Do music and art influence one another? Measuring cross-modal similarities in music and art

Amanda Catherine Duthie
Iowa State University

Follow this and additional works at: https://lib.dr.iastate.edu/etd

Part of the History of Art, Architecture, and Archaeology Commons, and the Music Commons

Recommended Citation
Duthie, Amanda Catherine, "Do music and art influence one another? Measuring cross-modal similarities in music and art" (2013). Graduate Theses and Dissertations. 13163.
https://lib.dr.iastate.edu/etd/13163
Do music and art influence one another?
Measuring cross-modal similarities in music and art

by

A. Catherine Duthie

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

Major: Interdisciplinary Graduate Studies (Arts and Humanities)

Program of Study Committee:
John Cunnally, Major Professor
Brent Holland
Christopher Hopkins

Iowa State University
Ames, Iowa
2013

Copyright ©A. Catherine Duthie, 2013. All rights reserved.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>CHAPTER 1: INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER 2: HYPOTHESIS</td>
<td>8</td>
</tr>
<tr>
<td>CHAPTER 3: METHODS</td>
<td>11</td>
</tr>
<tr>
<td>CHAPTER 4: RESULTS</td>
<td>16</td>
</tr>
<tr>
<td>CHAPTER 5: DISCUSSION</td>
<td>17</td>
</tr>
<tr>
<td>CHAPTER 6: CONCLUSION</td>
<td>21</td>
</tr>
<tr>
<td>APPENDIX: FIGURES</td>
<td>23</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>39</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Madonna with the Long Neck</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Belle, Bonne, Sage, Baude Cordier</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>The shapes “Takete” and “Maluma”</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Carol Steen, Runs Off in Front, Gold</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>Values of paintings histograms</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>Appearances of compositions histograms</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>Ticks of compositions histograms</td>
<td>29</td>
</tr>
<tr>
<td>8</td>
<td>Simulated painting values</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>Simulated composition appearances</td>
<td>31</td>
</tr>
<tr>
<td>10</td>
<td>Simulated composition ticks</td>
<td>32</td>
</tr>
<tr>
<td>11</td>
<td>Expected value means</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>Expected value standard deviations</td>
<td>34</td>
</tr>
<tr>
<td>13</td>
<td>Expected appearance means</td>
<td>35</td>
</tr>
<tr>
<td>14</td>
<td>Expected appearance standard deviations</td>
<td>36</td>
</tr>
<tr>
<td>15</td>
<td>Expected ticks means</td>
<td>37</td>
</tr>
<tr>
<td>16</td>
<td>Expected ticks standard deviations</td>
<td>38</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

I would like to thank John Cunnally for his immense support and encouragement throughout my time at Iowa State University. John has provided me with a mentorship that encouraged me to perceive and think critically as a scholar. His breadth of knowledge and flair for contextualization has inspired me to continue my interdisciplinary pursuits.

I would also like to thank Brent Holland, who instilled in me a priority of thoughtfulness, confidence, and professionalism in regards to my work and research. His forthright critiques motivated me to view my own work in a deliberate, analytical manner, and my hand and eye improved tremendously under his instruction.

I am also indebted greatly to Christopher Hopkins, without whom I would never have entered the Interdisciplinary Graduate Studies program. Dr. Hopkins graciously offered me his time and guidance when I inquired about the IGS Masters Program at Iowa State University, and he has been exceptionally accommodating and considerate to me, especially when I was seeking out my niche in the departments.

I would also like to thank Erik Ruser and Martin Krzywinski, who provided me with the tools and codes to extract data from my collected files. I am deeply thankful for my family, who have always encouraged, indulged, and suffered the development of my curiosity and creativity. Finally, this thesis would not be possible without my husband, Brad, who has offered me endless support and motivation in my academic endeavors, and who provided his consultation on my statistical analyses.
CHAPTER 1: INTRODUCTION

The interaction between visual art and music has become an integral part of art theory and history. Within the last 100 years, the presence of music-influenced artists has become unsurprising. Abstract Expressionist Jackson Pollock and Cubist painter Stuart Davis openly embraced jazz music among their artistic influences. Pop artist Andy Warhol was deeply influenced by the rock band Velvet Underground (an influence that was reciprocated when he became their manager in 1965). Even when visual art and music do not overtly influence one another, they can share abstract qualities without having direct communication. Because music and visual art occupy a place and time, they often share the same external influences. These influences may be social inspirations as political movements or cultural innovation, or technological developments such as the establishment of mass-manufacturing, which led to uniformity of materials and instruments.

In addition to sharing their muses, visual art and music are also allied in the way their movements are titled, such as Mannerist, Classical, Romantic, Impressionist, Pointillist, and Minimalist. Generally, music and visual art movements of the same title share the same period in time. However, some temporally separate music and art movements have been linked to one another because of their similar abstract characteristics, such as the movement known as Mannerism. The term “Mannerism” in art applies to an artistic style employed in the 16th century, while Mannerism in music identifies a compositional style practiced in France nearly 200 years prior, also referred to as Ars Subtilior. These movements share an abstract quality of intense distortion. In visual art, a quintessential example of Mannerism is Parmigianino’s 1535-1540 painting, The Madonna of the Long Neck (Fig. 1), which manifests this distortion through space by elongating and warping the figures, almost to the point of disorientation. This disorientation is consistent with the Mannerist musical movement in pieces such as Baude Cordier’s c.1385 choral work, Belle,
Bone, Sage (Fig. 2), wherein melodic content is rhythmically tangled and dizzyingly complex. Cordier also notated this piece visually in the shape of a heart (using a style known as eye music), creating a striking metaphor for the visually attuned, avant-garde nature of this musical style. While these pieces were created 155 years apart, they are grouped together into the Mannerist category because of their shared quality of distortion, manifested respectively in light and sound.

On a more fundamental level, there are also parallels between the terminology of music and that of the visual arts, such as texture, balance, form, line, and harmony, which also share abstract qualities. For example, texture in visual art translates to the physical thickness and roughness of the medium, while texture in music refers to the audible activity of voices and the number of appearances and movements vertically notated along the staves. While these shared qualities are similar in their abstract form, a method for quantifying these qualities may establish a more direct connection between them, and may help us understand the extent to which they influence one another. To my knowledge, there are currently no researchers attempting to empirically measure any abstract similarities in music and visual art.

While visual art and music have not been measured directly with one another, there has long been evidence that people do make connections between visual and auditory input. In 1910 Wolfgang Kohler conducted a psychological experiment to determine if humans are capable of mapping a connection between sounds and visual objects, specifically between speech and shapes (Köhler, 1910). He presented his subjects with two shapes: one jagged and sharp, the other organic and rounded. He then instructed the participants to assign the names “Baluba” and “Takete” to these shapes (Fig. 3). He found that an overwhelming majority of the participants associated “Takete” with the jagged shape. In later experiments with variations on the names and subjects (Köhler, 1947; Ramachandran and Hubbard, 2001; Maurer et al., 2006), the results remain con-
sistent with the initial survey. For native speakers of multiple languages (in the case of Maurer et al. [2006], which included toddlers) 95-98% make identical picture-word associations. This shape-sound correspondence study is now commonly referred to as the “Bouba/Kiki” study, and the results are known as the “Bouba/Kiki Effect.” From the results of these studies, it is clear that there exists a cross-sensory translation between visual and auditory information that is generally consistent within a population. This effect has been dubbed “cross-modal abstraction,” the semi-conscious act of isolating characteristics of an experience in one modality (sense) and applying or comparing that characteristic to another modality through metaphor. Neuroscientist V. S. Ramachandran explains this phenomenon through an example of the “sharpness” of cheddar; the cheese itself does not become physically sharper, but people refer to that characteristic as the taste increases in strength and pungency (Ramachandran and Hubbard, 2003).

Russian painter Wassily Kandinsky’s 1911 book, Concerning the Spiritual in Art is the first written mention of an inherent relationship between music and visual art. Kandinsky believed that art should exist as frozen music, invoking both a physical effect and an “inner resonance” in its recipient (Kandinsky, 1911). That is, a color will instigate within its observer the emotion ostensibly inherent within it. Kandinsky went so far as to make specific connections between colors and the moods (some musical) that they invoke. For example, he described black as a symbol of “absolute silence” and noted that colors such as blue and yellow carried intrinsic timbral characteristics, such as those of the flute and the trumpet. Kandinsky’s connections between colors and musical textures, while deliberate to him, may not be apparent to those without his synesthesia. However, this philosophy brings to light the notion that visual art and music may have been in an unspoken influence between one-another prior to Kandinsky’s revelation. There are papers and books that have been written on relationships and similarities between visual art and music (e.g., Janson, 1968; Vergo, 2012; Wallen, 2012) as well as deliberate
translations from one modality into another (e.g., Miller, 1959; Beck, 1999, 2005). What has yet to be addressed is whether there are measurable similarities between the musical and visual works of an entire artistic movement or period.

Many cognitive scientists, neuroscientists, and art historians now suspect that Kandinsky was a chromesthesia synesthete (e.g., Marks, 1975; Berman, 1999; Ione and Tyler, 2004). Synesthetes involuntarily undergo an additional experience in a secondary sense upon receiving a stimulus. A person with chromesthesia will experience the sensation of perceiving a color upon hearing specific pitches or timbres. Because of the automatic nature of synesthesia, many synesthetes do not realize that their perception is any different from that of a non-synesthete until it is pointed out to them. Kandinsky made it clear in his writings that he allowed his painting style and voice to be influenced by the musical textures he encountered. He wrote of the orchestration of paint, the musical significance of color, and the extra-chromatic activity that the palette evokes.

Synesthesia continues to abound among living artists, many of whom openly acknowledge that their condition strongly affects the choices they make in their art. Carol Steen, a New York oil painter, described her synesthetic experience in an artist statement about her painting Runs Off in Front from 2003 (Fig. 4):

This is based on an especially colourful photism that occurred while I listened to Santana’s version of a song called Adouma. The colours I see are the colours of light, not the colours of pigment, and I played this song over and over again as I painted the moving colours. The advantage of sound visions, or photisms as the researchers call what we synesthetes see, is that I don’t have to rely on my memory. I can replay the song as often as I want to watch the colours (McDonald, 2006).

The prevalence of self-identified synesthetic painters is becoming so widespread that historians and cognitive scientists are investigating artists of the past who were possible
synesthetes, such as Van Gogh, Gauguin, and the aforementioned Kandinsky (Ione, 2009), all of whom were notably extravagant and uninhibited in their use of color.

Synesthesia has been linked to higher levels of both visual and verbal intelligence, and capacity for metaphor (Ramachandran and Hubbard, 2003). In 1989, Domino conducted a study to determine whether or not synesthesia is more prevalent among artists, since a connection between synesthesia and creativity has been anecdotally linked (Domino, 1989). After surveying and testing 358 students majoring in fine arts, he found a much higher percentage of them were synesthetes (23%) than what would have been expected in the general population (slightly less than 5%). Those who possess the variations of synesthesia that include visual stimuli may be inspired and drawn into artistic professions by this sensitivity.

The words “synesthesia” and “cross-modal abstraction” have been, until very recently, used interchangeably in many of the articles addressing them. Many researchers have placed synesthesia at the very edge of a continuum of cross-modal abstraction: at one end is the common phenomenon of simple cross-sensory metaphors (which are generally present and consistent within and between populations); at the other end is pure synesthesia (wherein one experiences an automatic activation of one sense upon the stimulation of another). In her 1999 article “Synesthesia and the Arts,” Greta Berman writes, “It is my own belief that synesthesia exists on a continuum; the range extends from pure synesthetes to individuals who have no cross-modal associations at all” (Berman, 1999). This sentiment has been implicitly corroborated in subsequent papers, as the terms “cross-modal” and “synesthetic” are undifferentiated. It was not until 2013 when Deroy and Spence countered with the revelatory argument that such a continuum would be fundamentally inconsistent (Deroy and Spence, 2013). Cross-modal abstraction is a process of intuitive, but conscious sensory metaphor that is consistent between people. Synesthesia, instead, is an anomalous, vivid, cross-sensory activation that occurs in a
minute percentage of the population, and is inconsistent between synesthetes in its details of sensory-activation. For example, while many people would make a cross-modal connection between the sharpness of a shape and the crispness of a plosive speech sound (as in the Bouba/Kiki Effect), a synesthete may, upon viewing an otherwise plain jagged shape, variously experience the color of mauve, the sound of a harp being plucked, or the taste of creamed spinach. In addition to the logical inconsistency between these phenomena, these experiences also take place in separate parts of the brain. Cross-modal abstraction is currently believed to occur largely in the angular gyrus, a portion of the brain that performs a wide variety of functions including language, spatial cognition, and memory retrieval (Hubbard and Ramachandran, 2005). Synesthesia, however, can occur in two or more parts of the brain through cross-communication between the portions of the brain that control the senses being activated. These portions of the brain are different for each synesthete, depending on the nature of their synesthesia. For example, number-color synesthetes have a cross-connection between the number and color portions of their brain (Ramachandran and Hubbard, 2003).

In light of these differences, Deroy and Spence make the point that cross-modal/cross-sensory abstraction and synesthesia should be considered separate processes which should not be lessened or compromised by one another (Deroy and Spence, 2013). As a consequence of this partition, researchers into these subjects must now call into question many of the studies conducted on abstraction and synesthesia prior to their paper, as the methodologies of these earlier studies did not make this delineation.

While occurrences of the explicit influence of music on visual art and vice-versa have become more common in the time of Jackson Pollock, they are not entirely absent from more remote history. For example, Marchetto da Padova based his Motet, composed for the dedication of the Scrovegni Chapel in 1305, on the architecture of the building and many of the murals (painted by Giotto) therein. There is also evidence suggesting
that Giotto was sensitive to the appropriateness of the sound qualities of the instruments he painted in his murals. In one instance he painted over his earlier fresco to shorten what was previously a boisterous trumpet (the traditional instrument used in wedding processions of the time) into a much quieter and serene flute for the mural depicting the Procession of the Virgin Mary. The development of live performance art, such as ballet in the 15th century and of opera in the 16th, afforded many opportunities for musical and visual artists to work in tandem to develop a synergy between set, costume, and music.

Hasenfus conducted a study in 1983 suggesting that self-purported laypeople, or people who consider themselves to be artistically naïve, have the ability to group and connect cross-media artistic movements. While this study is still held in high regard, the reason for the results remains a mystery. Hasenfus believes that cross-modal metaphor occurs when stimuli are “processed at a level abstract enough to allow intersensory comparisons” (Hasenfus et al., 1983). However, the specific translations that must occur in order to allow for these intersensory comparisons have not yet been concretely determined. I believe that an exploration into the potential cross-modal similarities between artistic movements may corroborate the results of the Hasenfus study.

There is solid evidence to suggest that populations generally associate lighter visual value (degree of brightness) with higher auditory pitch (e.g., Galeyev, 2007, 2003; Klapetek et al., 2012). These traits are measurable in both the visual and the musical works, and I believe that measuring and comparing the attributes of pitch and value has the potential to be a useful tool to gauge cross-modal similarities among the works of artistic movements.
CHAPTER 2: HYPOTHESIS

Domino’s aforementioned evidence indicates a prevalence of synesthetes (or, at the very least, individuals considered very prone to cross-modal abstraction) among people with artistic backgrounds and inclinations (Domino, 1989). If that prevalence is as high as Domino supposed, and if is to be presumed relatively consistent throughout time and location, there is a likelihood that there will be evidence of a sensitivity between musical and artistic works from historical artistic movements. If this is the case, information on artistic priorities and cultural philosophies that permeate multiple media may be gathered by comparing the measurable qualities of the art and music shared by a culture in time.

I employ a model that extracts and measures attributes that have been linked with one another through cross-modal abstraction: strength of color, lightness of value, and height of pitch. These qualities were chosen because they are both empirically measurable, and because there is a solid body of evidence to support a shared cross-modal gradient between them. Pitch is arguably the most consistent component of a musical composition, unlike note lengths and volume which may vary between performances. In this study, I compare pitch to “brightness,” using that term to mean the greyscale lightness of value rather than strength of chroma (saturation of color).

To test this model, I have applied it to Russian and French music and visual art created between 1870 and 1920. This is a very rich period for applying these analyses due to its breadth of musical and artistic innovation and development. This timeframe was host to who we now refer to as the French Impressionists, both in music (exemplified by composers such as Satie and Debussy) and in art (illustrated by the works of Degas and Monet). This era in Russia was a great time for establishing a unique national voice in art and music. In music it was dominated by the Mighty Five (Balakirev, Cui, Mussorgsky, Rimsky-Korsakov, and Borodin), and in the visual arts by The Peredvizhniki (including
the well known Shishkin, Repin, and Surikov), all of whom took it upon themselves to establish a distinctive and unmistakable artistic and musical voice for Russia.

While Nationalism was a priority during this time, it is likely that French and Russian artists and composers in this era interacted with one another, at least through influence and assimilation of their respective arts. The new Russian music (including works by the Mighty Five) became popular in Western Europe after 1873 due to Liszt’s appreciation (Meyers, 1958). Even the most quintessentially French composers were likely to have exposure to Russian works such as the 1878 performance of Rimsky-Korsokov’s opera Sadko in Paris. Members of the Peredvizhniki had a complicated relationship with French Impressionist art. For example, when Repin was inspired to paint French-style landscapes in the mid-1870s, he was chided by the philosopher Kramskoy, who accused him of “fleeing the field of battle” by neglecting his artistic obligations to his country, and insisted that Russian artists portray scenes and people of their native land. However, when Kramskoy visited France ten years earlier, he had encouraged his artistic constituents to study Western art theory and history (Valkenier, 1975).

There are indications that French and Russian music may have fundamental pitch differences. In choral music, the Basso Profundo and the Oktavist, both of which are noted for their extraordinarily low vocal ranges, were frequently used in traditional Russian Orthodox music before the 18th century. These vocal parts seldom, if ever, appear in French choral works, liturgical or secular. For this reason, Russian choral liturgical music prior to the 19th century can be predicted to be generally lower in pitch.

Little has been written on the value differences between Russian and French visual art. However, it is anecdotally suggested that Russian art from the early 1900s is generally darker than French art of the time. This is explained both by the French Impressionist goal of representing light-filled atmosphere in their paintings, and the geographical differences in the amount and strength of natural sunlight in France and Russia.
Any selection of works deliberately chosen by even the most well intentioned researcher runs the risk of bias. While the author has made an effort to find a large number of musical and visual works representing each country, it must be noted that they were not selected using a double-blind method, and the author was limited by the digital availability of said works. As such, this study should be considered a preliminary reconnaissance into the problem of measuring connections between music and art of the same period or movement.
CHAPTER 3: METHODS

In selecting images, I ensured that the works conformed to specific criteria which would qualify them for analysis and cross-comparison. In order to obtain a consistent sample, only images completed between 1870 and 1920 were considered. All of the undated works which were considered were accepted only when the artists’ professional lives fell into the 50 year period observed. To ensure that medium and chemical availability of paint colors did not influence in the results, the samples consist entirely of oil paintings, either on canvas or panel. In order to ensure a consistent range of manipulable atmosphere in each work, only landscapes and large-figure compositions were admitted, because these subjects allow the artists to depict a fully-controlled environment. Because the samples were gathered in digital form, it was imperative that the images were large, high-resolution photographs. The paints that were available to French and Russian artists during the late 19th century were similar to those available to artists today, allowing the author to carefully isolate and evaluate saturation of color and quality of image, thus ensuring that none of the photographs chosen were altered in a way that would distort the results.

Each music piece selected was also taken from the time period between 1870 and 1920. To avoid problems arising from differences in harmonic overtones and instrument ranges, all pieces chosen consist of instruments that are singular (or similar) in timbre. The pieces chosen were written for piano, organ, harmonium, choir (a cappella), brass, and string quartet. Both programmatic and absolute music were accepted. While some pieces chosen were originally written for other instruments, only arrangements written by the composer (or another composer from the same time and country) were accepted.

In order to mitigate the risk of cross-contamination from other musical and artistic ideologies as much as possible, only composers and artists were chosen who had studied their craft in and embraced the compositional principles of their own country. For this
reason, a few rather notable and famous composers (such as Piotre Tchaikovsky, who studied in the Western-style of composition and had a complex relationship with the Russian Five as a result) and artists (such as Wassily Kandinsky, who studied extensively in many places, including Estonia and Germany) were omitted from this study. While cross-cultural interaction is inevitable, factors such as purported nationalism and acceptance amidst the artists’ and composers’ respective peers were taken into account in order to attenuate the effect that strong cross-cultural interaction could have on the results. Once 80 images were collected from both countries, the data of each file were extracted using a color summarizer (Krzywinski, 2006). Each image was run through this process, which isolated and quantified each pixel, providing a set of measurements. From these, I extracted the measurements of value and saturation, and calculated both the mean and the standard deviation of the value and saturation of each image. This ensured that the data not only include the mean value, but the tonal range of each piece. The completed image extractions were then tested for significant differences in means and standard deviations between the works of both countries.

The 153 musical pieces collected (77 French items and 76 Russian) were analyzed in their MIDI form. MIDI, an instructional file for the computer playback of a musical piece, employs a binary standard. Each file was broken down into its binary components, specifically extracting the pitch data. I included in these data both the frequency of each pitch occurrence (hereafter referred to as “appearance”), but also the amount of time for which each note was played (by measuring each note appearance in “ticks,” the unit by which note lengths are measured in the MIDI code). From these data, I calculated the mean and standard deviation of pitch just as I calculated the mean and standard deviation of value within the images.

Although the unaltered musical and image data cannot be directly compared with one another (the visual data are measured on a scale of 1-100 and the audio data fall on a
set of 1-127 or 0-128, and there is no indication of the scale degree on which they could be lined up), it is reasonable to compare the relative differences in and between media from the different countries. If, for example, French art and French music were both higher in their respective modality measurements than those of Russia, these results would suggest that there may be one or more forces acting on the arts, manifesting itself in more than one medium through cross-modal translations. I administered a series of tests to compare these pitch and value data and to determine whether there is a statistical significance between countries.

A "Student’s t-test" is generally used to test whether or not the mean values of two groups are statistically significant in difference. Two groups can be considered significantly different if they are more different than what would be expected by chance. Statistical assumptions of the Student’s t-test include a normal (Gaussian) distribution of data errors, and the equality of distribution variances between groups. Significant deviations from normality can be tested with a Shapiro-Wilk test, and significant differences between group variances can be tested using an F test. The distributions of painting value means and standard deviations (Fig. 5), composition appearance means and standard deviations (Fig. 6), and tick means and standard deviations (Fig. 7) were typically normally distributed with equal variances. Exceptions to normality only occurred in compositions, including Russian appearance means (Fig. 6a), French appearance standard deviations (Fig. 6d), and Russian ticks standard deviations (Fig. 7c). Exceptions to equality of variances included the differences between French and Russian value standard deviations in paintings (Fig. 5c-d), and French and Russian ticks standard deviations in compositions (Fig. 7c-d). To statistically account for non-normality, transformations of the data can be used (e.g., a log transformation), and although Student’s t-tests are generally robust to unequal variances, a Welch’s t-test can be used to test for the differences between groups with different variances. Alternatively, randomization tests, in which val-
ues (e.g., value means of paintings) are randomly assigned to groups (e.g., countries), can be used to test the significance of differences between group means. Randomization tests are advantageous in being applicable regardless of whether or not the true distribution of the data is known, but, like the Student’s $t$-test, they assume equal group variances. A further advantage of using randomization tests is the intuitiveness of the statistical methodology, which can be described more easily in non-technical terms. As such, tests for significant differences between groups here use randomization techniques, but results were found to be qualitatively identical to what they would have been if Student’s $t$-tests (or Welch’s $t$-tests) were used instead. All analyses were performed using R software (R, 2011).

To test whether or not differences between groups are statistically significant, group assignment is randomized over many iterations. This is known as a randomization (or permutation) test. The logic of randomizing group assignment is to determine whether or not the actual difference between groups in the observed data is greater than what would be expected by chance. If the difference between mean group values is not different than what would be expected by chance, then randomly shuffling the groups to which data are members should produce mean group values that are not much different from the actual observed values. For example, in the case of value means of Russian and French paintings, all of the 160 data (80 Russian and 80 French paintings) can be randomly reassigned to either Russian or French labels so that a new data set is produced with the same 160 data randomly split into two groups of 80 (either Russian or French). If the difference between the estimated means of the randomly assigned groups is not much different than that of the difference between the estimated means in the observed data, this is evidence that the difference between the group means in the actual data (French versus Russian painting value means) is not different than what would be expected by chance. It could then be concluded that the average value mean is not different in Russian versus
French paintings. Of course, more than one random permutation of group assignments is necessary to determine with confidence whether or not the actual difference between groups is greater than that predicted by chance. In the statistical tests that follow, group identity is randomly reassigned 999 times. For each of these 999 iterations, the difference between groups is calculated. After these iterations, the observed difference between groups is compared to the distribution of randomly calculated differences to estimate the probability that the size of the observed difference between groups is due to chance. This is also known as the Type I error; that is, the probability that the differences between means observed in the data are actually due to chance instead of a real difference between groups. For example, if the difference in the observed data is greater than any difference in the randomized data, the estimated Type I error (indicated as $P$) is $1/(1 + 999) = 0.001$. If the difference in the observed data is only greater than 901 values in the random data, then $P = (99)/(99 + 910) = 0.010$. Customarily, values of $P$ lower than 0.05 are considered to indicate statistically significant differences between groups.

Six tests of differences between French and Russian data included tests for differences between painting value 1) mean and 2) standard deviation, composition appearance 3) mean and 4) standard deviation, and composition ticks 5) mean and 6) standard deviation. For each test of a difference between French and Russian data, randomization tests were used to estimate the Type I error of differences between groups. Bootstrapped 95% confidence intervals for the values of group means were calculated by randomly sampling data within groups with replacement (Manly, 2007). Data were re-sampled with replacement 1000 times with sample sizes equal to the sizes in the observed data, and means of each sample were collected and sorted. The 25th lowest value was then used as the lower confidence interval, and the 775th value was used as the upper confidence interval.
CHAPTER 4: RESULTS

Results of the randomization tests are shown in Figures 8-10, which depict the distributions of randomly simulated values. Arrows in each figure point to the differences between Russian and French data in the actual paintings and compositions. Differences between painting value means ($P = 0.001$; Fig. 8a) and painting value standard deviations ($P = 0.002$; Fig. 8b) were significant, but difference between composition note appearance means ($P = 0.236$; Fig. 9a) and standard deviations ($P = 0.113$; Fig. 9b) were not significant, nor were the differences between composition ticks means ($P = 0.481$; Fig. 10a) or standard deviations ($P = 0.531$; Fig. 10b). As such, differences between Russian and French paintings can be interpreted as statistically significant, but compositions were never statistically significant, so the estimated means of these data are considered to be statistically identical. Bar plots showing the differences between mean values in all six measured values are shown in Figures 11-16. Figure 11 shows that value means are higher in French paintings (estimated mean = 59.00) than in Russian paintings (estimated mean = 50.28). Figure 12 shows that value standard deviations are higher in Russian paintings (estimated mean = 20.66) than in French paintings (estimated mean = 18.47). Figures 13-16 show estimated means for composition appearance means (Fig. 13), appearance standard deviations (Fig. 14), ticks means (Fig. 15), and ticks standard deviations (Fig. 16), which are all statistically identical.
CHAPTER 5: DISCUSSION

From the 160 painting samples collected, I inferred that art in Russia was found to be both significantly darker and to have a significantly larger range of value than the art in France. From the 153 musical samples collected, no significant difference was found in pitch or range of pitches between Russian and French music. These results could be brought about by multiple possible underlying factors. It could be that the relationship of value and pitch only manifests itself within individuals, not affecting art movements as a whole. It is also possible that there were strong cross-modal influences acting on the large-scale art movement in visual art and music between 1870 and 1920, but it was not present or not strong enough to show manifestation in the relationship of pitch and value. However, there are other extra-sensory factors to consider.

The differences in value between Russian and French visual art are indicators of the differences in the goals of Russian and French artists. When the same white or yellow is added to different pigments of paint (lightening the overall value of a piece), there exists an overall effect of brightness and unity within the lights. In many of the French pieces gathered, white or yellow (often a mixture of the two) was added to pure tube paint to maximize the chroma-to-light ratio. This intensified the effect of the sun in the light portions of the painting, encouraging the viewer to experience the overwhelming brightness of a sunlit day. In maintaining a smaller range (which I’ve measured in standard deviation) of value between the lightest lights and the darkest darks, the paintings hold a strong sense of atmosphere, as if the air between the viewer and the shadows were soaked in sunlight. When less white is used in the lights (resulting in lower values), the resulting colors have a stronger sense of chroma, giving the viewer an impression of drama. In the Russian visual works gathered, many of the painted skies included pigments that could have been used straight out of the tube. Just as some of the French works gave a sensation of intense lightness (established by using a large amount of white and yellow) in their
sunlight, many of the Russian works gave a sensation of intense chroma (established with the use of full-chroma paint) in their sunlight. Both of these methods allow the artists to establish the abstract quality of “brightness” in their works, but through different means. Also, each of these methods of capturing brightness create natural consequences in chroma. By adding whites and yellows to the lights, the French artists were able to use stronger colors in their shadows, as unadulterated pigments are dark enough to be a contrast to lighter values. However, the whites and yellows in the lights mitigate the natural chroma of the colors in which they are mixed. By not adding whites and yellows to the lighter colors, the Russian works have stronger chroma in their sunlight. However, the dark portions of their paintings must be lower in value than unadulterated pigment to contrast, resulting in a sacrifice of chroma in the shadows. Although the usage of value diverged between these countries, each technique employs a balance of potency and restraint in color using opposite ends of the value spectrum.

While potency in chroma is affected by its value, human sensitivity to sound also exists within music, and that sensitivity lies in both pitch and tone. The human ear is attuned to hear the notes in roughly a 10-octave range, and to be more easily discerning of pitches that lie near the traditional musical grand staff, or the notes that are found on the modern piano. The modern piano has a range of a little over 7 octaves. Most modern orchestras can span up to 6 octaves, each of their instruments having a range of their own. Most modern choirs hold a range of just under 4 octaves. Because of the pitch limitations of human hearing (and consequently the pitch limitations of these instruments), the available sliding scale of pitches does not typically encompass notes that are difficult for the human ear to perceive, or notes that differ in their discernibility. As such, there is no sacrifice of musical potency in using the entirety of the musical notes available. While French and Russian art accomplish balance of chroma and value in different ways, maximizing strength of pitch does not necessitate the relinquishment of
potency in another auditory quality.

The openness to incorporate artistic elements from one culture into another varied between media, as well as between countries. The Russian Peredvizhniki were actively discouraged from embracing the artistic styles of Western Europe (including the French, with whom they were both inspired by and strived to distinguish themselves from). The philosopher Kramskoy insisted that it was imperative that Russian artists view French art critically, in order to separate the aesthetic of Russian art entirely from that of the remainder of Europe (Valkenier, 1975). Conversely, French composers such as Debussy and Ravel were noted to be directly affected by the works of the Russian composers of the time (Meyers, 1958). In 1878, at least four concerts of Russian music (composed by Glinka, Tchaikovsky, Dargomizhsky, Alexander Serov, and Rimsky Korsokov) were performed in Paris (Meyers, 1958).

In addition to the philosophical and political reasons for these differences, it is likely that, because of the transportability of music, there is a greater capacity for cross-pollination of musical ideas and voices than those for visual art, which could only remain in a single place at any given time. Even when Kramskoy encouraged the Peredvizhniki to study and learn from the art and history of Western Europe, the artists would still be required to travel to France in order to see large collections of then-contemporary French art. However, the same piece of music can be played in two cities at once without any loss of information, and thus, music traveled more readily than art at the time. Because of this isolated co-mingling, it would be natural for music to share more cross-cultural similarities than art.

This portability of music brings up an interesting notion: if music can travel between cultures more easily than visual art, this could suggest that if the visual arts were to influence one another in a period wherein works were difficult to replicate, music could potentially be used as a cross-sense conduit of information. If, for example, a piece of
music was affected by the immediate visual art of the time, the abstract, cross-sensory qualities that it may have acquired could travel from one country to another, and it would have the potential to influence the visually artistic works there. This cross-pollination would explain any lag in similarities between French and Russian art, should they have later homogenized in value and the standard deviation thereof.
CHAPTER 6: CONCLUSION

Hasenfus showed evidence that people with no artistic training have the ability to discriminate between cross-modal works from temporally-defined artistic movements, concluding that these works were “processed at a level abstract enough to allow intersensory comparisons” (Hasenfus et al., 1983). While the results of my study do not suggest that the abstract level of value-pitch perception is the sole indicator of this innate differentiation, this does not necessarily indicate that all other elements of cross-modal abstraction do not have a use in illuminating these results. It may be useful to investigate other shared abstract elements, as well as fundamental qualities such as programmatic content, ornamentation, and frequency of patterns. If these properties can be quantified, the statistical methods I have employed may be of use in determining these features’ significance.

While this model was applied in this study to a small pocket of time and location between music and art, it could also have use in determining whether or not these cross-modal similarities appear, or have become stronger or weaker, throughout a longer period of time. The model can be applied to different times to determine if shared abstract qualities appear in communities wherein a unity between the arts was a priority, such as the subscribers of Wagner’s popularization of Gesamtkunstwerk. When applied to other times wherein there is a pervading credo or inspiration, such as political movements or activism, this model can be used to detect whether or not these inspirations manifest in similar ways. In measuring whether or not there is a stronger connection between art and music in some areas and times than others, the resulting data may indicate different instantiations of similar artistic philosophies of that age. An interesting application of the visual portion of this model could be used to see whether the differences in the arts of France and Russia persist today, and if they have maintained the value differences in their national artistic identities despite the increasing globalization of the arts.
Both visual art and music have undergone their own respective evolutions as techniques and technologies have allowed for growing and divergent styles and subject matter. Domino (1989) provided evidence suggesting that synesthetes are very prevalent in the artistic community, and many of these synesthetic artists are now actively and publicly incorporating other media into their inspirations. This model is a tool to measure whether or not the cross-modal abstraction of lightness and pitch has influence on their artistic choices, and if these choices are consistent within and between the works of these artists and their inspirations.
Figure 1: The Madonna with the Long Neck, Parmigianino, 1535-1540, Oil on Panel.
Figure 2: Belle, Bonne, Sage, Baude Cordier, c.1385.
Figure 3: The shapes “Takete” and “Maluma,” or “Kiki” and “Bouba” (respectively) referred to in the Bouba/Kiki Effect.
Figure 4: Carol Steen, Runs Off in Front, Gold, 2003, oil on paper.
Figure 5: Distributions of values obtained from Russian and French paintings (1850-1920). Data include mean values for individual Russian (a) and French (b) paintings, and the standard deviation of values for individual Russian (c) and French (d) paintings. Black arrows indicate the estimated mean of each distribution.
Figure 6: Distributions of pitch appearances obtained from Russian (1850-1920) and French (1850-1920) compositions. Data include mean pitch appearances for individual Russian (a) and French (b) compositions, and the standard deviation of pitch appearances for individual Russian (c) and French (d) compositions. Black arrows indicate the estimated mean of each distribution.
Figure 7: Distributions of length of pitch-appearance (measured in ticks) obtained from Russian (1850-1920) and French (1850-1920) compositions. Data include mean ticks for individual Russian (a) and French (b) compositions, and the standard deviation of ticks for individual Russian (c) and French (d) compositions. Black arrows indicate the estimated mean of each distribution.
Figure 8: Simulated differences between groups when French and Russian painting (1870-1920) value means (a) and standard deviations (b) are randomly assigned to one of these two countries. Data include differences in value means and standard deviations from 999 iterations. Black arrows indicate the actual observed difference between value means ($P = 0.001$) and standard deviations ($P = 0.002$) between countries.
Figure 9: Simulated differences between groups when French (1870-1920) and Russian (1850-1920) composition note appearance means (a) and standard deviations (b) are randomly assigned to one of these two countries. Data include differences in note appearance means and standard deviations from 999 iterations. Black arrows indicate the actual observed difference between appearance means \( (P = 0.236) \) and standard deviations \( (P = 0.113) \) between countries.
Figure 10: Simulated differences between groups when French (1870-1920) and Russian (1850-1920) composition appearance means (a) and standard deviations (b) are randomly assigned to one of these two countries. Data include differences in length of pitch appearance (measured in ticks) means and standard deviations from 999 iterations. Black arrows indicate the actual observed difference between ticks means ($P = 0.481$) and standard deviations ($P = 0.531$) between countries.
Figure 11: Expected value means for French ($N = 80$) and Russian ($N = 80$) paintings (1870-1920). Error bars show 95% bootstrapped confidence intervals around means.
Figure 12: Expected value standard deviations for French ($N = 80$) and Russian ($N = 80$) paintings (1870-1920). Error bars show 95% bootstrapped confidence intervals around means.
Figure 13: Expected appearance means for French ($N = 77$; 1870-1920) and Russian ($N = 76$; 1850-1920) compositions. Error bars show 95% bootstrapped confidence intervals around means.
Figure 14: Expected appearance standard deviations for French ($N = 77; 1870-1920$) and Russian ($N = 76; 1850-1920$) compositions. Error bars show 95% bootstrapped confidence intervals around means.
Figure 15: Expected ticks means for French ($N = 77; 1870-1920$) and Russian ($N = 76; 1850-1920$) compositions. Error bars show 95% bootstrapped confidence intervals around means.
Figure 16: Expected ticks standard deviations for French ($N = 77$; 1870-1920) and Russian ($N = 76$; 1850-1920) compositions. Error bars show 95% bootstrapped confidence intervals around means.
REFERENCES


Deroy, O., and C. Spence. 2013. Why we are not all synesthetes (not even weakly so). Psychonomic bulletin & review.


