compiling an exhaustive list of 515 emotional terms, sourced from various “affective lexicons” and scholarly works on music and emotion. Affective lexicons, in this case, are comprehensive collections of words and phrases that describe a wide range of emotions and are used in psychological research to understand and categorize human emotions. These lexicons, such as those developed by Johnson-Laird & Oatley (1989) and Clore, Ortony, & Foss (1987), offer detailed terms that capture the diverse emotional experiences people encounter. This comprehensive list of 515 concepts aimed to cover the full range of possible emotions one might experience while listening to music, ensuring that no significant emotion was overlooked. Four studies were then conducted to refine the list of terms, and all studies had a mix of participants with and without a musical background.

The first study involved a focused evaluation by 92 students from the University of Geneva. These students were tasked with assessing each term's relevance in describing specific internal affective states, particularly in relation to music. Internal affective state, in this case, refers to the personal, subjective emotional experiences that individuals feel internally in response to music. These are not just observable emotions but encompass the full range of felt emotional experiences that music can evoke, which can be deeply personal and varied. Their ratings were essential in refining the list down to 146 terms, with the goal of ensuring that each term accurately reflected a distinct emotion commonly experienced in musical contexts.

The second study by Zentner et al. involved 262 participants from the same institution and focused on evaluating the frequency of refined emotion terms within musical contexts, including both perceived and induced musical emotions, as well as in everyday life situations. The study aimed to remove emotional terms less relevant to music, which led to the omission of 65 'nonmusical emotions,' such as guilt, shame, contempt, and jealousy, based on their low-frequency ratings. The researchers then structured the remaining 89 terms associated with emotions into a more cohesive framework. They identified nine distinct emotional dimensions that consistently appeared across various musical genres and rating conditions, capturing a broad spectrum of emotions, ranging from tranquil and serene to more agitated and tense feelings. Additionally, the study sought to validate these emotional ratings by comparing them with frequency ratings from a prior study by Laukka (2007), finding 80% congruence between terms used in the prior study and this current one. This suggested that the assessments were reliable and reflective of actual emotional experiences.

The third study by Zentner et al. focused on refining the 89 emotion terms from the last study into a more manageable framework. To streamline the investigation and make it more manageable for participants, the initial list of 89 was condensed to 66. This reduction was achieved by identifying and merging synonymous terms. This third study was driven by two primary objectives. The first aim was to extend the findings from the previous research, which involved emotions typically elicited by music, by engaging a larger and more representative sample of listeners. These participants provided affect ratings while experiencing live music performances during the Geneva Music Festival, offering a real-world context for the study. The second aim was to investigate whether these music-induced emotions could be sorted into distinct categories, forming a basis for classifying music-evoked emotions. The emotion descriptors were sorted into nine distinct emotional dimensions: wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension, and sadness, each encapsulating a unique aspect of the emotional impact of music. The list of 66 was then further reduced to 40, with words that were ‘relatively poor’ or ‘ambiguous’ markers of the nine categories removed. This approach not only refined the emotion terms but also established a foundational classification of music-evoked emotions, which was crucial in the creation of GEMS.

The final study by Zentner et al. aimed to replicate the nine-dimensional structure of music-induced emotions identified in earlier studies with a new sample of listeners. The listeners were exposed to a variety of non-lyrical music excerpts and used GEMS to rate them. This study also aimed to compare the GEMS model with the two well-established emotion models discussed earlier in this chapter: the discrete model and the dimensional model. The study found that the GEMS model was better in three key areas: it was the preferred choice of listeners for describing their affective reactions to music, it showed higher agreement among listeners, and it provided better discrimination of music excerpts than the alternative models. These findings not only confirmed the factorial structure of the GEMS but also demonstrated its effectiveness and relevance in capturing the unique emotional responses elicited by music. This comprehensive validation solidified GEMS as a nuanced, reliable, and essential tool for understanding the emotional impact of music in both research and practical applications in music psychology.

In examining music-induced emotions, the discrete, dimensional, and Geneva Emotional Music Scale (GEMS) models each offer unique perspectives. The discrete model identifies a set of universal basic emotions, providing clear categories for emotional experiences. However, its approach may be too broad to capture the more subtle and complex emotions that music can evoke. The dimensional model, especially in its two-dimensional form advocated by Russell, simplifies the emotional range into axes of valence and arousal. This model offers a more general view of emotional experiences but may lack the specificity needed for the nuanced emotions in musical contexts. Schimmack & Grob's three-dimensional proposition adds complexity to this model but still operates within the dimensional framework. GEMS, though conceptually similar to the discrete model, includes a wider array of emotions, and acknowledges both the positive and reflective states that music often induces. The latter could provide a more detailed framework compared to the other models due to its specificity to the domain of music, but this may limit its general applicability. Each model has its strengths and limitations, and the choice between them depends on the specific aspects of emotional experiences one aims to understand or measure, especially in the context of music. These models collectively contribute to a deeper understanding of the emotional impact of music, reflecting the diversity and complexity of these experiences.

1.2 Current Theories of Music-Evoked Emotions

Aside from models of music-evoked emotions, the distinction between felt and perceived emotions in response to music is also a central topic in the study of musical emotions. This dichotomy, in the form of two contrasting yet not mutually exclusive theories, dives into the nature of our emotional responses to music, questioning whether music directly triggers emotional experiences within the listener, or if it merely presents cues for emotional recognition without necessarily evoking a corresponding internal emotional state.

The ‘emotivist’ theory states that musical experiences can elicit genuine emotional reactions, similar to those elicited by non-musical stimuli. For instance, a piece of music might genuinely make a listener feel sad or happy, much as they might feel in response to a real-world event. In contrast, the ‘cognitivist’ theory suggests that the emotions we associate with music are more about recognition than actual feeling. According to this view, when we say a piece of music is sad or joyful, we are not necessarily experiencing those emotions ourselves. Instead, we are recognizing and identifying the emotions expressed or represented by the music. This interpretation aligns with the idea that musical emotions might be different from everyday emotions due to their lack of direct consequences for our well-being and the absence of overt, goal-directed actions in response to these emotions.

Both theories offer insightful contributions to our understanding of how music interacts with our emotional world. The emotivist view highlights music's powerful capacity to induce genuine emotional experiences, while the cognitivist approach underscores the complexities of emotional perception and the subtleties of emotional representation in music. Understanding these two viewpoints is crucial for a comprehensive study of the emotional impact of music.

Building on this conceptual framework, Krumhansl's 1997 study aimed to explore the emotivist and cognitivist positions by examining the emotional impact of music through both physiological responses and self-reported emotional experiences. The study sought to determine whether music truly elicits emotional responses in listeners, or simply expresses emotions that listeners recognize in the music.

To test this hypothesis, Krumhansl’s study involved recording psychophysiological measures while listeners heard musical excerpts that were chosen to represent specific emotions: sadness, fear, and happiness (utilizing the discrete model of music-evoked emotions). These measures included a range of cardiac, vascular, electrodermal, and respiratory functions. In parallel, another group of subjects provided dynamic self-reports on the emotions they experienced while listening to the same music. These reports focused on four scales: sadness, fear, happiness, and tension, and were made in real-time during the listening experience.

The findings of the study were revealing. The physiological measures showed statistically significant effects of music, differing from the pre-music interval. Each emotional category of music-induced specific psychophysiological changes: sad music elicited the largest changes in heart rate and blood pressure; fear-induced music affected blood transit time and amplitude most significantly; and happy music resulted in the most considerable changes in respiratory measures (Figure 1.2). These emotion-specific physiological changes only partially replicated patterns found for nonmusical emotions, suggesting a unique quality to music-induced emotional experiences.

TABLE 1
Average physiological measures (change scores from baserate)

Physiological Measures	All Excerpts	Sad Excerpts	Fear Excerpts	Happy Excerpts
IBI	9.29	10.87 A	8.93 B	8.06 B
FPTT	2.07	2.01 B	2.64 A	1.53 C
FPA	−.408	−.444 B	−.624 C	−.150 A
EPTT	2.90	2.70 B	3.32 A	2.66 B
ICI	−285	−205 A	−325 B	−324 B
RD	−39.1	−36.4 A	−34.5 A	−46.4 B
RSA	−10.7	−9.43 A	−12.3 A	−10.3 A
SBP	1.58	2.42 A	.892 C	1.44 B
DBP	.919	1.50 A	.535 C	.726 B
MAP	1.15	1.70 A	.718 C	1.04 B
SCL	−.401	−.459 C	−.384 B	−.360 A
TEM	−.154	−.205 B	−.193 B	−.062 A

Note: The letters indicate statistical significance of differences. Excerpts with the same letter were not significantly different. Letters are assigned alphabetically from the largest to the smallest mean. When the changes were negative, A signifies the smallest negative change, C the largest

Figure 1.2 Results from Physiological Measures Changes in physiological measures while listening to excerpts representing happiness, sadness, and fear. Acronyms: IBI (Interbeat Interval), FPTT (Finger Pulse Transmission Time), FPA (Finger Pulse Amplitude), EPTT (Ear Pulse Transmission Time), ICI (Intercycle Interval), RD (Respiration Depth), RSA (Respiration-Sinus Asynchrony), SBP (Systolic Blood Pressure), DBP (Diastolic Blood Pressure), MAP (Mean Arterial Pressure), SCL (Skin Conductance Level), TEM (Temperature)[2]

These results, demonstrating both significant physiological changes and consistent self-reported emotional experiences in response to music, generally supported the emotivist view. The study highlighted music's powerful capacity to elicit genuine emotional responses, underscoring its effectiveness as an emotional stimulus and providing a deeper understanding of the complex interplay between perceived and felt emotions in musical contexts.

[2] Krumhansl, C. L. (1997). Table 1. In "An Exploratory Study of Musical Emotions and Psychophysiology." Canadian Journal of Experimental Psychology, 51(4), 336-353. CPA as publisher. Reprinted with permission

With the given conclusion that music can cause physiological changes, a study conducted by Julia Merrill et al. (2020) investigated how the locus of emotion, that is, whether the emotion is perceived as expressed by the music (external locus) or felt as induced in the listener by the music (internal locus), influences the intensity of psychophysiological reactions to music. The study involved 40 participants who listened to 32 musical excerpts taken from movie soundtracks while their facial electromyography, skin conductance, respiration, and heart rate were continuously measured. Participants were asked to assess either the emotion expressed by the music (perceived task) or the emotion they felt in response to the music (felt task).

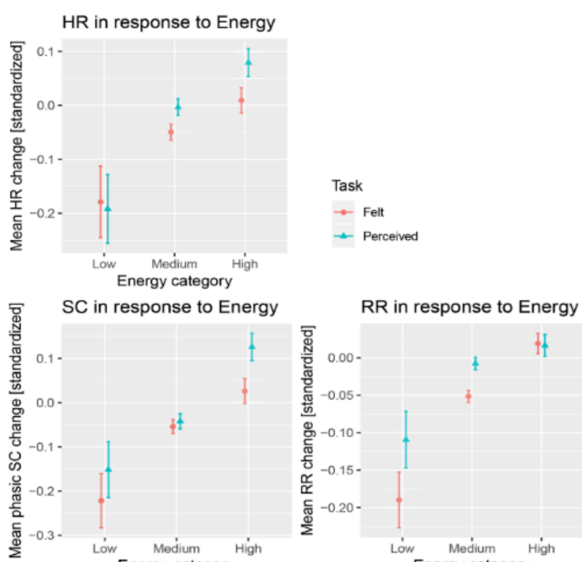

Figure 1.3 Results from Physiological Measures Changes in heart rate (HR), skin conductance (SC), and respiration rate (RR) with the increase of musical energy (tension). There is a positive correlation between mean physiological change and musical tension[3]

[3] Figure 1 Adapted from 'Locus of emotion influences psychophysiological reactions to music' by J. Merrill, D. Omigie, and M. Wald-Fuhrmann, 2020, PLOS ONE, 15(8), e0237641. © 2020 Merrill et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

The results showed that there was a higher mean response in psychophysiological measures for the perceived task compared to the felt task (Figure 1.3). This suggests that focusing on the music's expression, and thus on changes in musical features such as timbre, loudness, and harmony, enhances bodily reactions. In contrast, focusing on one's self and the emotions induced by the music leads to weaker bodily reactions, possibly because it distracts from the music itself.

This study has implications for emotion induction research using psychophysiology and the conceptualization of emotion loci. It suggests that different tasks can elicit different psychophysiological responses to the same stimulus and that both tasks elicit bodily responses to music, challenging the idea that a listener can adopt a purely cognitive mode when evaluating emotional expression in music.

1.3 Universality of Music-Evoked Emotions

Aside from models of music-evoked emotions and theories about whether people are able to genuinely feel these emotions rather than just recognize them, another pivotal question arises: Is the perception and emotional impact of music universal across different cultures, since musical traditions can vary across the globe? A cross-cultural study by Fritz et al. (2009), involving participants from the Mafa, a native Cameroonian population, and Western listeners, both unfamiliar with each other's music, offers insightful findings.

The first experiment in the study aimed to ascertain if the Mafa could recognize basic emotions like happiness, sadness, and fear in facial expressions. The Mafa participants were able to identify these emotions above chance levels, suggesting a universal aspect in the emotional expression of Western music. This outcome indicates that certain emotional cues in music might be universally comprehensible, transcending cultural boundaries (Figure 1.4). It is important to note, however, that across the board the Mafa participants had a lower recognition rate than the Western participants, which points to culturally specific differences in how emotions are displayed facially.

A second experiment focused on the perceived pleasantness of music. Both Mafa and Western listeners were exposed to original and spectrally manipulated versions of music from both cultures, where the manipulation altered aspects like sensory dissonance. The participants displayed a clear preference for the original compositions over the manipulated ones, indicating a universal inclination towards consonance and a rejection of dissonance in music (Figure 1.4).

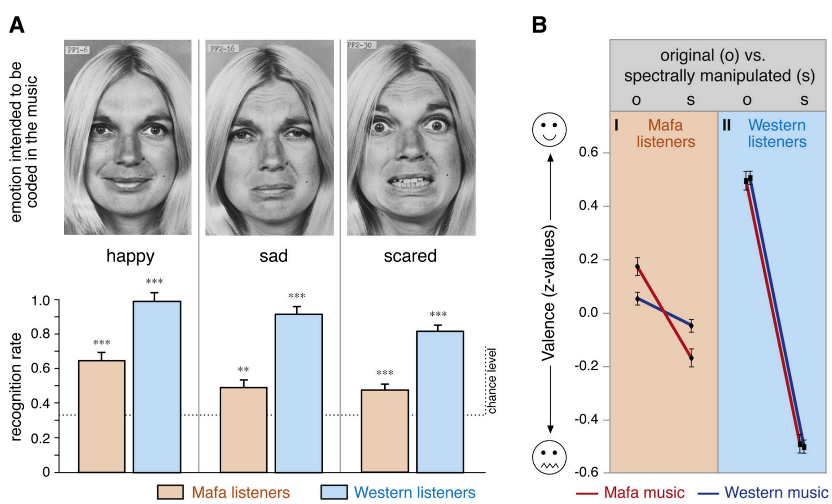

Figure 1.4 Universal Recognition of Emotions and Preference for Consonance Both Mafa and Western listeners were able to identify emotions in Western music. Both Mafa and Western listeners prefer consonance in both Mafa and Western music, albeit at different intensities.[4]

[4] Reprinted from Current Biology, Vol 19, Issue 7, Thomas Fritz, Sebastian Jentschke, Nathalie Gosselin, Daniela Sammler, Isabelle Peretz, Robert Turner, Angela D. Friederici, Stefan Koelsch, 'Universal Recognition of Three Basic Emotions in Music,' Pages 573-576, Copyright (2009), with permission from Elsevier.

These experiments collectively suggest that certain aspects of musical emotion and perception might be universally recognized and experienced. Despite diverse cultural backgrounds and musical traditions, both Mafa and Western listeners shared similar responses to the emotional content and consonance in music. This finding highlights the deep-rooted and fundamental role of music in human emotion and cultural expression, bridging diverse cultural experiences through a shared, universal language of music.

A more comprehensive study conducted by Heike Argstatter (2015) investigated the perception of basic emotions in music across multiple different cultures, specifically comparing listeners from Western Europe (Germany and Norway) with those from Asia (South Korea and Indonesia). The research aimed to determine whether six basic universal emotions (happiness, sadness, fear, disgust, anger, surprise) can be perceived in music that is unfamiliar to listeners with different cultural backgrounds and to identify any similarities and differences in the perception of musical emotions across these cultures.

Using a cross-cultural approach, the study presented 18 musical segments, each representing one of the six basic emotions, to participants from both Western Europe and Asia. Participants were asked to classify the emotion they perceived in each music segment. The segments were carefully selected to be unfamiliar to the participants, reducing the influence of prior musical experiences. Additionally, linguistic experts verified the accuracy of the emotional category labels used in the study to ensure cultural relevance. This methodology provided valuable insights into the universal and culture-specific aspects of emotional perception in music, shedding light on how different cultural backgrounds influence the interpretation and emotional response to music.

The results indicated that there is a pan-cultural emotional sentience in music, as basic emotions such as happy/sad were generally perceivable across all cultures (Figure 1.5). However, distinct cultural, emotional, and item-specific differences in emotion recognition were observed. For example, the German participants had the highest classification accuracy, followed by the Norwegians, Koreans, and Indonesians. Certain emotions, like happiness and sadness, were more universally recognized, while others, like surprise, were more challenging to decode cross-culturally.

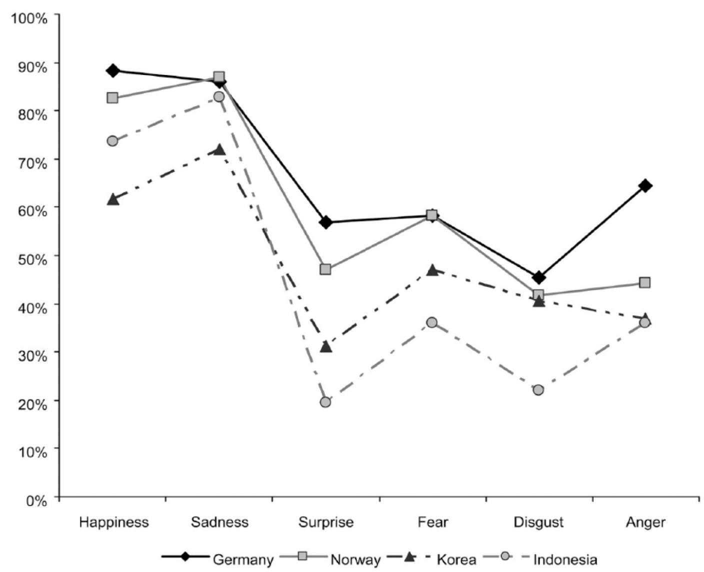

Figure 1.5 Cross-Cultural Recognition of Discrete Emotions Identification accuracy is displayed on the y-axis, happiness and sadness were the only two discrete emotions that were recognized above chance (50%) by all four cultures.[5]

One interesting aspect of the study was the impact of language and cultural connotations on emotion recognition. The term "surprise," for example, was ambiguous and had different connotations in the translations used for the Indonesian and Korean participants, leading to

[5] Figure 2: Adapted from 'Perception of basic emotions in music: Culture-specific or multicultural?' by H. Argstatter, 2016, Psychology of Music, 44(4), pp. 674-690. Copyright © 2016 by H. Argstatter. Reprinted by permission of SAGE Publications."

higher confusion rates for this emotion. In Indonesian, the emotional category "disgust" is not a distinct top-level category and is associated with "anger," which might explain why Indonesian participants had difficulty accurately classifying "disgust" in music.

Overall, the study supports the idea that while there is a universal sensitivity for basic emotions in music, cultural specificity plays a significant role in the recognition of emotional cues. The outcome measurement procedure, being language-based, reinforces cultural diversity and highlights the importance of considering linguistic and cultural nuances when studying emotion perception in music across different cultural backgrounds.

The exploration of music-evoked emotions encompasses a variety of theoretical models and empirical studies, highlighting the nuanced interplay between music and emotion.

The investigation of music-evoked emotions intertwines theoretical models with empirical research, illuminating the multifaceted relationship between music and emotion. Foundational frameworks like the discrete and dimensional models, along with the Geneva Emotional Music Scale (GEMS), provide comprehensive perspectives on categorizing musical emotions. Studies, such as those by Krumhansl and Julia Merrill, affirm the emotivist view, showcasing music's capacity to induce authentic emotional reactions, supported by physiological and self-reported data. Cross-cultural studies by Fritz et al. and Heike Argstatter highlight the universal nature of musical emotions, showcasing a common human ability to perceive and resonate with emotional expressions in music across different cultures. This body of research collectively underscores music's profound impact on emotions, transcending cultural barriers and reinforcing its essential role in human experience.

Chapter 2: Neurobiology of Music-Evoked Emotions

In this chapter, I embark on a journey to explore the intricate relationship between music and the brain's emotional processing. First, I will spotlight the amygdala, diving into its role in music-evoked emotions. Next, anchoring our understanding of the interconnected neural landscape, I will explore the synergy between various brain regions in music perception, drawing upon research by Stefan Koelsch et al. (2013) and the connectivity studies of Kari Kraus and Barbara Canlon (2012). Lastly, transitioning from anatomy to neurochemistry, I will explore the impact of neurotransmitters, notably dopamine, on our musical experiences, as illuminated by Valorie Salimpoor et al. (2011) and Blood & Zatorre (2001). Through these lenses, the chapter seeks to offer a holistic view of the neural pathways that shape our emotive responses to music.

2.1 The Amygdala and Music Processing

At the core of our emotional engagement with music lies the amygdala, a small cluster of nuclei located in the brain's medial temporal lobe. While the amygdala is often linked to the general processing of emotions, this exploration seeks to illuminate how the amygdala interprets, processes, and reacts to the emotions elicited by music.

This section focuses on the amygdala's influence on musical tension. However, it is essential to first define musical tension in and of itself. Musical tension refers to the unique and continuous cycle of tension and resolution experienced when engaging with Western tonal music. Tension arises due to the expectancy created by the implication of relationships between musical events, which is acquired implicitly through continued exposure to specific musical systems (Rohrmeier & Rebuschat, 2012). For instance in Figure 2.1, an unstable dominant seventh chord sets up harmonic implications, building tension, which is resolved upon to a stable tonic chord.

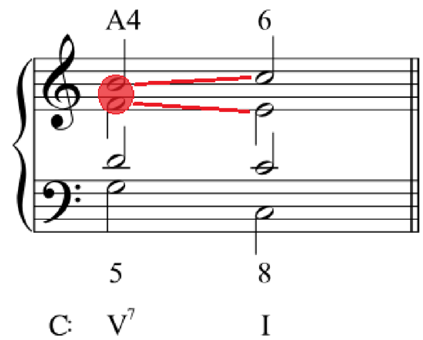

Figure 2.1 Harmonic Instability and Resolution from a Dominant seventh chord to the tonic chord in C major Tension is created through the interval of an augmented fourth between F_4 and B_4 (highlighted in red), an interval defined as a dissonance in the Western tonal system, requiring a specific type of resolution. Thus, the B_4 resolves upwards by one-half step, and the F_4 resolves downwards by one-half step, resolving this dissonant interval into a consonant major sixth interval with the least amount of movement between notes (i.e., parsimonious voice-leading).[6]

In order to investigate the brain's response to the discrete and dimensional aspects of music, studies often employ functional magnetic resonance imaging (fMRI), a neuroimaging procedure that measures brain activity by detecting changes associated with blood flow. The fMRI detects the BOLD (Blood Oxygen Level Dependent) signal, which refers to the levels of hemoglobin in red blood cells, shown in Figure 2.2. By observing the flow of blood to particular areas of the brain post-activation, fMRI acts as a proxy for gauging brain activity.

[6] Mount, A. (n.d.).. In Fundamentals, Function, and Form: Theory and Analysis of Tonal Western Art Music.

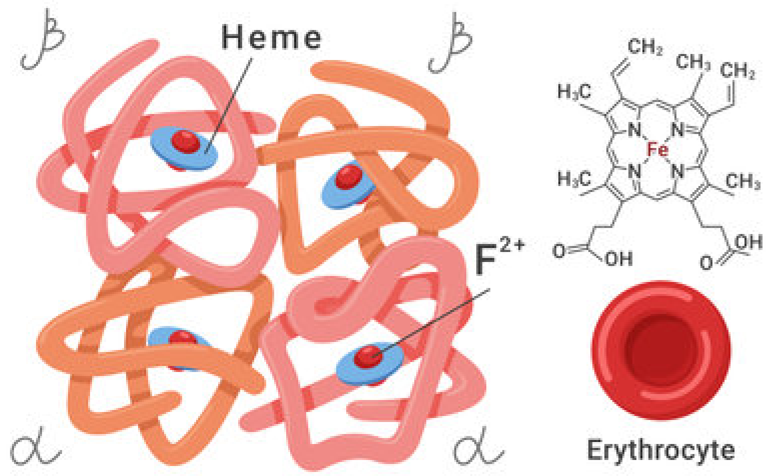

Figure 2.2 Structure of Hemoglobin Red blood cells are essentially large hemoglobin containers, each carrying around 260 million hemoglobin molecules. Each hemoglobin molecule has four heme groups attached, each of which has an iron molecule that oxygen is free to bind and dissociate from.[7]

In Lehne, Rohrmeier, & Koelsch's study (2013), they sought to identify the neural correlates of subjectively experienced tension in music. The participants were asked to subjectively measure the felt tension as they listened to piano pieces by Mendelssohn, Mozart, Schubert, and Tchaikovsky. The researchers simultaneously used fMRI to identify regions of increased BOLD signal correlating with periods of perceived musical tension. The most striking finding was the involvement of the right superficial amygdala during periods of increasing tension when compared to decreasing tension, as shown in Figure 2.3. This result underscores the amygdala's role in processing subjectively experienced tension increases in real music pieces.

[7]123RF. (n.d.). Retrieved from Goolge Images

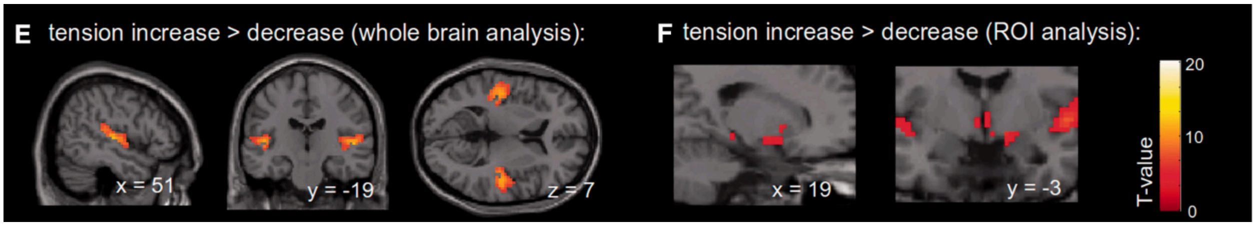

Figure 2.3 Brain Areas Activated With Increasing Tension When Compared With Decreasing Tension

(E) Increased BOLD signal is shown in Heschl's gyrus (auditory cortex) through a whole brain analysis, casting a wide net of general brain activity that compares broad regions with each other. (F) Increased BOLD signal is also shown in the Right Superficial Amygdala through a Region of Interest analysis, a more detailed and zoomed-in method of analysis, comparing very small areas in a targeted region of interest to each other. [8]

However, this study highlights an intriguing distinction: while the amygdala displayed increased activation during periods of rising musical tension compared to periods of decreasing tension, it exhibited no activation during continuous assessments of musical tension. This nuanced difference implicates a cognitive process where the escalation in tension aligns with the buildup of emotional intensity, and its decrease corresponds to feelings of relaxation or resolution.

Following our exploration of the amygdala's involvement in musical tension, it is imperative to further our understanding of its role in distinct emotional experiences. The auditory experience is much more than a passive reception of sound waves; it is a complex interaction between neural networks, leading to diverse emotional responses.

[8] Reprinted by permission of Oxford University Press on behalf of the Society for Social Cognitive and Affective Neuroscience. Lehne, Moritz; Rohrmeier, Martin, 'Tension-related activity in the orbitofrontal cortex and amygdala: an fMRI study with music,' Social Cognitive and Affective Neuroscience, 2013, Vol. 8, Issue 6, Page 1519, Copyright (2013).

Koelsch et al. (2013) sought to explore the neural underpinnings of music-evoked fear and joy in particular. In this study, eighteen participants listened to segments of music pulled from movies and video games designed to evoke either fear, joy, or neutral emotions. fMRI was then used to investigate the neural correlates associated with these music-evoked emotions. Notably, BOLD signal intensity in the superficial amygdala (SF) increased during joy and decreased during fear when compared to the neutral condition, as shown in Figure 2.4. The results underscored the heightened sensitivity of both the SF and auditory cortex (AC) to joy. This is consistent with prior findings by Mueller et al. (2011), which suggested the SF's increased activation in response to joyful music compared to sad music.

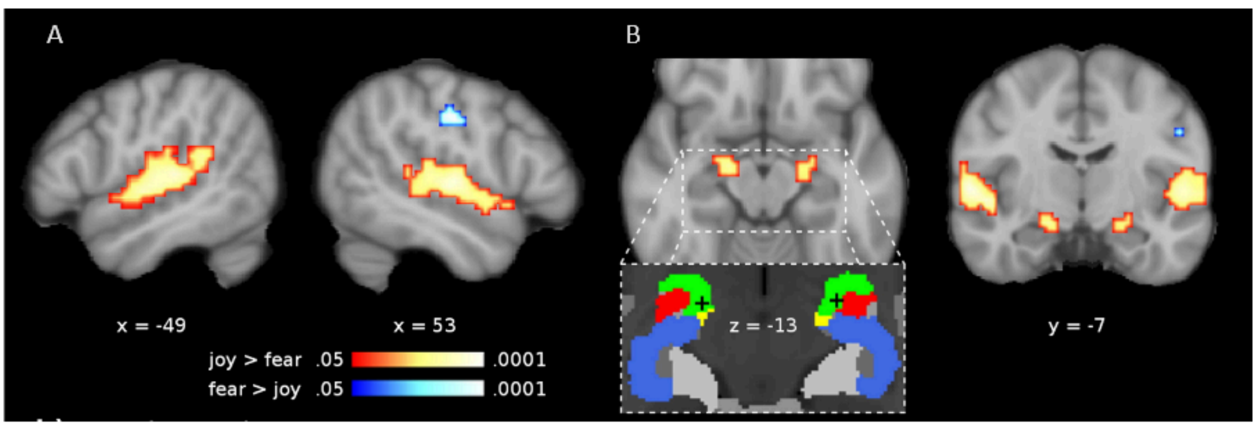

Figure 2.4 Brain areas activated by joy and fear

(A) Increased BOLD signal is shown in Heschl's gyrus (yellow) in joyful pieces when compared to fearful pieces, increased BOLD signal is shown in the sensory cortex (blue) in fearful pieces when compared to joyful pieces. (B) Pictured is a Zoomed-in portion of the amygdala. The highest Increased BOLD signal in joyful pieces when compared to fearful pieces shown by the black plus sign, located in the green region (superficial amygdala). Red region = basolateral amygdala, yellow = hippocampal-amygdaloid transition area, blue = hippocampus.[9]

[9] Reprinted from NeuroImage, Vol 81, Stefan Koelsch, Stavros Skouras, Thomas Fritz, Perfecto Herrera, Corinna Bonhage, Mats B. Küssner, Arthur M. Jacobs, 'The roles of superficial amygdala and auditory cortex in music-evoked fear and joy,' Pages 49-60, Copyright (2013), with permission from Elsevier.

Conversely, fear-evoking music, led to a reduced increase of neuronal activity within the right SF when compared to neutral and joyful music, and virtually no increase at all in the left SF (Figure 2.5). The reduced response of the left SF to fear stimuli compared to a neutral baseline emphasizes that the SF's response pattern can potentially indicate an auditory signal's emotional quality. Furthermore, similar increases in BOLD activity highlighted alleged connectivity between the SF and auditory regions, which suggests that the AC influences amygdala activity based on the emotional valence of auditory stimuli.

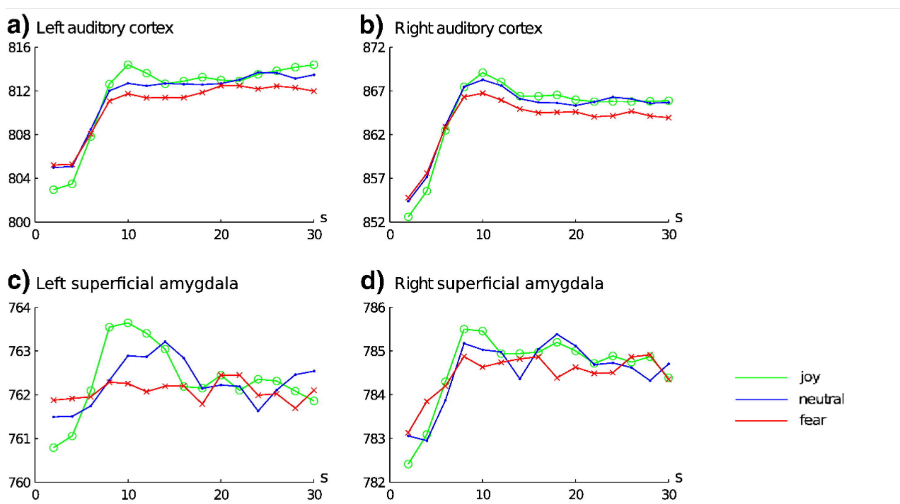

Figure 2.5 Brain areas activated by joy and fear

BOLD signal levels in auditory cortices and amygdalae over time of stimulus presentation

In addition, the left SF demonstrates functional connectivity to the visual cortices during fearful music when compared to joyful music (Figure 2.6).[10]

[10] Reprinted from NeuroImage, Vol 81, Stefan Koelsch, Stavros Skouras, Thomas Fritz, Perfecto Herrera, Corinna Bonhage, Mats B. Küssner, Arthur M. Jacobs, 'The roles of superficial amygdala and auditory cortex in music-evoked fear and joy,' Pages 49-60, Copyright (2013), with permission from Elsevier.

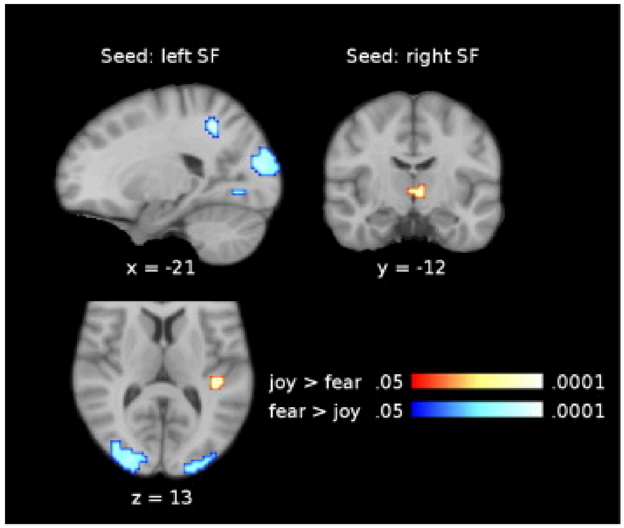

Figure 2.6 Psychophysiological Interaction Analysis: Regions showing functional connectivity with the left and right SF

(A Visual cortices (blue) are shown to have increased functional connectivity to the left SF in fearful pieces when compared to joyful pieces.[11]

Building on the understanding of the amygdala's response to joy and fear, I will address its interaction with another prevalent emotion in musical experience—sadness. Mitterschiffthaler et al. (2007) examine the neural basis of mood shifts caused when listening to Western classical music. This pilot experiment assessed emotional reactions to 60 classical music pieces. After the evaluation, 20 musical pieces for joy, sadness, and neutrality were selected based on their ability to reliably induce the intended emotional states. While listening to each piece, volunteers rated their mood state by moving a cursor along a computerized visual analog scale (VAS), ranging from 0 (sad) through 50 (neutral) to 100 (happy). Each piece was rated by every participant.

In the main fMRI experiment, the (BOLD) signal contrast was measured in response to the mood states induced by these musical selections in 16 participants. As shown in Figure 2.7,

[11] Reprinted from NeuroImage, Vol 81, Stefan Koelsch, Stavros Skouras, Thomas Fritz, Perfecto Herrera, Corinna Bonhage, Mats B. Küssner, Arthur M. Jacobs, 'The roles of superficial amygdala and auditory cortex in music-evoked fear and joy,' Pages 49-60, Copyright (2013), with permission from Elsevier.

their findings showed that the presentation of sad music led to heightened BOLD signal responses in the hippocampus/amygdala and auditory association regions.

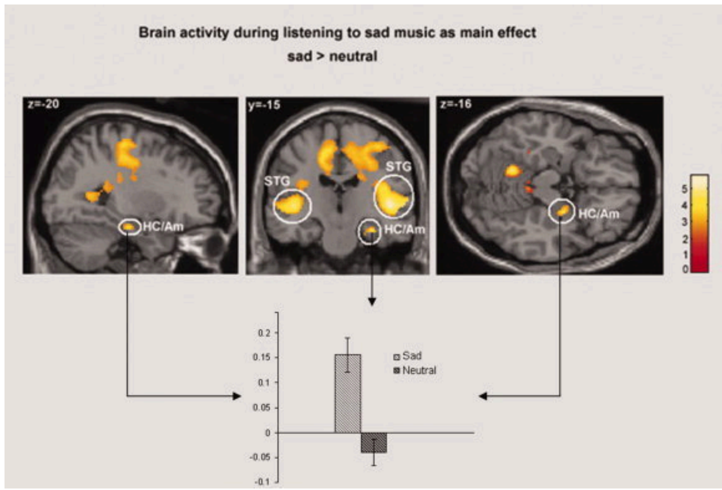

Figure 2.7 Brain areas activated by sad music when compared to neutral music

Increased BOLD signal shown in the superior temporal gyrus region (STG) (containing Heschl's gyrus) and the right hippocampal/amygdala area (HC/Am) in sad pieces when compared to neutral pieces. The graph details the average change in BOLD signal for these regions.[12]

This result complements findings from Koelsch et al. (2006), who reported general left amygdala activation with "unpleasant," or dissonant music, highlighting this area's specialized role in processing negative emotions. In this particular study, Koelsch et al. utilized fMRI to discover the neural correlates of processing both "pleasant" (consonant) and "unpleasant" (dissonant) classical musical compositions. In order to create the unpleasant stimuli, the pleasant stimuli were manipulated in online audio editing software to play simultaneously with itself at the dissonant interval of a tritone.

[12] Reprinted with permission from John Wiley and Sons. Martina T. Mitterschiffthaler, Cynthia H.Y. Fu, Jeffrey A. Dalton, et al, 'A functional MRI study of happy and sad affective states induced by classical music,' Human Brain Mapping, 2007, Vol. 28, Issue 11, Copyright (2007).

During exposure to “unpleasant” (i.e., dissonant) music, prominent activations were noted in the left amygdala as well as the hippocampus, parahippocampal gyri, and temporal poles, as shown in Figure 2.8. Such findings detail the involvement of these brain structures in processing stimuli of negative emotional valence.

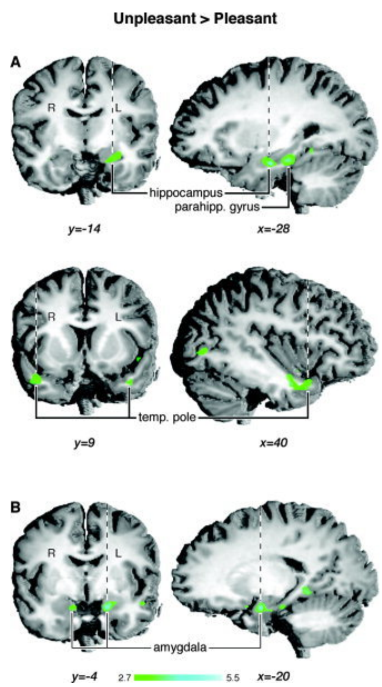

Figure 2.8 Brain areas activated by “unpleasant” music when compared to “pleasant” music

Increased BOLD signal shown in the hippocampus, parahippocampal gyrus, temporal pole, and bilateral amygdala in “unpleasant” pieces when compared to “pleasant” pieces. It is important to note that there was increased activation in the left amygdala compared to the right amygdala.[13]

The parahippocampal gyrus and temporal poles also are densely connected with the amygdala, emphasizing their importance in emotion processing. The parahippocampal gyrus's

[13] Reprinted with permission from John Wiley and Sons. Stefan Koelsch, Thomas Fritz, D. Yves v. Cramon, et al, 'Investigating emotion with music: An fMRI study,' Human Brain Mapping, 2005, Vol. 27, Issue 3, Copyright (2005).

activation during the perception of “unpleasant” music coincides with previous findings (Blood et al. 1999), underlying its pivotal role in the processing of emotionally charged auditory stimuli. The temporal poles have previously been recognized for their role in processing negative emotional valence in acoustic stimuli (Zald and Pardo, 2002). However, contrasting activations were reported when indulging in “pleasant” music (Brown et al. 2004), but the areas of temporal pole activation in that study were higher in the brain than the ones found in this current study. Both regions, receiving inputs from auditory association areas, seem to be integral components of a paralimbic circuit, driving the processing of complex auditory information with emotional nuances.

Music's power to evoke a myriad of emotions in listeners is deeply rooted in the brain's neurobiology. The continuous dynamics of musical tension and its resolution, detected by our subconscious-acquired understanding of musical systems, serve as a foundation for these emotional responses. Neuroimaging studies have provided significant insights into the brain's regions that mediate these emotions, especially the amygdala's nuanced reactions to varying musical stimuli. Notably, the amygdala's intricate responses to musical tension, joy, fear, and sadness underscore its central role in emotion processing. As I advance our understanding, it becomes increasingly evident that our emotional engagement with music is a multifaceted experience, reflecting the beauty and complexity of both the human brain and the art of music itself.

2.2 Neurocooperation and Music-evoked Emotions

When an individual listens to music, what occurs in the brain is far from a simple auditory response. Multiple regions of the brain are activated simultaneously, working in tandem to produce the listener's holistic musical experience. This neural activity is foundational to how humans perceive and respond to music, encompassing emotional reactions, memory retrieval, and even physical sensations.

The previously referenced study by Koelsch et al. (2013) provides profound insights into the ways the auditory cortex, superficial amygdala, and visual cortices collaborate during music-evoked emotions. Their research highlighted that during exposure to fear-evoking music, the amygdala showcased pronounced functional connectivity with visual cortices, potentially heightening visual alertness and attention. In contrast, during joyful musical sequences, the connectivity was more pronounced between the amygdala and the auditory cortex, emphasizing the intertwined nature of joyous auditory perception and emotional processing.

Kraus & Canlon (2012) explore the interconnectedness of the auditory system and limbic structures, shedding light on how external auditory disturbances, such as loud noises, can lead to heightened amygdala activity and stress responses (Figure 2.9). They conclude that the amygdala continuously gauges auditory stimuli for potential emotional significance or threat.

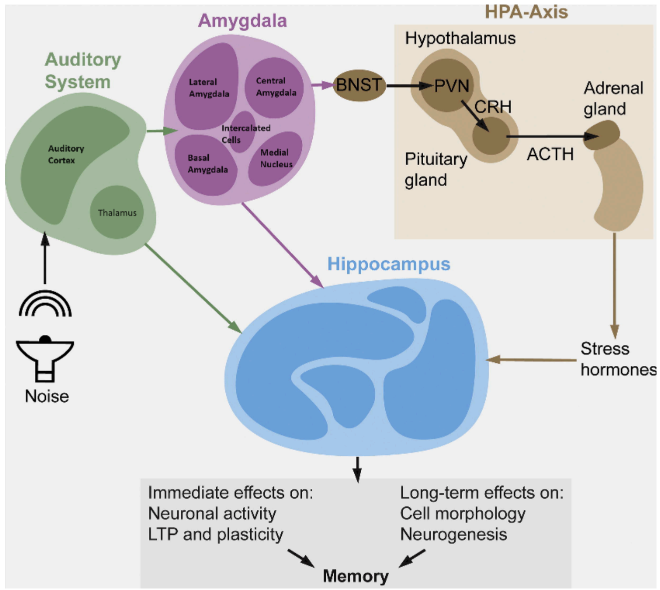

Figure 2.9 Connectivity of the auditory system, amygdala, hippocampus, and the hypothalamus/pituitary gland/adrenal gland (HPA)

When loud sounds are played, the auditory system and amygdala (directly or indirectly through the HPA axis) can modulate the activity of the hippocampus in the long term, potentially forming new memories to avoid sounds in the future.[14]

2.3 Neurotransmitters and music-evoked emotions

It can be concluded that the amygdala, along with multiple distinct regions of the brain, are all in play in the processing of music and its emotions. However, how do these different regions communicate with one another? Within the vast connections of the brain, neurotransmitters emerge as the chemical messengers that enable neurons to communicate. Among these neurotransmitters, dopamine stands out for its intricate involvement in the brain's reward and pleasure systems, playing a pivotal role in regulating emotions, motivations, and feelings of pleasure.

[14] Reprinted from Hearing Research, Vol 288, Issue 1-2, Kari Suzanne Kraus, Barbara Canlon, 'Neuronal connectivity and interactions between the auditory and limbic systems. Effects of noise and tinnitus,' Pages 34-46, Copyright (2012), with permission from Elsevier.

Dopamine is integral to our experiences of pleasure and reward, as well as bodily movement. While often associated with the gratifying effects of food and recreational drugs, its role extends to modulating mood and emotional responses. As shown in Figure 2.11, the release of dopamine to regions known to induce pleasure can help reinforce behaviors, thus playing a role in motivation, learning, and memory.

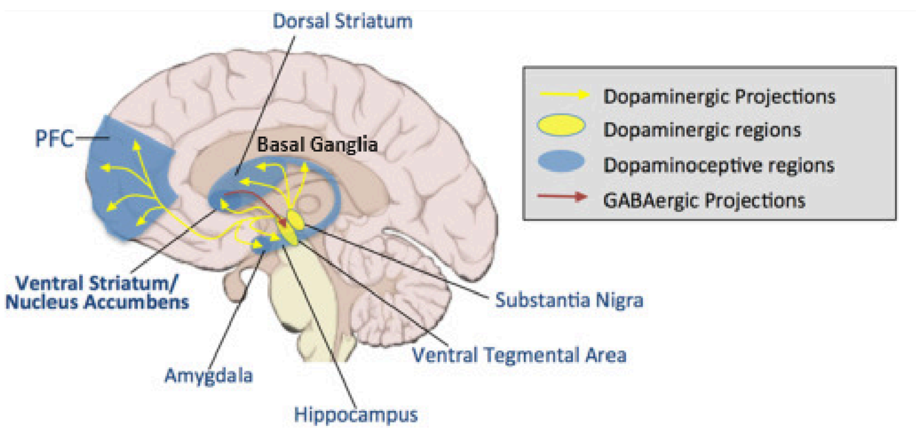

Figure 2.10 Dopaminergic regions in the brain

Neurons from the ventral tegmental area project to multiple dopaminoreceptive structures such as the nucleus accumbens, prefrontal/orbitofrontal cortex (PFC), ventral/dorsal striatum, and amygdala. These connections are called the mesolimbic dopamine (reward) pathway, and the pathway's activation can be used to reinforce behaviors. Neurons from the substantia nigra project to the basal ganglia, an area of the brain known for motor function.[15]

Moving from the general realm of stimuli to the specialized domain of music, Blood & Zatorre (2001) explored the brain's response to music that elicits intensely pleasurable emotions.

[15] Telzer, E. H. (2016). Dopaminergic reward sensitivity can promote adolescent health: A new perspective on the mechanism of ventral striatum activation. Elsevier BV. doi: 10.1016/j.dcn.2015.10.010

The study monitored BOLD signal changes in response to music that provoked the experience of "chills," often indicative of an intense emotional response to music. In order to create these chills, the participants chose music that had consistently evoked chills for themselves in the past.

The subjective reports of chills were matched with physiological markers, such as changes in heart rate and respiration, and those markers revealed that as the intensity of the chills heightened, there were observable BOLD signal changes in regions located in the mesolimbic dopamine pathway, notably the ventral striatum, midbrain, amygdala, and prefrontal cortex, as shown in Figure 2.12.

[REFER TO FIGURE 3 IN BLOOD & ZATORRE (2001)]

Figure 2.11 Correlation between chill intensity and regional cerebral blood flow (rCBF)

Increased BOLD signal from chill intensity is seen in the ventral striatum (VStr) and dorsomedial midbrain (Mb). Decreased BOLD signal from chill intensity is seen in the left hippocampus and amygdala (LH/Am), the right amygdala (RAm), and the medial prefrontal cortex (VMPF).

Interestingly, these patterns mirror those seen in other euphoria and/or pleasurable emotion studies, especially in response to stimuli like cocaine (Brieter et al. 1997). Such parallels further emphasize the significant role of specific brain areas, like the ventral striatum, in reward processes.

Salimpoor et al. (2011) also dove into the role of dopamine in the neurochemical underpinnings of musical pleasure. The study primarily sought to understand how an abstract stimulus like music could evoke feelings similar to tangible rewards like food, largely mediated by dopaminergic activity within the mesolimbic system.

As illustrated in Figure 2.13, changes in endogenous dopamine release were found in the right nucleus accumbens and caudate nucleus at peak emotional arousal during music listening.

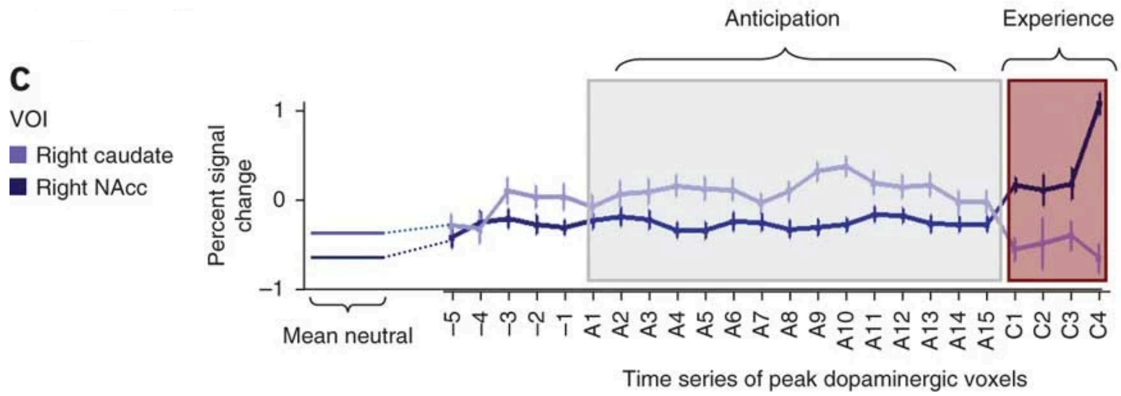

Figure 2.12 Temporal dynamics of chills and dopamine release

the Increased signal change of the right nucleus accumbens (NAcc) compared to the right caudate nucleus during anticipation (A1-A15) and peak arousal (C1-C4) of musical pieces.[16]

Intriguingly, the results from Salimpoor et al. illustrated a functional difference—while dopamine was released in the caudate during the anticipation phase, there was heightened dopamine release in the nucleus accumbens during the experience of peak emotional responses to music. This implies that the anticipation of an abstract reward (like an expected musical climax) can result in dopamine release in a pathway distinct from the one engaged during the experience of the reward itself.

The research's emphasis on music as an abstract yet potent stimulus reinforces the notion of its far-reaching and potentially universal value. In comparison to tangible rewards like food or money that have direct survival implications, the persistent and universal response to music, despite its abstract nature, suggests an evolutionary and socio-cultural significance.

The investigations from Salimpoor et al., in conjunction with the earlier discussed work of Blood and Zatorre (2001), greatly enrich our understanding of the neurochemical foundation

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[16] Reprinted with permission from Springer Nature. Valorie N Salimpoor et al, 'Anatomically distinct dopamine release during anticipation and experience of peak emotion to music,' Nature Neuroscience, 2011, Copyright (2011).

of musical experiences. They reinforce the notion that music's capacity to induce pleasure and reward goes beyond mere cultural appreciation, rooted deeply in our very biology. This convergence of art and science elucidates why, across ages and cultures, humanity has been captivated by the emotional power of music.

This chapter has delved into select studies of the neurobiology of music-evoked emotions, shedding light on the intricate processes within the human brain that underlie our emotional responses to music. The amygdala, a key player in the brain's emotional processing network, has been a focal point of our exploration. I have uncovered how certain parts of the amygdala respond to musical tension, joy, fear, and sadness, illustrating its central role in mediating various emotional experiences triggered by music.

I have also examined the intricate interplay between different brain regions during music-induced emotions. The connectivity between the auditory cortex, the amygdala, and visual cortices during joy and fear has demonstrated the complexity of neural cooperation during emotional responses to music. Additionally, studies have revealed the amygdala's heightened activity in response to auditory disturbances, highlighting its role as a moderator for potential emotional significance.

Neurotransmitters, particularly dopamine, have been shown to play a pivotal role in the brain's reward and pleasure systems during music listening. The release of dopamine in the nucleus accumbens during musical climaxes reinforces music’s impact on our mood and contributes to our ability to form strong emotional connections with musical compositions.

Having navigated the theoretical landscape of music-evoked emotions and the neurobiological underpinnings that give rise to these intricate emotional experiences, we find ourselves at a pivotal juncture. The first part of this thesis has laid the groundwork by exploring diverse models and empirical findings, alongside the neurological mechanisms that underly music's emotional impact. Now, we transition from theoretical and neurobiological insights to the tangible area of music composition.

Chapter 3 marks the beginning of this new phase, where the focus shifts to the detailed musical analysis of my string quartet, Imọlara. Here, we will bridge the gap between the previously discussed abstract principles of emotion evoked by music and their practical application within the framework of composition.

Chapter 3: Imọlara

In this chapter, I embark on a detailed musical analysis of my string quartet, *Imọlara*, the focal point of my honors thesis. I will dissect the piece's compositional fabric, highlighting the specific musical techniques and elements I employ to evoke the range of emotions in each of the four movements and illuminating the interplay between these structural elements of music and their emotional impact. This analysis will demonstrate how compositional techniques like harmony, timbre, and texture combine to create a compelling emotional experience, offering a window into the complex process of translating emotion into music. This exploration will be a technical analysis of the composition and a window into my compositional process, revealing how personal insights and academic research combine to create a musical narrative that is both emotionally resonant and intellectually grounded, reflecting the complexities and nuances of translating emotion into music.

3.1 The Creation and Themes of Imọlara

Imọlara is the Yoruba word for "emotion" or "feeling," and the inspiration for this piece came from an unexpected occurrence. While browsing Instagram, I found a collage that the app had created. This collage, featuring snippets of stories I had posted previously while watching VHS tapes of my childhood, was paired with the second movement of Rachmaninoff's Second Piano Concerto. This combination of visuals and music evoked a deep sense of nostalgia and sadness in me, and it led me to ponder what was it about this particular piece that stirred such profound feelings in me—feelings that definitely would have been different had another piece of music been used in its place.

Building on this experience, I was inspired to compose *Imọlara,* explore the expression of emotions through music, and understand what musical building blocks were the source of these emotions. I analyzed a variety of music from classical, movie, and video game genres used in research from the fields of psychology and neuroscience on music-evoked emotions. My approach involved examining these pieces from a composer's perspective, aiming to discern precisely what musical building blocks contributed to emotional expression that had been scientifically proven and published and what common trends were seen across studies. Through this process, I identified common compositional elements like harmony, timbre, and texture that are typically modified to evoke different emotions and isolated other musical aspects that resonated with my creative vision. These insights were key in shaping the musical expression of *Imọlara*'s four movements, "Ayọ," "Ibinu," "Ijaya," and "Ibanuje," each of which is meant to represent a different emotion—joy, anger, fear, and sadness. I chose these particular emotions because they provide a broad spectrum for musical expression. These discrete categories allow for creative freedom while also being distinct enough to offer clear thematic direction. Some studies, like Vieillard et al. (2008) and Balkwill & Thompson (1999) tend to focus on discrete emotions that still contain vagueness, like "peacefulness," which I believe could still fall under broader categories like joy or happiness. My selection aims to encompass a wider emotional range while avoiding such ambiguities.

A central thematic element in *Imọlara* is the heartbeat motif, represented by a dotted eighth note followed by a sixteenth note (Figure 3.1). This rhythmic motif is a foundational element of the piece, acting as a unifying thread through all four movements. In developing this motif, I was mainly influenced by the findings from Krumhansl's 1997 study. This study reveals how music-evoked emotions are associated with changes in heart rate (among many other physiological markers), as measured by the interbeat interval (IBI). Sadness-evoking excerpts showed the most significant increase in IBI, indicating a slower heart rate, with joy-evoking and fear-evoking excerpts showing a lesser increase. These insights were key in shaping how I adapted the heartbeat motif for each movement of *Imọlara*, tailoring it to accurately reflect the intended emotional impact. The implementation of this motif throughout the piece will be further discussed in the analysis of each movement.

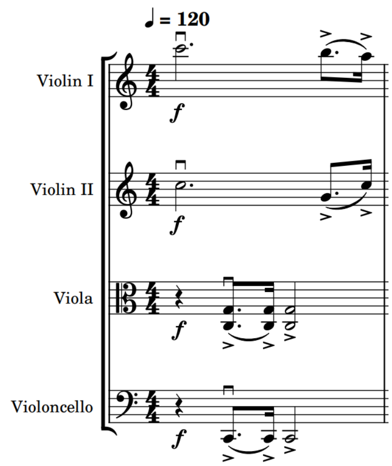


Figure 3.1 The Heartbeat Motif. The first example of the heartbeat motif is shown in the first measure of the first movement, “Ayọ” of *Imọlara*. It first appears in the viola and cello parts on the second beat of the measure, then is echoed by the violins on the last beat of the measure.

3.2 Movement I: "Ayọ"

"Ayọ," the title of the first movement of *Imọlara*, is the Yoruba translation for “joy” and it encapsulates the essence of this emotion in line with my artistic vision. Joy can have several interpretations, thus this movement takes the listener on a journey that explores the joy of adventure. In the first section, ending at measure 66, I aimed to portray a grand journey across expansive landscapes, where the destination is not as important as the travel itself, intending to express a sense of exploration. The second section, starting at measure 67, continues this narrative by delving into the excitement and curiosity of venturing into new, uncharted territories, further enriching the adventurous spirit that defines my artistic vision in "Ayọ."

To convey this sense of joy, I employ various musical elements. The timbre is brought to life with articulations like *staccato* (Figure 3.2) and trills (Figure 3.3), adding to the movement's lively character. The entire second section of the piece features *pizzicato* (Figure 3.4), giving a more playful character to the music. Additionally, the movement uses the major mode, contributing to the overall joyful atmosphere. The heartbeat motif in "Ayọ," as shown in Figure 3.1, is adapted to reflect joy's physiological expressions, with a tempo of 120 beats per minute (BPM). This tempo is what the subsequent alterations of the motif will be based on.

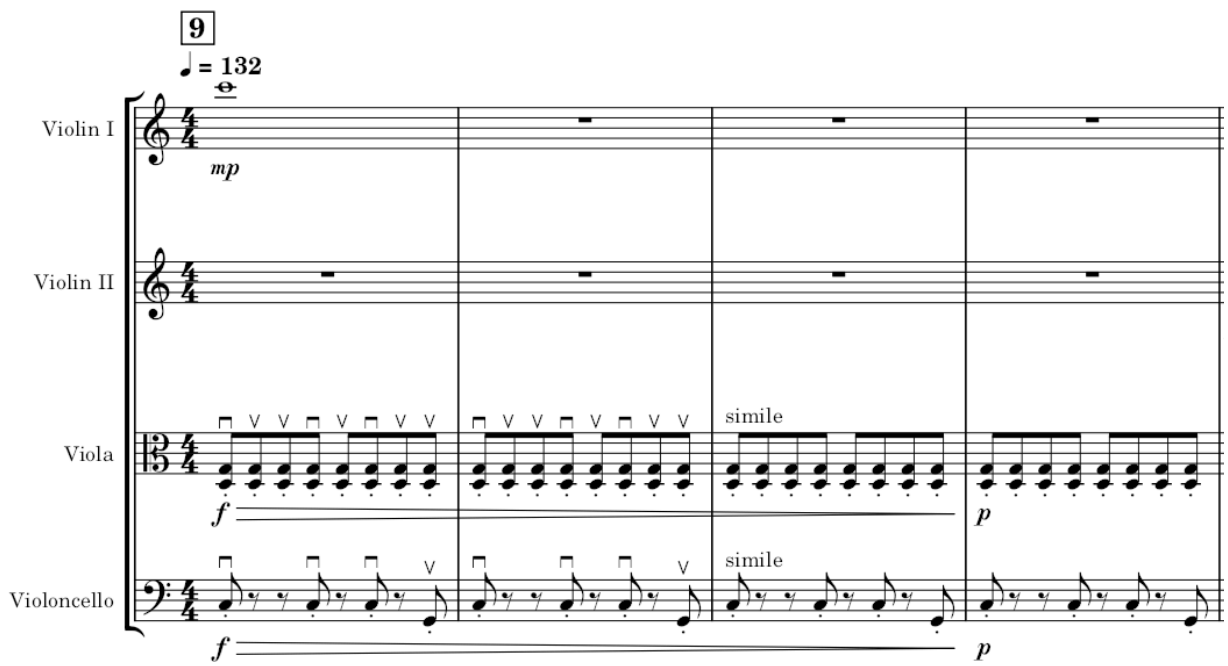


Figure 3.2. Articulation: Staccato. First shown in mm. 9–12 of "Ayọ," the viola and cello parts demonstrate *staccato* articulation. The down bows create a subtle accent on specific notes that would otherwise lack nuance if I were to provide printed accents.

Figure 3.3. Articulation: Trills. In this passage, beginning in m. 37 of "Ayọ," the second violin and viola trade off on this upward flair, ending on a trill. The cello has the superimposed rhythmic figure of both inner voices, which provides some stability to the flittering nature of this section.

Figure 3.4. Articulation: Pizzicato. The second half of "Ayọ" begins here in m. 67 with an echoing rhythmic figure in the lower strings. The remainder of this movement is in 5/4 time,

adding a sort of destabilizing groove that is entirely different from the previous passages of the movement.

While composing this movement, I drew inspiration from various pieces that evoke joy. For instance, the 5/4 time signature in music from the film *The Rainmaker,* which was utilized in Eerola & Vuoskoski's 2011 study, influenced the second section of "Ayọ." The third movement of Niccolò Paganini's Violin Concerto No. 1, which was used in Koelsch et al.'s 2013 study, along with Antonín Dvořák's Slavonic Dance No. 8, J.S. Bach's Bourrée (BWV 1066) and Réjouissance from Orchestral Suite No. 4 (BWV 1069), used in Koelsch et al.'s 2006 study, served as references for using *staccato* to create an upbeat mood. The first movement of Mozart's *Eine Kleine Nachtmusik*, used in Mitterschiffthaler et al.'s 2007 study, and the third movement of Beethoven's Piano Concerto No. 4, used in Peretz et al.'s 1998 study, also provided examples of light, bouncy articulations and the use of trills. "La volière" from Saint-Saëns' *Carnaval des Animaux,* also used in Peretz et al.'s 1998 study, and the music from the film *The Omen*, used in Eerola & Vuoskoski's 2011 study, inspired my use of pizzicato in the second half of "Ayọ."

"Ayọ" sets the stage for the emotional journey of *Imọlara*, establishing a tone of joyful exploration. This movement is not just an introduction to the piece but a doorway into the diverse emotional landscape that *Imọlara* traverses.

3.3 Movement II: "Ibinu"

"Ibinu," the title of the second movement of *Imọlara*, is the Yoruba translation for the word anger, and "Ibinu" encapsulates this intense emotion through its dynamic musical narrative. The movement is divided into three distinct sections: the first section represents a raw form of anger, starting off the piece with an intense soundscape. In the second section, with a dance-like rhythm in 9/8 time, I explored the passion and intensity of anger. The third section serves as a recapitulation of the first, lending a structure reminiscent of ternary form to the entire movement, where the initial themes of anger are revisited and developed.

I employ a range of musical techniques to express anger in "Ibinu." The harmony is based on the Phrygian mode, particularly emphasizing the dissonant flat 2 (♭2) scale degree (Figure 3.5). This choice is more personal, as I did not find specific literature on music-evoked emotions that demonstrated a correlation between this mode and anger. However, I believe it resonated well with my creative vision. The entire movement is characterized by heavy accents, as opposed to the more stylistic ones in “Ayọ,” first appearing in the movement’s opening passage (Figure 3.6). *Tutti* orchestral hits, shown in measures 10 and 12 (Figure 3.7), were inspired by the music from the film *Lethal Weapon 3* (Eerola & Vuoskoski, 2011). Additionally, loud chord bursts, as found in *The Rainmaker* (Eerola & Vuoskoski, 2011), are evident in measures 21 and 25 of "Ibinu" (Figure 3.8).

Figure 3.5. Harmony: Phrygian Mode “Ibinu” is primarily in the key of E Phrygian. The ♭2 scale degree (pitch F), first appears in the cello part in beat four of m. 6 and then on the last note of the violins of that same measure. The dissonance caused by the pitch G in the violins over the F and A in the cello and viola, respectively, adds to the emotional turmoil of the movement.

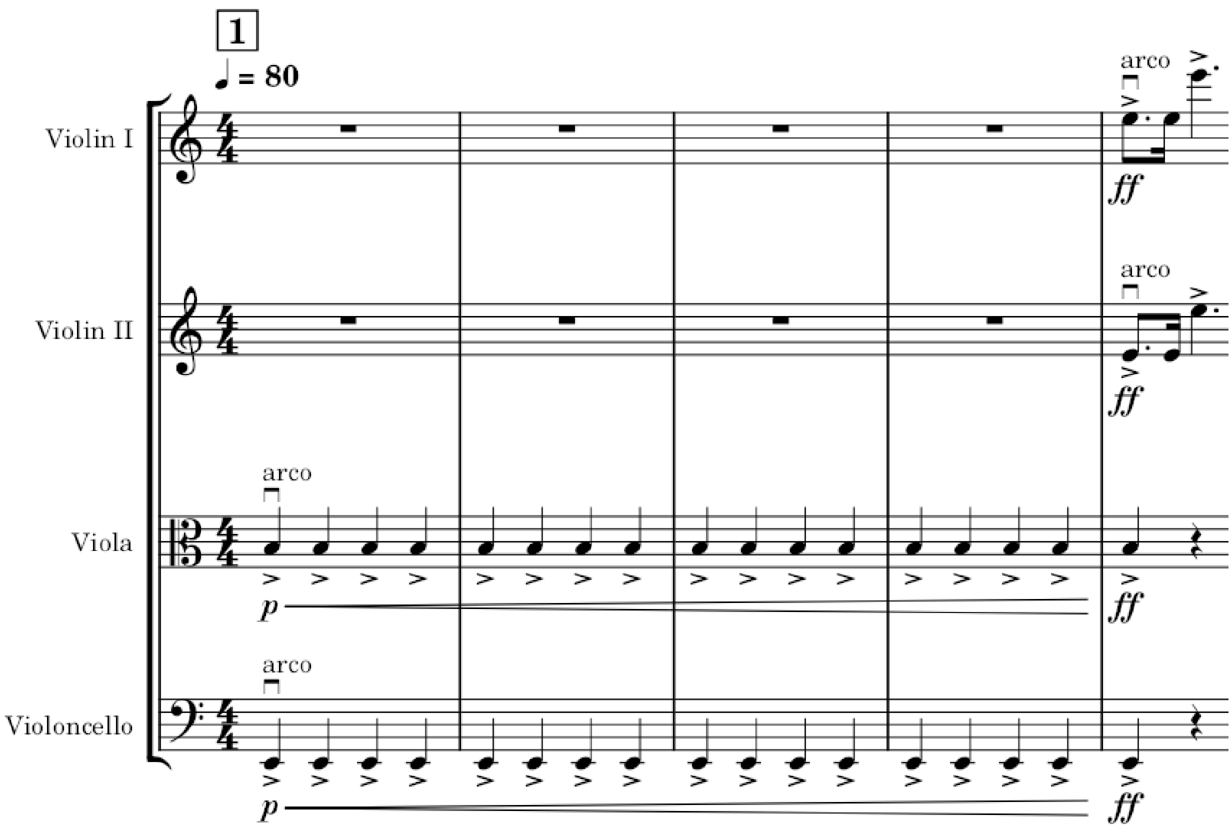


Figure 3.6. Articulation: Accents Accents first appear in m. 1 of “Ibinu” in the viola and cello. They start from the *piano* dynamics, building up to m. 5, where the violins enter dramatically with an octave leap in *fortissimo*. This dynamic swell represents a buildup of anger that is released in a shout.

Figure 3.7. Texture: Tutti Orchestral Hits This passage includes a call and response between the first violin and the rest of the string quartet. The *tutti* accented triplets in mm. 10 and 12 contribute to emphasizing those beats.

Figure 3.8. Texture: Chord Bursts shown is mm. 19–26. This passage features the stacking of a rhythmic motive from the viola to the first violin. The accented beat 2 of mm. 21 and 25, where the first violin joins, are particularly dense and powerful.

The consistent rhythmic pulsation in the lower instruments, a concept found scattered throughout the three sections, draws inspiration from *The Alien Trilogy* (Eerola & Vuoskoski, 2011). The aggressive 32nd-note flurries played by the violins, beginning in m. 15, were inspired by music from *Cape Fear* (Eerola & Vuoskoski, 2011) (Figure 3.9). The "Man of Galilee CD1" (Eerola and Vuoskoski, 2011) influenced the use of complex time signatures and meter changes, particularly in the second section of "Ibinu," where the rhythm switches between groupings of 2+2+2+3 and 3+2+2+2 (Figure 3.10).

Figure 3.9. Texture: 32nd-note flurries. The 32nd note flurries in the violins, starting in m. 15, add a layer of forward-pushing energy above the viola and cello, which repeat the main theme of this movement.

(a)

(b)

Figure 3.10a/b. Changing Meter The 9/8 bar is grouped in 2+2+2+3 in mm. 43–46 (top) and 3+2+2+2 in mm. 67–70 (bottom), as evidenced by the beaming in the viola and cello parts.

In adapting the heartbeat motif for "Ibinu," I ventured beyond the scope of Krumhansl's 1997 study, which unfortunately does not delve into the emotion of anger. This lack of scientific basis for music-evoked anger's effect on heart rate led me to focus on modifying the motif's timbre as opposed to its speed. This transformation is manifested in the motif, frequently articulated with accents and emphasized within a loud dynamic (Figure 3.11). This decision demonstrates an exploration into uncharted territory in the physiological effects of music-evoked emotions, as I musically interpreted anger in a way that resonated with my personal creative vision of "Ibinu."

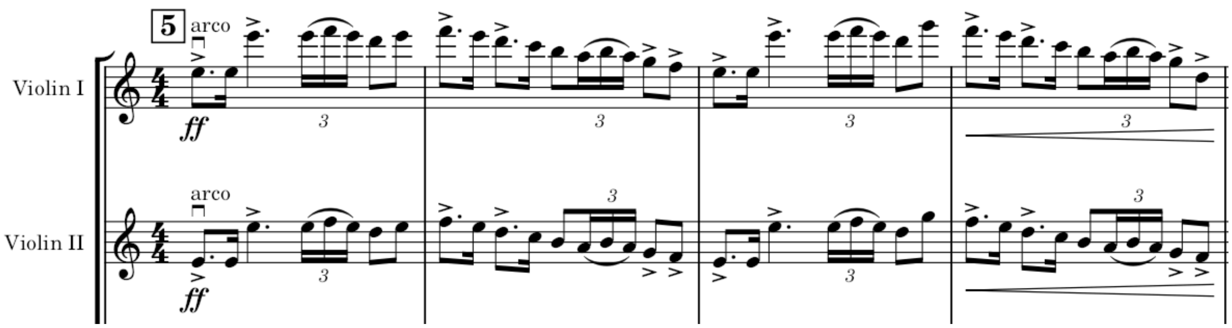


Figure 3.11. Heartbeat Motif in "Ibinu" The heartbeat motif is shown periodically in the main theme of "Ibinu," such as on the first beat of mm. 5–8 and the second beat of mm. 6 and 8.

"Ibinu" plays a crucial role in the broader narrative of *Imọlara*, adding depth and contrast to the emotional journey. By exploring the multifaceted nature of anger, this movement contributes to the diverse emotional tapestry that *Imọlara* weaves, offering a vivid portrayal of this intense emotion.

3.4 Movement III: "Ijaya"

"Ijaya," the title of the third movement of *Imọlara*, is the Yoruba translation of the word for "fear." It captures the essence of fear in a traditional sense, evoking a sense of the unknown and the unpredictable. The movement is structured into multiple distinct sections, creating an atmosphere of suspense and surprise.

The goal of "Ijaya" is to instill a sense of fear and unease in the listener, reflecting its role in the emotional landscape of *Imọlara*. This is achieved through combining different musical elements designed to create a fearful atmosphere. The harmonic progression, particularly the movement from the tonic (i) chord to the minor flat-six (♭vi) and major three (III) chords, plays a pivotal role in establishing the mood (Figure 3.12). Additionally, the timbre is enriched with various extended techniques, including harmonics (Figure 3.13), Bartók (or snap) *pizzicato* (Figure 3.14), *glissando* (Figure 3.15), *tremolo* (Figure 3.13), and *sul ponticello* (Figure 3.16). Accents are also used (Figure 3.17), but in this movement, they are sharper, intended to surprise the listener, as opposed to the heavier accents in "Ibinu."

Figure 3.12. Harmony: Chromatic Mediants. In this passage, starting at measure 42 of "Ijaya," the harmony switches from i to ♭vi in measure 44 and III in measure 48.

Figure 3.13. Timbre: Artificial Harmonics and Tremolo. In this passage, starting in m. 50 of "Ijaya," the first violin utilizes artificial harmonics. This technique causes the heard pitch of a note to sound two octaves above the notated pitch, making the sound more "glassy" and flute-like. The second violin and viola play *tremolo* on each of the eighth notes in this passage, producing a frantic edge.

Figure 3.14. Timbre: Bartók Pizzicato. In this passage, starting in m. 7 of “Ijaya,” the first and second violins feature the Bartók *pizzicato*, during the last half of m. 10 and the beginning of m. 11. This technique makes an aggressive snapping sound as the string rebounds on the instrument's fingerboard.

Figure 3.15. Timbre: Glissando. In this passage, starting in m. 23 of “Ijaya,” the first violin plays a *glissando* down to the open E string. This slide, augmented by a very wide vibrato, is intended to imitate a scream.

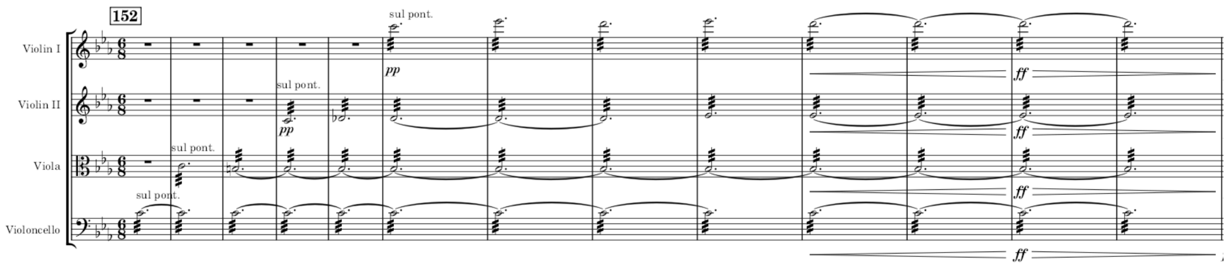


Figure 3.16. Timbre: Sul ponticello. In this passage, starting in m. 152 of “Ijaya,” the strings stack *sul ponticello tremolo* gesture from the cello to the first violins. This technique gives the *tremolo* figure a very “glassy” timbre, which sounds quite eerie.

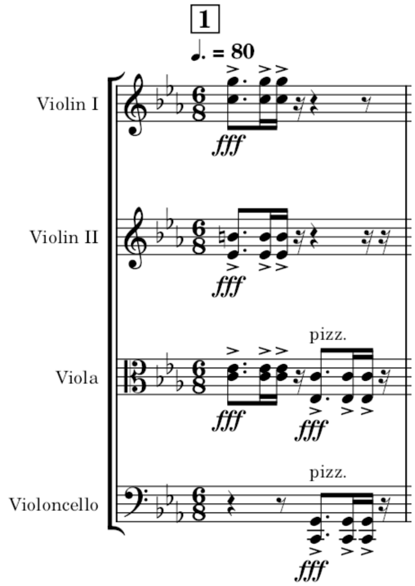


Figure 3.17. Timbre: Accents The previous movement (Ibinu) ends in silence, starkly contrasting with the startling opening *fff* chords of "Ijaya," acting as jumpscare for the audience.

The compositional techniques in "Ijaya" draw inspiration from various fear-evoking works. The dissonances in high strings and use of *glissando* are inspired by the music from *Batman Returns* (Eerola & Vuoskoski, 2011), *The Fifth Element* (Eerola & Vuoskoski, 2011), and Michael Giacchino's "Monsters Are Such Interesting People" (from the TV series *Lost*) (Koelsch et al., 2013). The dynamic swelling, a prominent feature throughout "Ijaya," mirrors techniques used in the music from *JFK* (Eerola & Vuoskoski, 2011). The use of *tremolo* is influenced by Danny Elfman's song The Killing (Koelsch et al., 2013) and Modest Mussorgsky's *Night on Bald Mountain* (Eerola & Vuoskoski, 2011). Harmonic movements, such as the transition from the i chord to the ♭vi and III chords, are influenced by the original compositions labeled P01 and P10 from Vieillard et al.'s study (2008).

In "Ijaya," the tempo is 80 BPM per dotted quarter note, so the heartbeat motif is presented at the same tempo as in “Ayọ” (Figure 3.18), which aligns with Krumhansl's 1997 study, with fear-evoking and joy-evoking excerpts having similar heart rate changes.

Figure 3.18. Heartbeat Motif in “Ijaya” The heartbeat motif is first shown in the opening measure of “Ijaya.” An additional sixteenth note was added onto the traditional dotted-eighth-note- and sixteenth-note motifs to emulate the arrhythmic stutter that one might feel when startled.

Through "Ijaya," the listener is invited to confront and experience the multifaceted nature of fear, further enriching the emotional journey of *Imọlara*.

3.5 Movement IV: "Ibanuje"

Lastly, "Ibanuje," the Yoruba word for “sorrow,” is the concluding movement of *Imọlara*. It delves into a profound sense of melancholy and nostalgia, different from the clichéd sadness typically associated with the minor mode. In "Ibanuje," I sought to explore a more nuanced and introspective type of sorrow, akin to the nostalgic sadness in Rachmaninoff's work that originally inspired this thesis. During the composition of this movement, I experienced the loss of my uncle, to whom "Ibanuje" is dedicated, adding a deeply personal layer to the piece.

The movement's mood is somber and reflective, intending to evoke a deep sense of melancholy in the listener. To achieve this, I used a blend of musical elements. Since the minor mode is traditionally synonymous with sadness, I chose to primarily use the major mode in this movement to avoid that cliché. However, a section in the minor mode is included, effectively conveying the intended emotion in a more traditional sense (Figure 3.19). The timbre of "Ibanuje" is enriched with *tremolo* in certain sections, much less aggressive than the type used in “Ibajune,” and the texture becomes relatively thin, with a 4–3 suspension theme serving as a transition between different sections of the movement (Figure 3.20).

Figure 3.19. Harmony: Minor Mode, illustrated in mm. 19–23. The shift to the minor mode happens in m. 19, with the D minor chord (subdominant (iv) in the movement's original key of A ♭ major) simultaneously functioning as the submediant (vi) in the new key of F minor, which starts in m. 20.

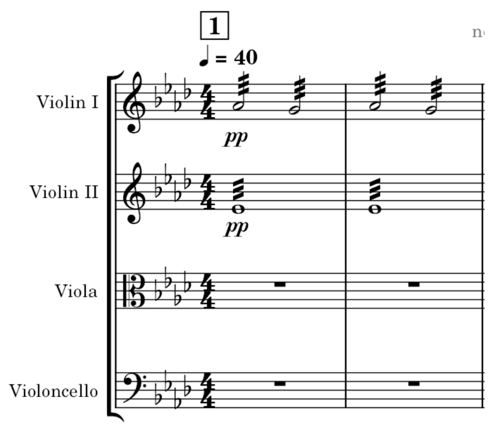


Figure 3.20. Texture: Suspension Theme, shown here in mm. 1_2 of "Ibanuje," the first violin's movement from A-flat to G natural over the second violin's E-flat pedal creates a 4–3 suspension. These notes form the first, fifth, and seventh scale degrees, respectively, which implies the harmony of a major seventh chord (which normally includes the third scale degree).

Drawing inspiration from the second movement of Rachmaninoff's Piano Concerto No. 2 (Peretz et al., 1998), "Ibanuje" utilizes the minor four-chord (iv), particularly in climactic moments (Figure 3.21). Other references include music from *Angel Heart*, *The English Patient*, *Running Scared*, *The Portrait of a Lady*, *Big Fish*, and *Man of Galilee* (Eerola & Vuoskoski, 2011) for their use of the minor mode. Music from *Dracula (1931)* (Eerola & Vuoskoski, 2011) is referenced for its major seventh chords, capturing a nostalgia-infused sadness, reflected in a 4–3 suspension theme prevalent throughout "Ibanuje" (Figure 3.20). The movement's major mode and thin texture were also inspired by music from *The English Patient* (Eerola & Vuoskoski, 2011).

The heartbeat motif in "Ibanuje" is the slowest in the entire work, with a tempo of 40 BPM, aligning once again with the sad-excerpt-induced lower heart rate observed from Krumhansl's 1997 study. This slower, more measured rhythm effectively captures the essence of sorrow (Figure 3.22).

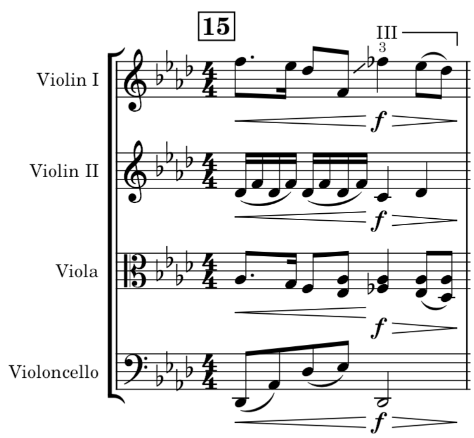


Figure 3.21. Harmony: Minor Four Chord. An example of the minor four-chord is shown here on the fourth beat of m. 15, the first musical climax of the piece. The altered F ♭ in the first

violin and viola, as opposed to F♮, gives this D chord a minor sound. The dramatic shift of the first violin on beat three also adds to the climactic effect.

Figure 3.22. Heartbeat Motif The heartbeat motif is shown here on the first beats of mm 8–11 of "Ibanuje." The second violin and viola join the first violin on the motif in m. 9 and trade-off supporting the melody in mm. 10 and 11.

My personal journey in composing "Ibanuje" was both emotional and introspective. The beginning of the movement, inspired by "Nimrod" from Edward Elgar's *Enigma Variations,* transitions *attacca* from the preceding "Ijaya." The second violin carries their E♭ tremolo from the end of "Ijaya," recontextualizing it into an A♭ major chord's fifth in "Ibanuje." The themes from all previous movements are revisited, showing how memories once colored with joy, anger, and fear can be reinterpreted through the lens of sadness and nostalgia. The movement also features an inverted version of the heartbeat motif, first introduced in "Ayọ" and echoed here in the second violin between mm. 16 and 19, symbolizing a reversal or transformation of emotions. At the end of the piece, this inverse motif, paired with the recurring thinly textured theme, progressively fades, growing quieter with each repetition. This gradual diminuendo, particularly from m. 61 to the end, serves as a farewell not only to "Ibanuje" and *Imọlara* as a whole but also to my uncle.

"Ibanuje" weaves together the themes from the entire composition, demonstrating how emotions can transform over time and in reflection. It concludes the emotional journey of *Imọlara*, bringing a sense of closure and introspection. The recurring themes and the transformation of the heartbeat motif throughout this movement underscore the complexity and depth of sorrow, offering a poignant conclusion to the exploration of human emotions in *Imọlara*.

Bibliography

Argstatter, H. (2015). Perception of basic emotions in music: Culture-specific or multicultural? SAGE Publications. doi: 10.1177/0305735615589214

Balkwill, L.-L., & Thompson, W. F. (1999). A Cross-Cultural Investigation of the Perception of Emotion in Music: Psychophysical and Cultural Cues. University of California Press. doi: 10.2307/40285811

Barrett, L. F., & Wager, T. D. (2006). The Structure of Emotion. SAGE Publications. doi: 10.1111/j.0963-7214.2006.00411.x

Blood, A. J., & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. Proceedings of the National Academy of Sciences. doi: 10.1073/pnas.191355898

Blood, A. J., Zatorre, R. J., Bermudez, P., & Evans, A. C. (1999). Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions. Springer Science and Business Media LLC. doi: 10.1038/7299

Breiter, H. C., Gollub, R. L., Weisskoff, R. M., Kennedy, D. N., Makris, N., Berke, J. D., … Hyman, S. E. (1997). Acute Effects of Cocaine on Human Brain Activity and Emotion. Elsevier BV. doi: 10.1016/s0896-6273(00)80374-8

Brown, S., Martinez, M. J., & Parsons, L. M. (2004). Passive music listening spontaneously engages limbic and paralimbic systems. Ovid Technologies (Wolters Kluwer Health). doi: 10.1097/00001756-200409150-00008

Clore, G. L., Ortony, A., & Foss, M. A. (1987). The psychological foundations of the affective lexicon. Journal of Personality and Social Psychology, 53(4), 751–766. doi:10.1037/0022-3514.53.4.751

Eerola, T., & Vuoskoski, J. K. (2011). A comparison of the discrete and dimensional models of emotion in music. Psychology of Music, 39(1), 18–49. doi:10.1177/0305735610362821

Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, R., … Koelsch, S. (2009). Universal recognition of three basic emotions in music. Current Biology: CB, 19(7), 573–576. doi:10.1016/j.cub.2009.02.058

Johnson-Laird, P. N., & Oatley, K. (1989). The language of emotions: An analysis of a semantic field. Cognition & Emotion, 3(2), 81–123. doi:10.1080/02699938908408075

Koelsch, S., Fritz, T., v. Cramon, D. Y., Müller, K., & Friederici, A. D. (2006). Investigating emotion with music: An fMRI study. Wiley. doi: 10.1002/hbm.20180

Koelsch, S., Skouras, S., Fritz, T., Herrera, P., Bonhage, C., Küssner, M. B., & Jacobs, A. M. (2013). The roles of superficial amygdala and auditory cortex in music-evoked fear and joy. Elsevier BV. doi: 10.1016/j.neuroimage.2013.05.008

Kraus, K. S., & Canlon, B. (2012). Neuronal connectivity and interactions between the auditory and limbic systems. Effects of noise and tinnitus. Elsevier BV. doi: 10.1016/j.heares.2012.02.009

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. Revue Canadienne de Psychologie Experimentale [Canadian Journal of Experimental Psychology], 51(4), 336–353. doi:10.1037/1196-1961.51.4.336

Laukka, P. (2006). Uses of music and psychological well-being among the elderly. Springer Science and Business Media LLC. doi: 10.1007/s10902-006-9024-3

Lehne, M., Rohrmeier, M., & Koelsch, S. (2013). Tension-related activity in the orbitofrontal cortex and amygdala: an fMRI study with music. Oxford University Press (OUP). doi: 10.1093/scan/nst141

Merrill, J., Omigie, D., & Wald-Fuhrmann, M. (2020). Locus of emotion influences psychophysiological reactions to music (M. Sadakata, Ed.). Public Library of Science (PLoS). doi: 10.1371/journal.pone.0237641

Mitterschiffthaler, M. T., Fu, C. H. Y., Dalton, J. A., Andrew, C. M., & Williams, S. C. R. (2007). A functional MRI study of happy and sad affective states induced by classical music. Wiley. doi: 10.1002/hbm.20337

Peretz, I. (1998). Music and emotion: perceptual determinants, immediacy, and isolation after brain damage. Elsevier BV. doi: 10.1016/s0010-0277(98)00043-2

Rohrmeier, M., & Rebuschat, P. (2012). Implicit Learning and Acquisition of Music. Wiley. doi: 10.1111/j.1756-8765.2012.01223.x

Russell, J. A. (1980). A circumplex model of affect. American Psychological Association (APA). doi: 10.1037/h0077714

Salimpoor, V. N., Benovoy, M., Larcher, K., Dagher, A., & Zatorre, R. J. (2011). Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. Springer Science and Business Media LLC. doi: 10.1038/nn.2726

Thayer, R. E. (1989). The origin of everyday moods: Managing energy, tension, and stress. Oxford University Press.

Vieillard, S., Peretz, I., Gosselin, N., Khalfa, S., Gagnon, L., & Bouchard, B. (2008). Happy, sad, scary and peaceful musical excerpts for research on emotions. Informa UK Limited. doi: 10.1080/02699930701503567

Zald, D. H., & Pardo, J. V. (2002). The Neural Correlates of Aversive Auditory Stimulation. Elsevier BV. doi: 10.1006/nimg.2002.1115

Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: characterization, classification, and measurement. Emotion (Washington, D.C.), 8(4), 494–521. doi:10.1037/1528-3542.8.4.494

Oluwasijibomi Osunkoya

Imolara

INSTRUMENTATION

2 Violins
Viola
Cello

PROGRAM NOTE

"Imolara," meaning "emotion" or "feeling" in Yoruba, is a string quartet I composed as part of my honors thesis. The piece delves into the complex relationship between music and emotion, drawing from an extensive analysis of research in the fields of neuroscience, music cognition, and psychology on music-evoked emotions. All of these studies used music from classical, film, and video game genres, and by listening and analyzing these pieces through the lens of a composer, I identified key musical elements—such as timbre, texture, and harmony—that elicit specific emotional responses across multiple studies. This research informed the compositional choices for "Imolara," with each movement intentionally crafted to evoke a distinct emotion. The work serves as a creative exploration of how music can tap into and express the depths of human emotion.

I. Ayo

"Joy"


A
♩ = 132
Adventurous
8
mp
p
f
simile
simile
12
mf
p
p
simile
16


20
mp
f
mp
mp
simile
23
27
mf
mf
mf


31
mf
36
B
f
tr
simile
39
tr
simile


42
45
48


51
C
mf
mf
simile
55
59
f
simile
simile


63
rit.
3
tr
tr
tr
D
♩ = 132
Playful!
67
pizz.
mp
pizz.
f
p
pizz.
f
p
72
pizz.
f
f
f


76
f
f
mp
mp
mp
80
E
f
f
84
f
p
p

88
91
94
F
f
mp
arco
mf


98
f
f
pizz.
f
f
102
arco
mf
mp
arco
mf
mp
107
pizz.
f
f
pizz.
f
f
mp


111
117
accel. poco a poco
122
♩ = 200
f
ff

II. Ibinu

"Anger"


Like a swarm of angry bees
Like a swarm of angry bees


17
3
3
18
ff
ff
3
3
ff
21
ff


27
ff
f
ff
f
30
p
p
ppp


A
♩. = 90
Fiery
35
p
mp
mp
39
pp
(V)
mf
mf
mf
f
f
f


43
ff
46
Like your chair was lit on fire
ff
ff
ff
48


51
f
mf
mf
55
f
B
59
p
p
mp
mp
p
mp


63
(V)
pp
mf
f
67
ff


70
ff
ff
ff
ff
73
pizz.
pizz.
pizz.
pizz.
mf
mf
mf
78
f


♩ = 80
83
arco
3
p
♩. = 90
f
arco
p
f
p
mf
arco
mp
f
p
mf
arco
mp
f
p
mf
86
♩ = 80
arco
p
f
p
arco
3
f
p
pizz.
mp
f
p


C
♩. = 90
89
arco
p
p
mp
mp
mp
93
(V)
pp
mf
mf
mf
f
f
f


97
ff
100
ff
ff
ff
103


107
D
♩ = 80
110
p
p
p
112
simile


114
ff
3
simile
f
f
f
116
arco
ff
3
118
arco
ff
3


120
arco
ff
3
3
accel. poco a poco
122
arco
ff
3
3
124
arco
ff
3
3


126
ff
128
130
♩ = 120
3

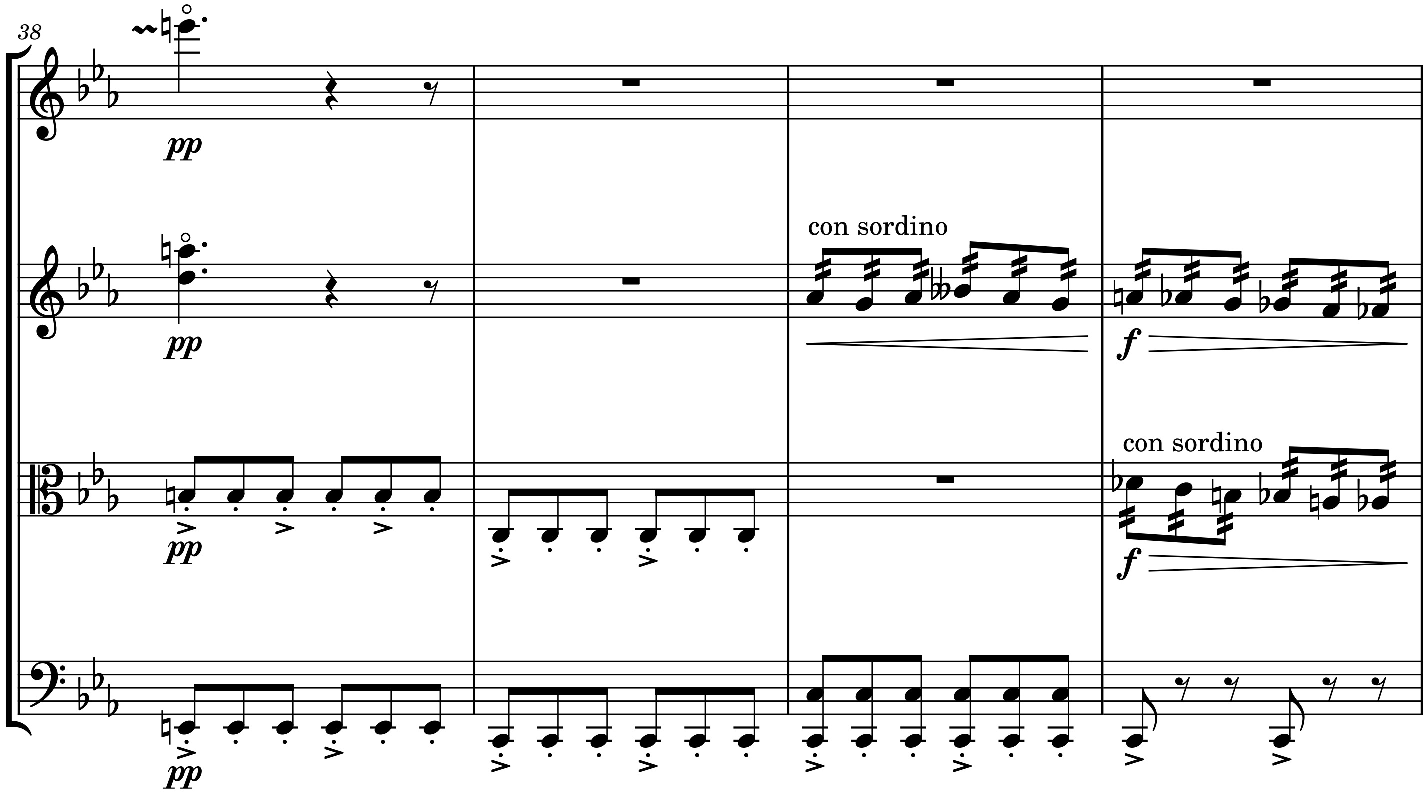

132
3
3
ff
ff
tremolo
ff
ff
135
mf
mp
p
p

III. Ijaya

"Fear"


A
arco
fff
3
arco
fff
3
13
arco
pp
ff
arco
pp
ff
18
pp
pp
pp
pp


23
like a scream
gliss.
fff
ff
pp
28
33
like a scream
gliss.


38
pp
pp
con sordino
f
con sordino
f
pp
pp


42
B
Anxiously
pp
f
pp
f
pp
f
f

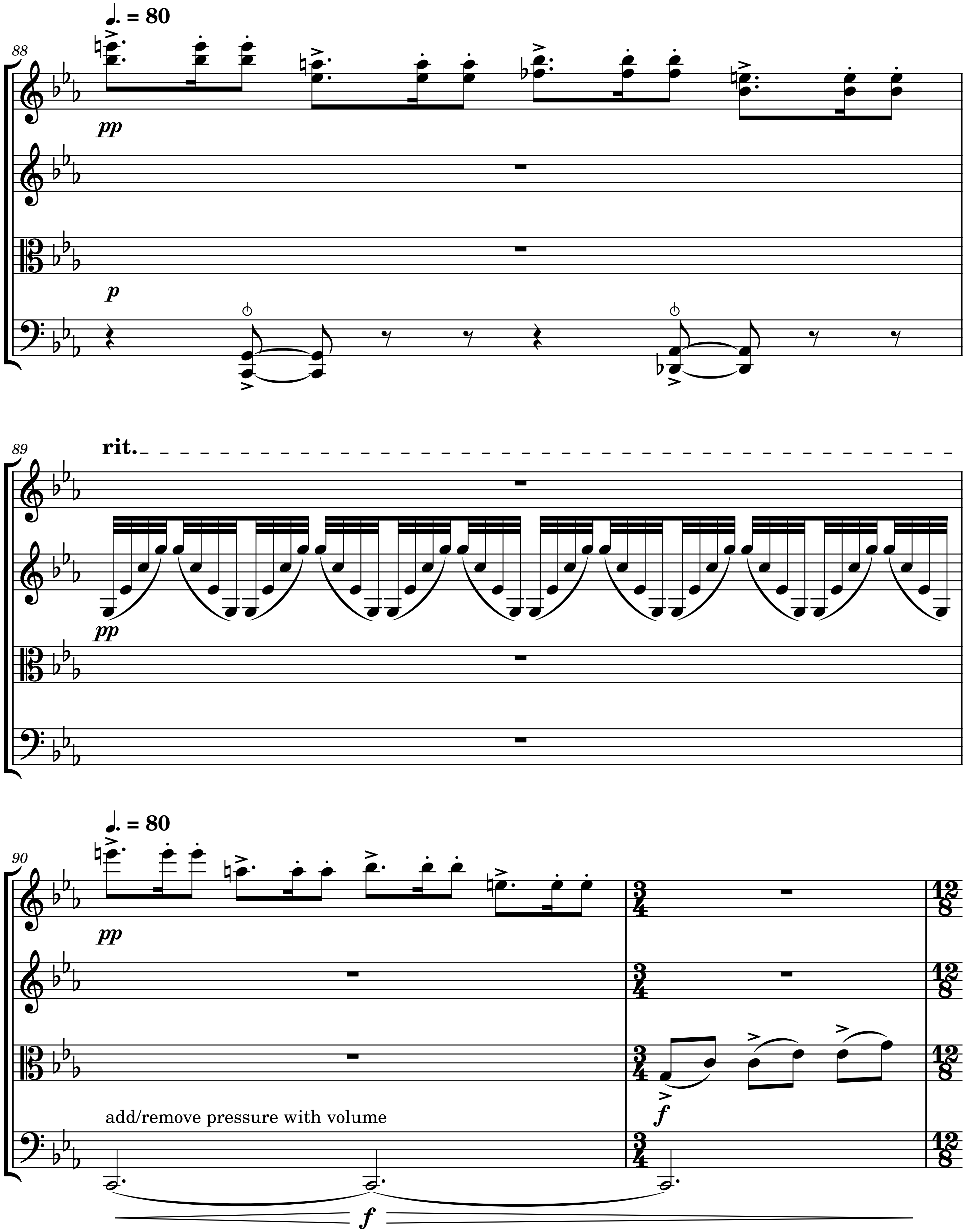

46
pp
pp
pp
simile
pp
f
f
f
f


50
Sooo spooky
pp
mp
f
pp
mp
pp
mp
pp
mp


54
pp
mp
f
58


62
pp
pp
pp
f
mp
mp
pp
mp
66
pp
pp
senza sordino
ff
senza sordino
ff
pp
71
ppp
f
ppp
f
ppp


78
C
Freely
ppp
pp
rit.
f
82
♩. = 80
pp
rit.
♩. = 80
pp
pp
pp
pp
85
rit.
♩. = 80
pp
rit.
pizz.
ff
ff
2
2
2
f


♩. = 80
88
pp
p
89
rit.
pp
♩. = 80
90
pp
add/remove pressure with volume
f
f


92
pp
f
95
ff
100
fff
pizz.
p
arco
very rough gliss
gliss.

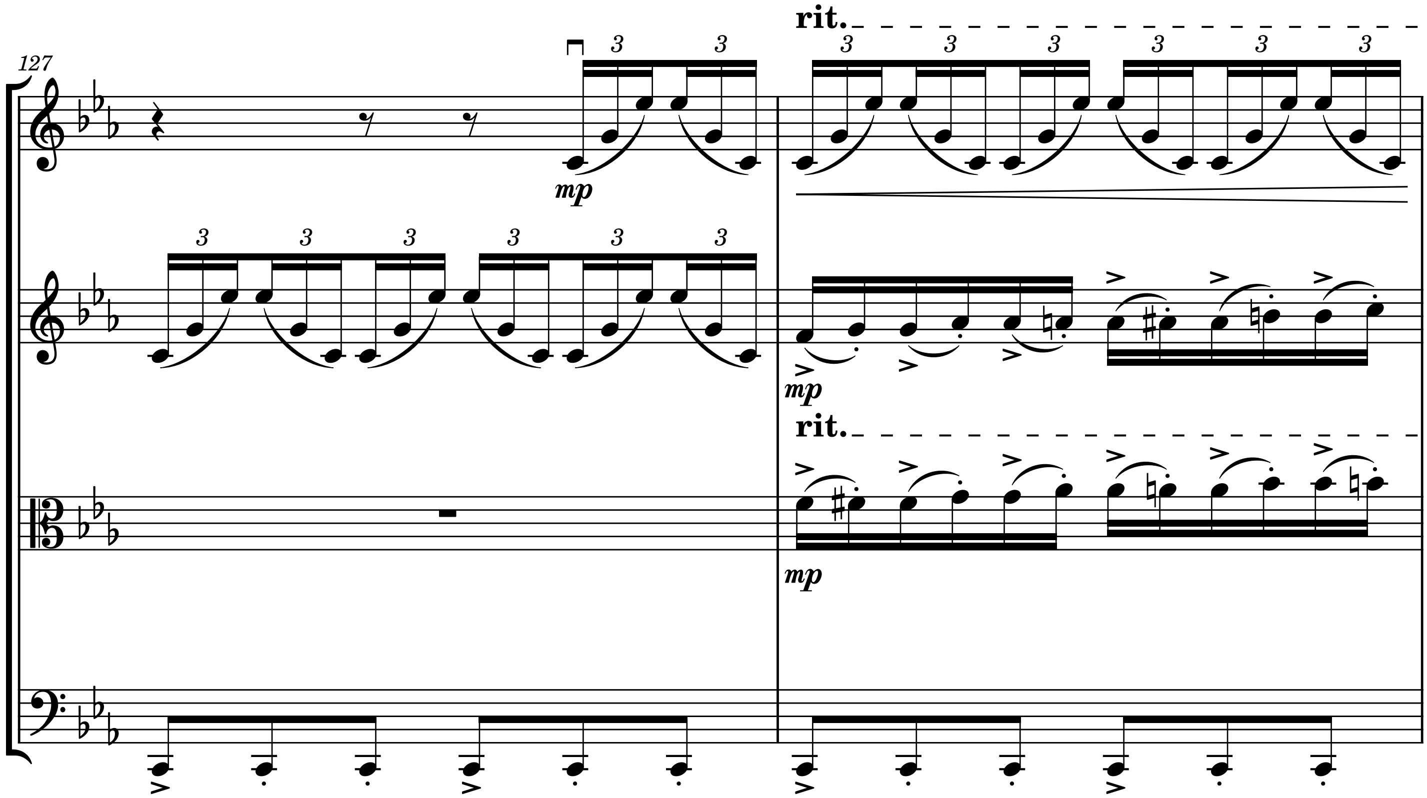

D
105
107
109
ff
p
pp
3

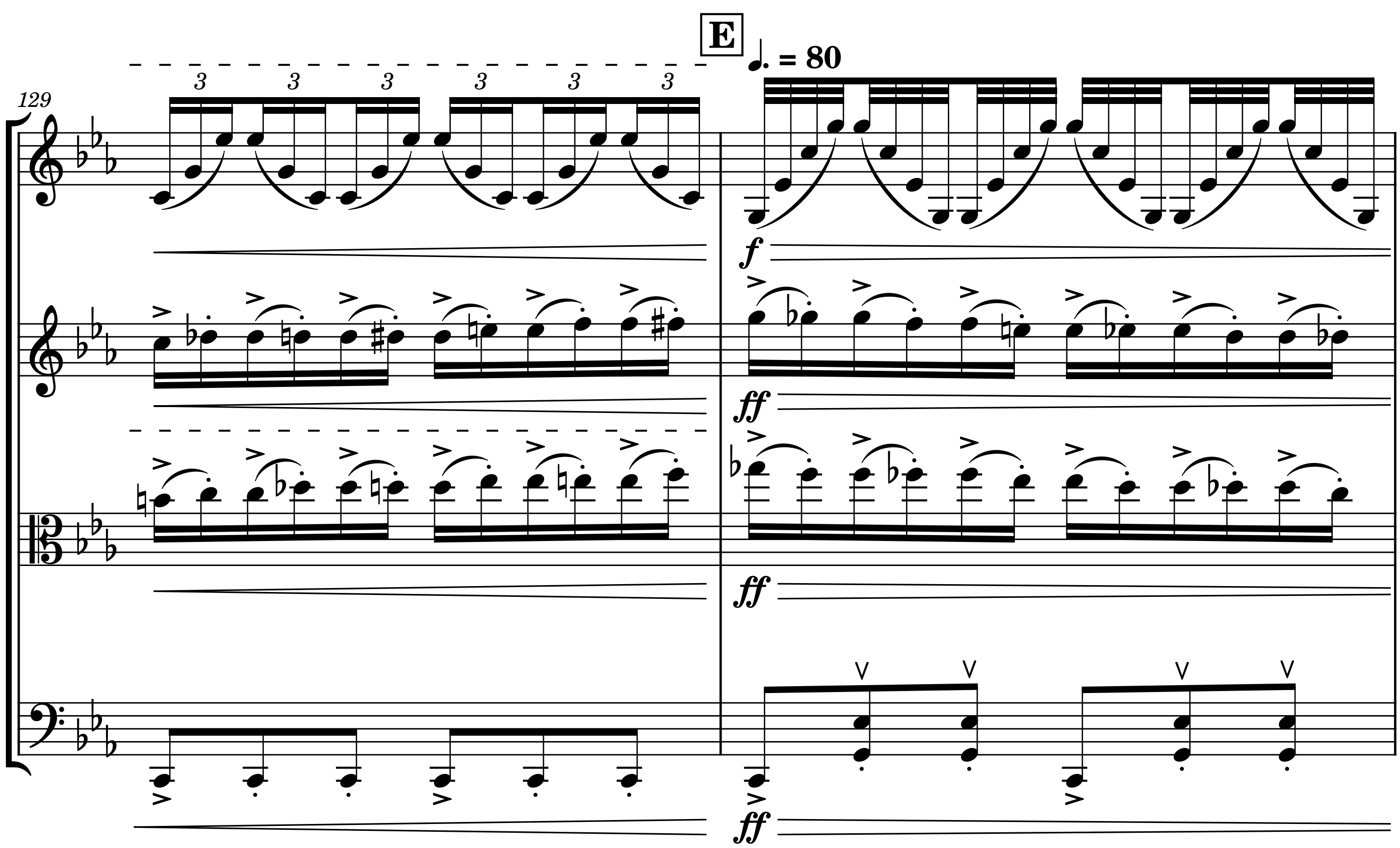

111
f
f
f
f
113
pp
pp
pp
pp


115
f
f
f
f
117
pp
pp
pp
p

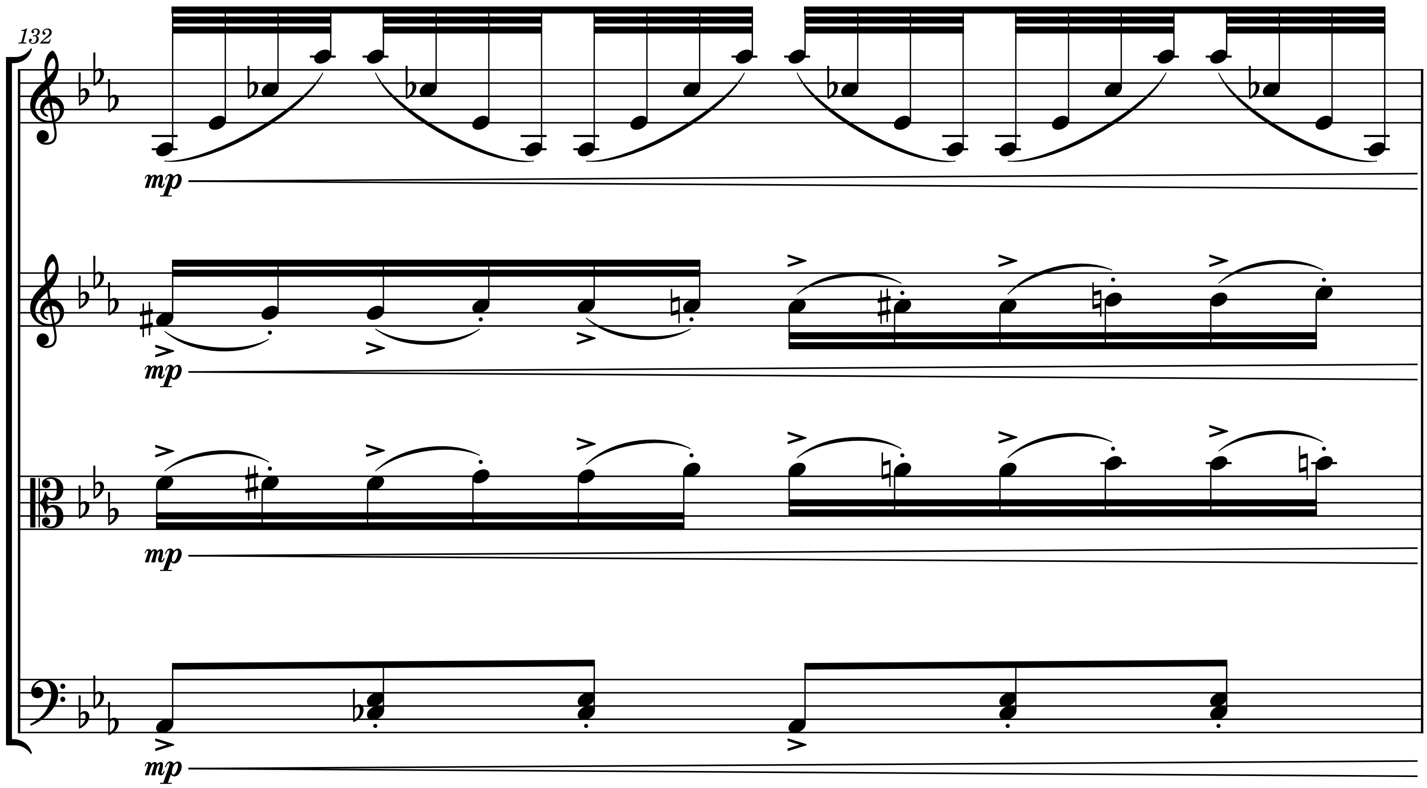

119
f
f
f
f
3
121
pp
pp
pp
pp
3

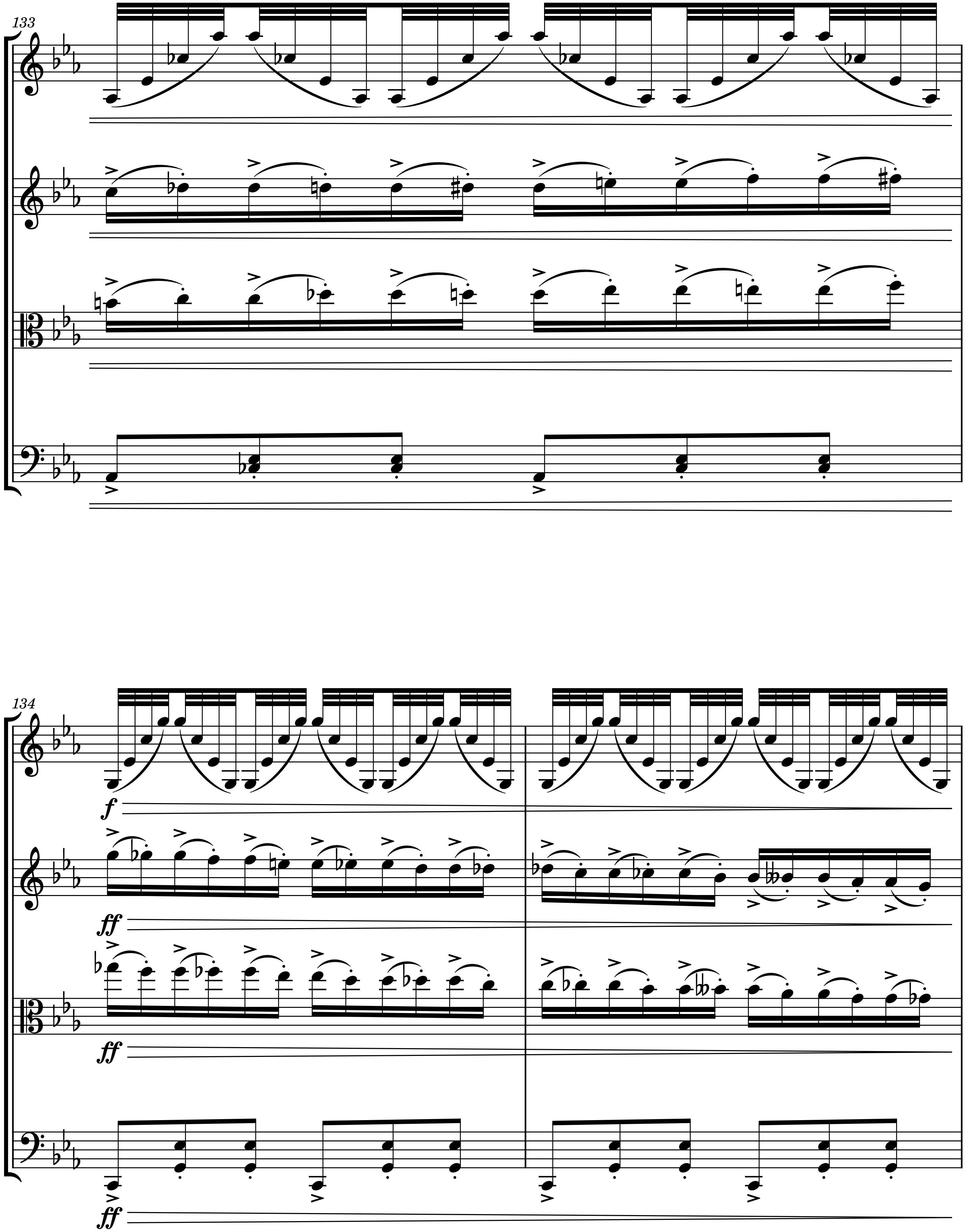

123
125


127
rit.
3
mp
rit.
mp

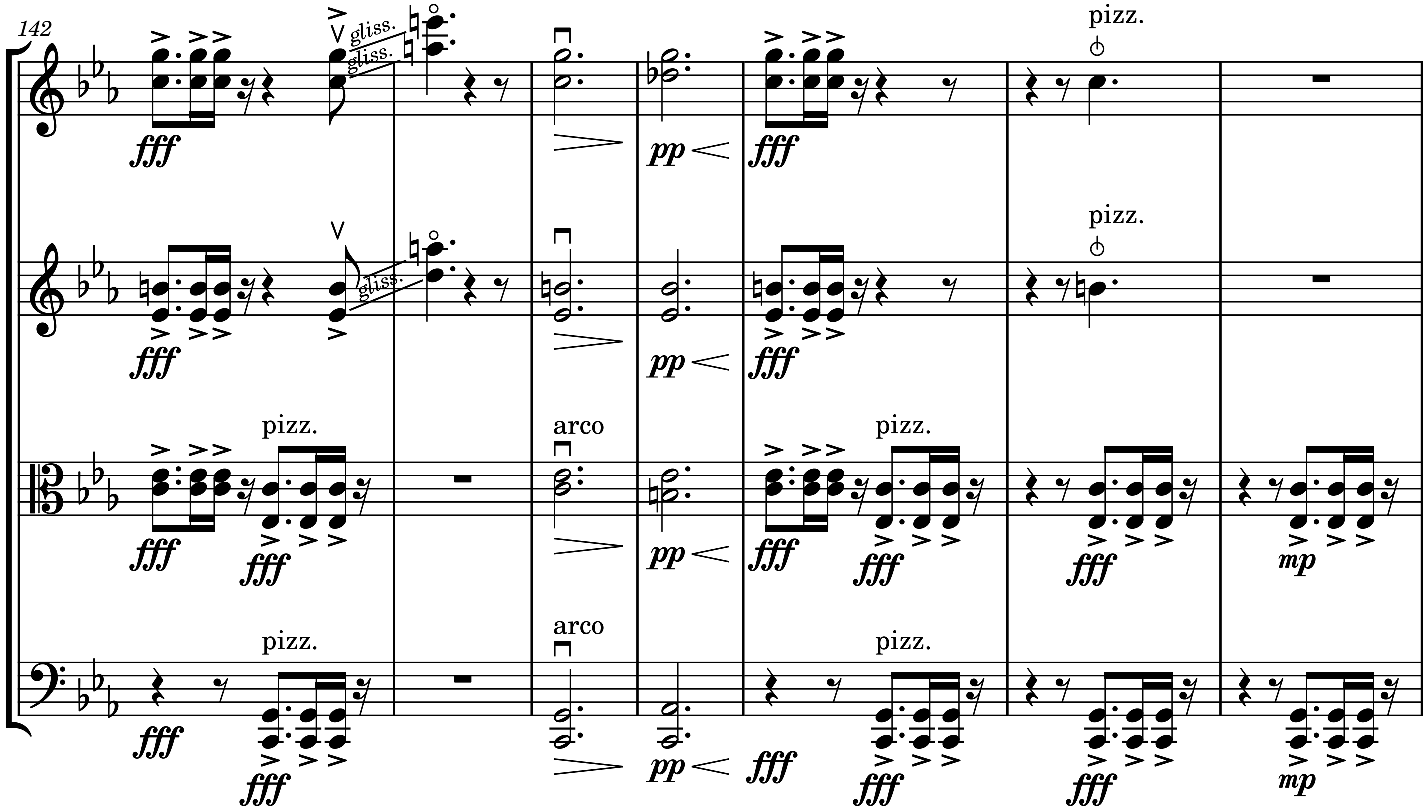

129
E
♩. = 80
3
f
ff
ff
ff

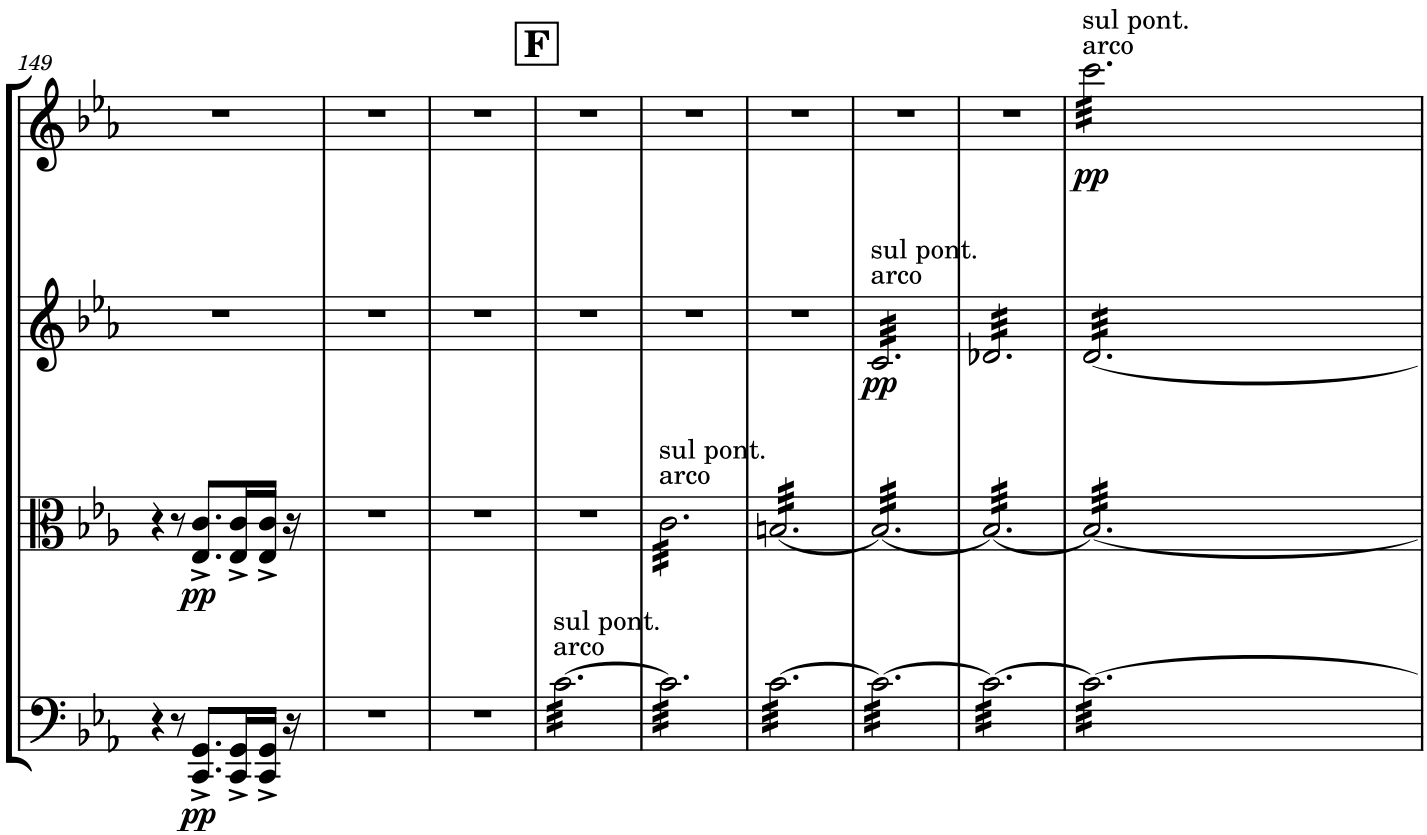

131


132
mp
mp
mp
mp

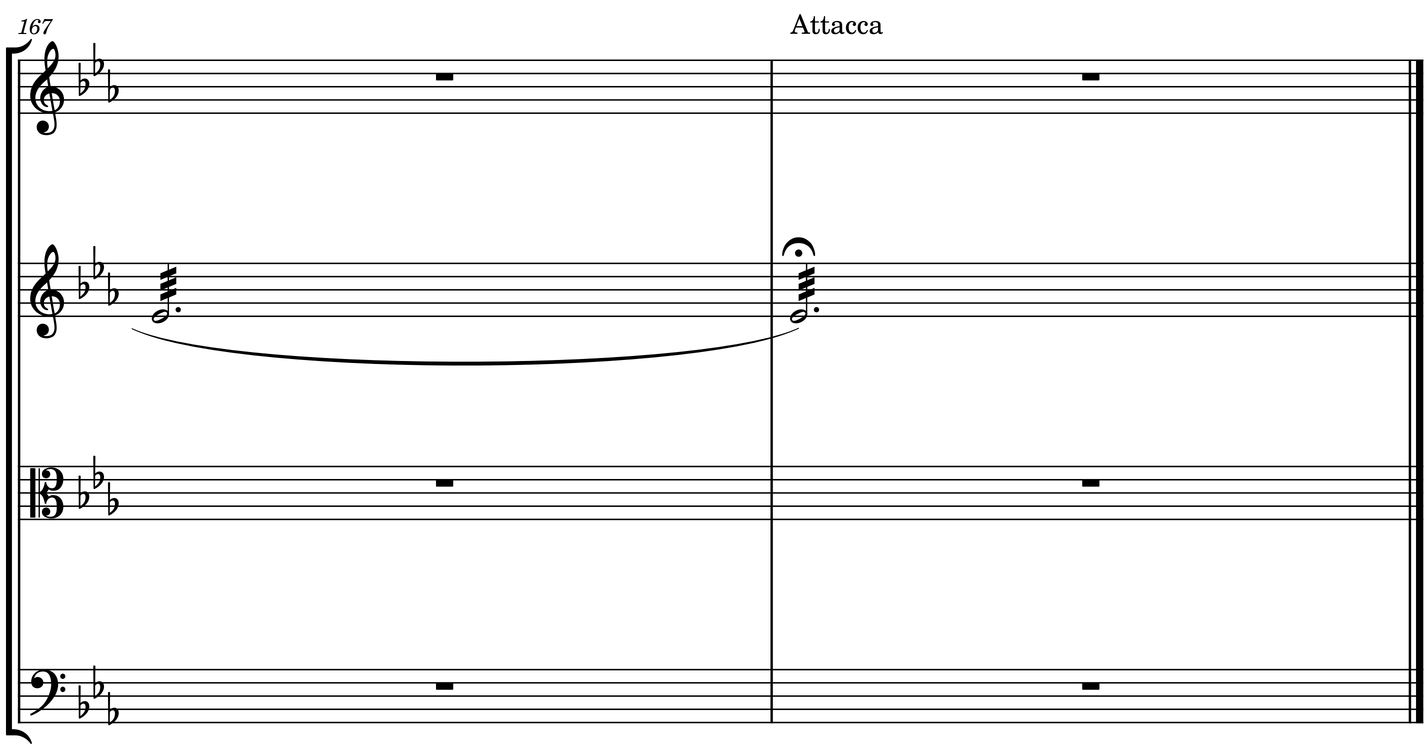

133
134
f
ff
ff
ff


136
mp
mp
mp
mp
137
fff
fff
pizz.
fff
fff
arco
pp
pp
pp
pizz.
ff
fff
arco
pp


142
gliss.
gliss.
gliss.
pizz.
pizz.
arco
arco
pizz.
pizz.
pizz.
fff
pp
mp


149
F
sul pont.
arco
sul pont.
arco
sul pont.
arco
sul pont.
arco
pp


158
ff
ppp
ff
pp
ff
ppp
ff
ppp


167
Attacca

IV. Ibanuje

"Sadness"


III
III
B

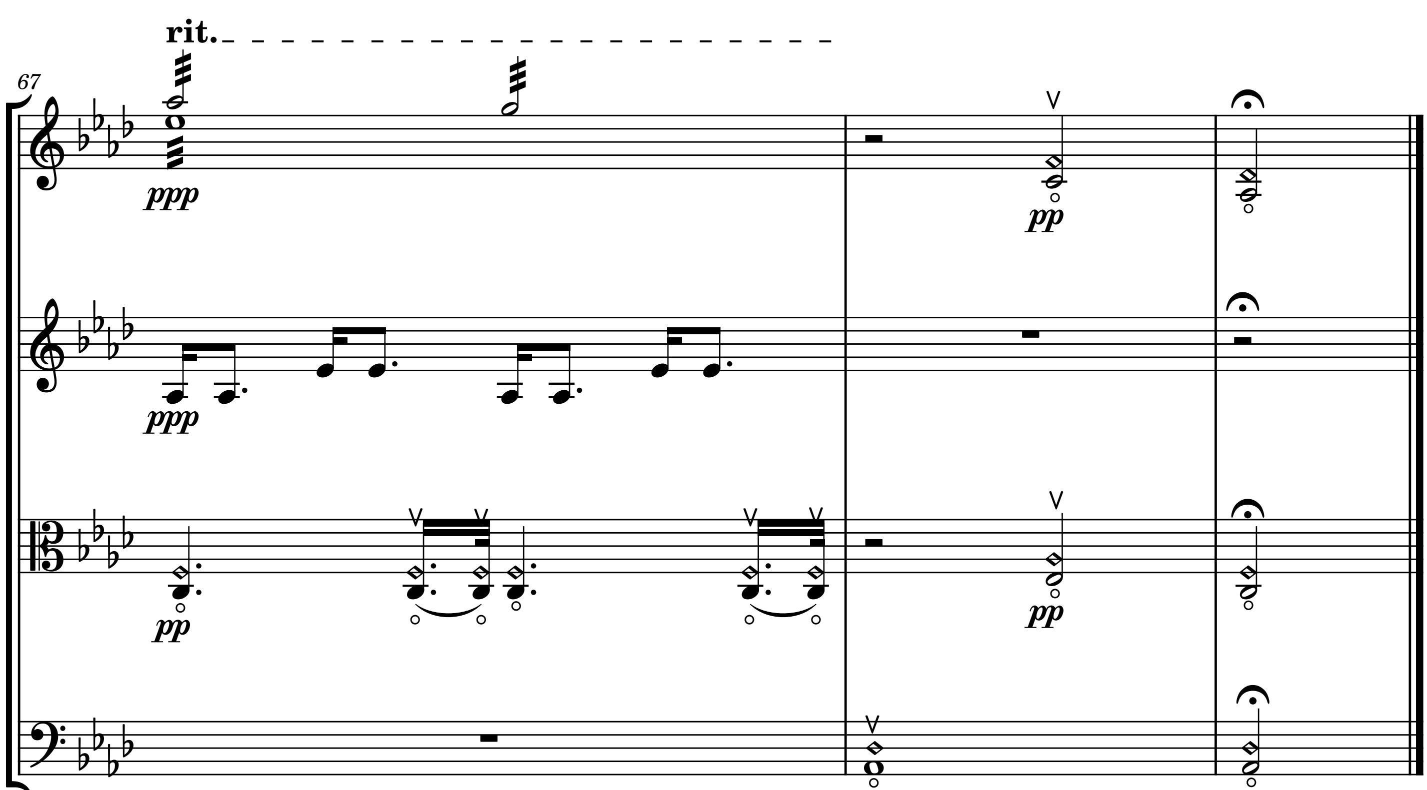

22
simile
27
simile
31


35
38
mf
mf
mf
mf
41
p
p
p
p

44
rit.
♩ = 40
f
p
mf
48
C
rit.
♩ = 40
p
mf
mp
51
mp


55
p
pp
pp
pp
58
mf
mp
61
D
p
p
p
p
mp


64
pp
pp
p


rit.
67
ppp
ppp
pp
pp
pp
pp