

## Do Music and Art Influence One Another? Measuring Cross-modal Similarities in Music and Art

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### Abstract

The visual arts and music interact with one another on both an individual scale (e.g. music-inspired synesthetes and artist-musician duos) and on a grand scale (e.g. the art movement Baroque, wherein abstract qualities such as “ornamentation” permeate both media). We develop a means to measure one of the many cross-modal similarities between music and visual art to reveal any direct influences between the media. We examined the cross-modally linked continuums of lightness of color and height of pitch within comparable paintings and music of a time-determined art movement. The model of comparison extracted, measured, and contrasted the attributes of lightness of color in art and height of pitch in music in works from Russia and France created between 1870 and 1920. Although Russian visual art was measurably darker in value than French visual art of the same time, no significant differences were found between Russian and French music. While our results do not suggest direct influences manifesting differently in each medium, they demonstrate the use of the lightness-pitch model, applicable to other eras to measure potential cross-modal convergence and divergence through time.

### Introduction

The interaction between visual art and music has become an integral part of art theory and history. Within the last one hundred years, the presence of music-influenced artists has become common. 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. Art and music share common cultural influences—they may be concurrently affected by localized societal pressures (e.g. political movements) or technological advancements such as mass manufacturing.

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 sixteenth century, while Mannerism in music identifies a compositional style practiced in France nearly two hundred 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.



Figure 1: Parmigianino, *The Madonna with the Long Neck*, 1535-1540, oil on panel

This disorientation is consistent with the Mannerist musical movement in pieces such as Baude Cordier's c.1385 choral work, *Belle, Bonne, 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.



Figure 2: Baude Cordier, *Belle, Bonne, Sage*, c.1385

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 determine the extent to which they influence one another. To our 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 Köhler 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 consistent with the initial survey. For native speakers of multiple languages (in the case of Maurer et al. [2006], which included toddlers) 95-98 percent 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."

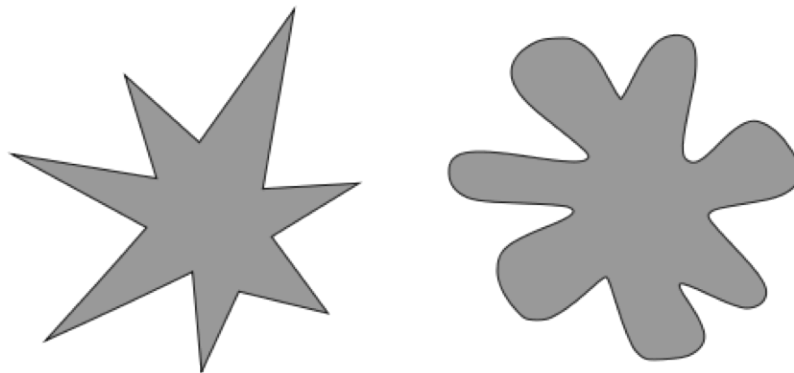


Figure 3: The shapes "Takete" and "Maluma," or "Kiki" and "Bouba" (respectively) referred to in the Bouba/Kiki Effect

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 (2003) 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.

Early attempts in the past to directly correlate light and sound can be traced back to antiquity (Mason 1958). Later, in the eighteenth century, Castel in his research gave directions for construction of a “color clavicin,” associating a specific spectrum order with the order of notes in terms of primary colors and tones (Mason 1958).

In the twentieth century, Russian painter Wassily Kandinsky was known largely for his painted interpretations of music. His 1911 book, *Concerning the Spiritual in Art* is one of the most noted mentions 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 unique perception of color as it relates to sound. 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 2010; 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, Gold* from 2003 (Fig. 4).



Figure 4: Carol Steen, *Runs Off in Front, Gold*, 2003, oil on paper

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, all of whom were notably extravagant and uninhibited in their use of color (Ione 2009). However, Paul Klee, who was not a synesthete, believed that he created visual music through experiment and re-evaluation with color and form, and was openly not fond of Kandinsky's self-proclaimed "scientific" and "objective" approach to reconcile the media that likely stemmed from his own synesthetic predilections (Ione and Tyler 2004).

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 article "Synesthesia and the Arts," Greta Berman (1999) 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." 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. Cross-modal abstraction is a process by which connections are made between specific and otherwise disparate sensory experiences through their more general properties, occurring almost universally and in the same way for everyone. 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 occur differently within the brain. Cross-modal abstraction is currently believed to occur within many sections of the brain at once, largely culminating and being compared to one another 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 direct cross-communication between those portions 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 (2013) 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. 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. This study is built on the observation of cross-modal abstraction as a non-overlapping and universal characteristic that affects both synesthetes and non-synesthetes alike.

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 fifteenth century and of opera in the sixteenth, 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 (1983) believes that cross-modal metaphor occurs when stimuli are “processed at a level abstract enough to allow intersensory comparisons.” However, the specific translations that must occur in order to allow for these intersensory comparisons have not yet been concretely determined. We 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 people across cultures generally associate higher visual value (degree of lightness) with higher auditory pitch (e.g., Galeyev 2003, 2007; Klapetek et al. 2012; Sagiv and Ward 2006). Unlike qualities such as modality in music (which could correspond with darkness) or subject matter in art or programmatic music, the cross-modal correlation of pitch and brightness have been extensively studied outside of an artistic context and are much less culturally subjective. These traits are measurable in both the visual and the musical works and we 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.

We therefore employ a model that extracts and measures attributes that have been linked with one another through cross-modal abstraction: 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. Music and art are both affected by common culture and nationality, and cross-modal abstraction could therefore be responsible for distinct properties in the works of musicians and artists of different nationalities. In this study, we compare pitch to “brightness,” using that term to mean value (grayscale lightness) rather than strength of chroma (saturation of color).

To test this model, we 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 at a time when national character was a priority. This timeframe was

host to artists who are now referred 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 eighteenth 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 nineteenth 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 we have 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 we were limited by the digital availability of said works. In particular, digital images, while offering information on the traits we are measuring, such as value, hue, and saturation, are unable to capture other important elements of a painting that we are not measuring, such as texture. Nevertheless, the loss of such information through pixilated reproduction would most likely produce a bias towards our null-hypothesis that differences between Russian and French works are not statistically significant, and we therefore expect our conclusions to be conservative. The differences between nationalities would be made more precise with more consistent image gathering techniques. 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. Because the focus of our study relies on the measurement of cross-modal abstraction of brightness and pitch as a universal trait experienced separately from synesthesia, we have not distinguished between posthumously conjectured synesthetes and non-synesthetes.

## Methods

In selecting images, we 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 fifty 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. We were careful in isolating and evaluating the quality of the images, 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.

Because of how widespread the arts were throughout Europe during this time, cross-cultural communication and wherewithal is almost certainly going to be a factor. However, in order to mitigate the risk of cross-contamination between musical and artistic ideologies as much as possible within our study, 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 eighty 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, we extracted the measurements of value and saturation, and calculated both the mean and the standard deviation of the value and saturation of each image (e.g., see Figure 5). 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. We 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, we calculated the mean and standard deviation of pitch just as we calculated the mean and standard deviation of value within the images.

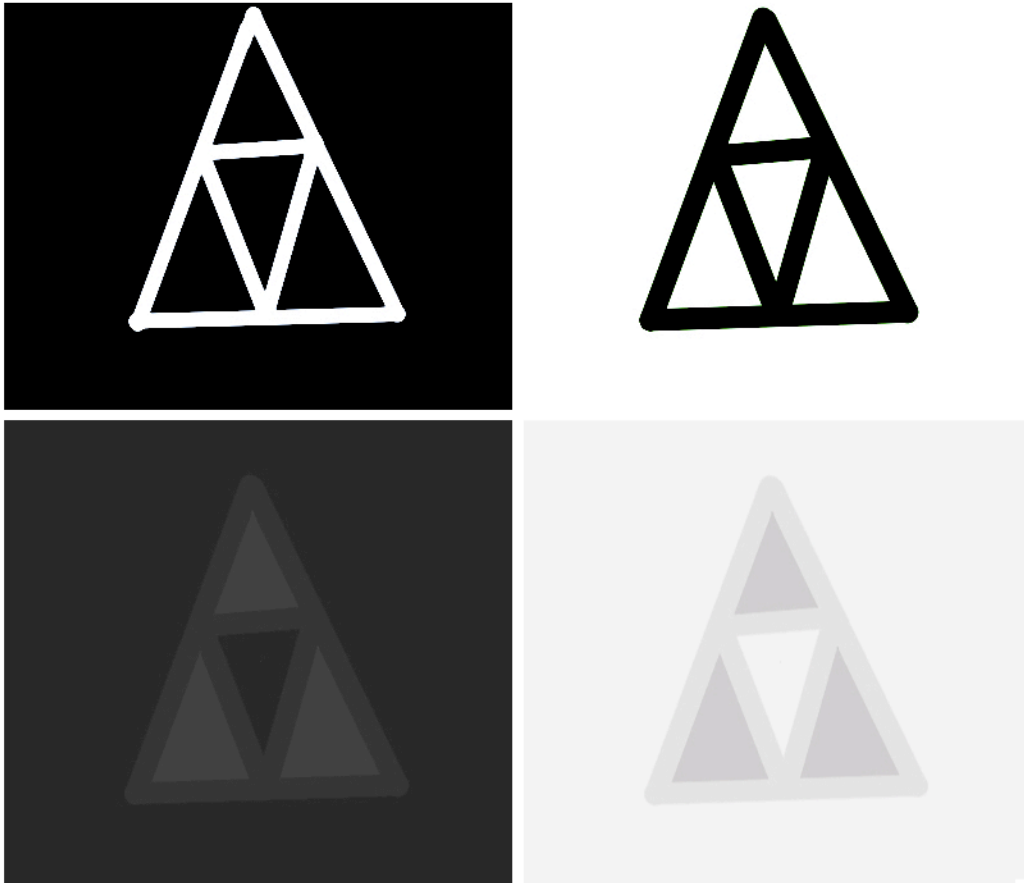


Figure 5: Four example images illustrating different value means and standard deviations: high mean and high standard deviation (upper left), low mean and high standard deviation (upper right), high mean and low standard deviation (lower left), and low mean and low standard deviation (lower right).

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. We administered a series of tests to compare these pitch and value data and to determine whether there is a statistical significance between countries. All data, including the artists, composers, and works that were analyzed, and all code for analysis, are provided as supplemental material. All analyses were performed using R software (R Development Core Team 2011).

To test whether or not differences between nations are statistically significant, group assignment is randomized over many iterations. 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 from what would be expected by chance, then randomly shuffling the groups to which data are members should produce randomized mean group values that are not much different in magnitude than the observed values. For example, in the case of value means of Russian and French paintings, all of the 160 data (eighty Russian and eighty 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 eighty (either Russian or French). If the difference between the means of the randomly assigned groups is not much different than that of the difference between the means estimated from the observed data, this is evidence that the difference between the group means in the observed data (French versus Russian painting value means) is not different than what would be expected by chance. It could then be concluded that value mean is not different in Russian versus French paintings. Of course, more than one randomization of group assignments is necessary to determine with confidence whether or not the observed 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 group means is calculated. After these iterations, the difference between estimated group means calculated from the observed data is compared to the distribution of differences from the randomized data to estimate the probability ( $P$ ) of observing a group mean difference of equal or greater magnitude assuming random group assignment. For example, if the difference in the observed data is greater than any difference in the randomized data, then  $P=(1+0)/(1+999) = 0.001$ . If the difference in the observed data is only greater than 900 values in the random data, then  $P = (1+99)/(1+999) = 0.010$ . As is customary, we use values of  $P$  lower than 0.05 as the



threshold below which differences between groups are considered statistically significant.

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 significance of differences between groups. Bootstrapped 95 percent 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 one thousand 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.

## Results

Differences between painting value means ( $P = 0.001$ ; Fig. 6) and painting value standard deviations ( $P = 0.002$ ; Fig. 7) were significant, but difference between composition note appearance means ( $P = 0.236$ ) and standard deviations ( $P = 0.113$ ) were not significant, nor were the differences between composition ticks means ( $P = 0.481$ ) or standard deviations ( $P = 0.531$ ). 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. Figure 6 shows that value means are higher in French paintings (estimated mean = 59.00) than in Russian paintings (estimated mean = 50.28). Figure 7 shows that value standard deviations are higher in Russian paintings (estimated mean = 20.66) than in French paintings (estimated mean = 18.47).

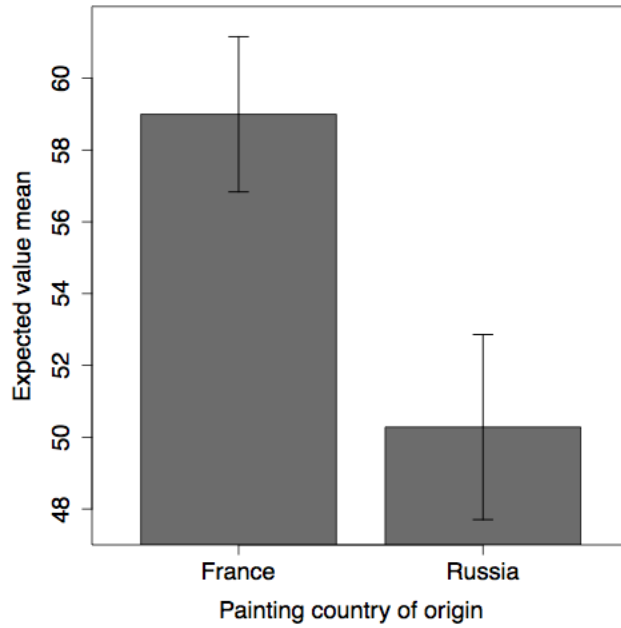


Figure 6: Expected value means for French ( $N = 80$ ) and Russian ( $N = 80$ ) paintings (1870-1920). Error bars show 95 percent bootstrapped confidence intervals around means.

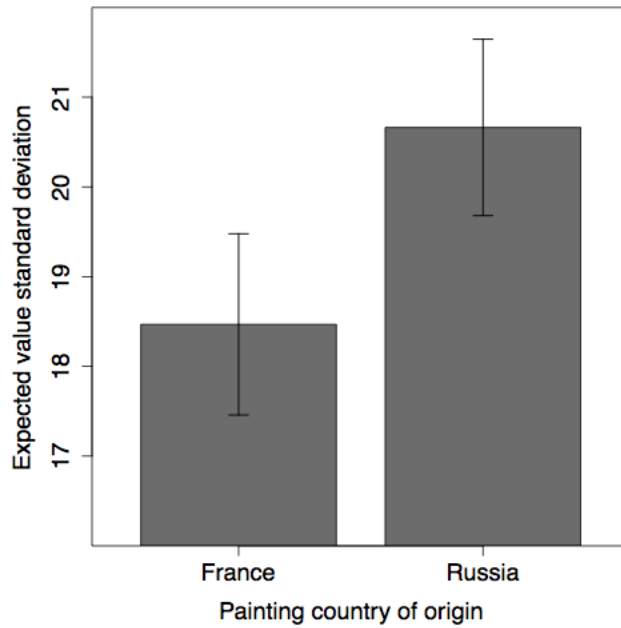


Figure 7: Expected value standard deviations for French ( $N = 80$ ) and Russian ( $N = 80$ ) paintings (1870-1920). Error bars show 95 percent bootstrapped confidence intervals around means.

## Discussion

From the 160 painting samples collected, we 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 within and between cultures 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 lightness 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 we measured using 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.

The resulting difference in values between this large sampling of artistic works of different cultures supports the cultural importance placed on these methods. If strong and widespread cross-cultural communication were more pronounced for either the French or for the Russian art groups, we would predict no statistically significant difference between cultural artifacts.

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 ten-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 seven octaves. Most modern orchestras can span up to six octaves, each of their instruments having a range of their own. Most modern choirs hold a range of just under four 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, 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. 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 comingling, 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.

## 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” (1983, p. 861). While the results of this 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

we have employed may be of use in determining these features' significance. Additionally, improved methods for obtaining and quantifying image and music data could improve the ability to address cross-modality between the arts.

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.

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