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Musical Variables and Color Association in Classical Music

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ABSTRACT

As studies between behavioral neuroscience and music have become increasingly popular, color association with music has grown as a topic of interest. Many studies analyze color correlation with individual musical variables such as the speed of the music or the notes used. However, there has not been significant research comparing the influence of these variables or exploring instrumentation. Due to this apparent gap, this study addresses the question: to what extent do tempo, key, and instrumentation affect variation in colors associated with classical music created from 1750 to 1910? Data was collected from approximately 150 participants, ages 11-18, who all had musical experience. Responses were recorded through a Google Form that asked participants to listen to a 20-second clip of music and choose 1 of 14 offered colors. A Chi-Squared test was utilized to test the statistical significance of the influence of the variable groups on the tonality and brightness of color choices. It was found that only one group, instrumentation, did not have a statistically significant effect on brightness. Previous studies were reaffirmed as major keys were heavily correlated with light colors and minor keys with dark. When grouping colors by neutral, warm, and cool, tempo was found to be the most influential variable for color choice tonality. Instrumentation in both color groupings yielded similar results as there was not much variation in the colors, indicating that instrumentation does not heavily influence the color choices of the listener.

Introduction

Classical music and the mind are traditionally studied in relation to learning and education. Most studies conclude that there are positive neurological effects of classical music on one's ability to study and memorize material.Studies often indicate that listening to classical music during activities is correlated with increased focus. These connections have been identified as medical facilities and psychiatrists often observe the brain while listening to or playing classical music (Peacocke, 2009). An emphasis has also been placed on the effects of this music on developing minds and young students as their malleable brains react differently, and often more extremely, to musical stimuli. As the pursuit of such topics proliferates, new interests in music and psychology have arisen. Many of these new questions involve the relationship between color and musical experiences as both are important elements of mass media production.

These new topics of inquiry indicate that color and music connections are a more modern topic to pursue than other psychology links in classical music and test subjects. Magnetic Resonance Imaging (MRI) has enforced the emotional connection between music and the brain, as well as increased neurological activity in subjects listening to classical music. Some studies, such as the one at the Institute of Behavioral Sciences in Finland, were able to identify activity in specific regions of the brain that indicate that music can evoke different neurological responses linked with emotion and color (Carlson et al., 2015). With new developments in these fields, artificial intelligence (AI) software has also been deployed to make connections between music and visuals within technology (such as screen savers) by collecting data from listeners and the visuals they often pair with certain songs. However, this technology does not evaluate the variables within music but rather uses human responses to formulate patterns (Marr, 2019).

Even before modern studies had reinforced the connection between music and human behaviors, a notable connection between music and emotion had been observed. Early philosophers such as Plato hypothesized that different keys and styles within music would stir a variety of emotions. Philosophers also hypothesized that the emotional significance of any particular piece of music would be mostly agreed upon by the majority of people. For example, major chords are generally accepted to be perceived as cheerful and minor ones sad. The influence of tempo, or speed of the music, on emotions has also been observed for centuries as slower music is perceived as less joyful than faster pieces of music (Douek, 2013). In fact, there is a significant neurological connection to these emotions that supports the correlation between music and feelings. Right hemisphere activity in the brain has been observed in subjects listening to, or even thinking of, music in studies using brain imaging (Peacocke, 2009). These neurological responses triggered by music have provoked a variety of studies between various psychological behaviors and classical music; one of these being color association. In recent years, two theories have been formed as to why direct links between colors and music may be apparent in the human brain. One theory claims that music and colors are related through a direct connection in the brain that processes and reacts to both visual and auditory stimuli. In contrast, another theory suggests that color and music are related indirectly through common emotional associations, such as experiences that relate joyful music with joyful colors in a less direct manner. Regardless of the cause for the colors and music association phenomenon, a connection between the two is apparent (Elliot, 2015).

Multiple studies have evaluated the established relationship between classical music and emotions. Notably, a study conducted by the Association for Consumer Research found that music either alters the emotions of a subject or enforces emotions already felt by an audience in up to 92% of cases (Aljanaki, 2016). Moreover, in 2015 Cornell recorded psychophysiological reactions while listeners heard two excerpts that were chosen to represent a variety of emotions. This data covered a fairly wide spectrum of cardiac, vascular, electrodermal, and respiratory functions. These physical observations about the state of the subject were accompanied by personal testimony from each subject regarding their emotions. These results indicated that music not only directly affects one's mind, and subsequently their emotions, but music also alters physical aspects of one's body such as their breathing and heart rate (Raglio, 2015). A connection between colors and emotion has also been observed by Stanford University which found that bright colors are consistently connected to positive emotions; red is often associated with anger; and dark colors are indicative of a sad feeling (Goldman, 2013). This supports a transitive relationship between colors and music as there has been a connection established between music and emotions and emotions and color.

When observing the connection between music and color, recent studies have evaluated connections between different musical variables and color association. For example, the University of California, Berkeley studied changing tempos in piano lines and their effects on color association patterns (Whiteford et al., 2018). These studies have been performed with multiple genres, including classical, pop, rock, and jazz. Most studies observe connections between the key of the music and the colors associated with the music across nearly every genre. A key in music refers to the notes used within the piece of music; different keys utilize different sets of pitches based on musical scales. Most keys are categorized as either major or minor, as these two classifications are relative opposites of each other (Douek, 2013). Studies agree that minor keys are associated with darker colors and major keys with lighter colors. These findings also conclude that these results are due to the sad emotions associated with minor keys and the happy emotions associated with major keys (Collier and Hubbard, 2004). Tempo is the other commonly observed variable in similar studies. Findings are also consistent across these studies as faster songs are considered happy and associated with brighter colors and slow songs are likely to be associated with dark, sad colors (Fernández-Sotos, 2016). As the primary focus of these studies is either tempo or key, other variables, such as the instruments used in the music (i.e. instrumentation), are kept constant and have yet to be observed. Other findings also indicate that poor sound quality may cause unease in the listener which evokes negative feelings even if the music is “happy” (Ball, 2012).

There has yet to be a study that compares multiple variables to each other in terms of how heavily they may affect color association for the listener. Studies examining the key of music in relation to color association are most common and yield broadly accepted results as the key is found to most heavily affect the behavior of the listener. These variables are most easily observed within purely instrumental classical music as this genre does not have lyrics

acting as another variable influencing the mood of the listener and subsequently the color associated with the music. In studies observing the effects of classical music on subject behavior, classical music is commonly defined to include the primary eras of classical music such as the Baroque, Romantic, and Classical eras that contained works from composers such as Mozart, Bach, and Haydn (Feld, 2012). The inquiry surrounding this era leads to the question: to what extent do tempo, key, and instrumentation affect variation in colors associated with classical music created from 1750 to 1910?

Methods

In order to test the effects of multiple musical variables on color association, an experiment was implemented that tracked three variables within music with subject responses. As the study worked with human participants, IRB approval was obtained through an ethics presentation to a review board. Additionally, consent and assent forms were presented to the subjects as the first page of the Google Form used in the experiment. If participants did not consent to the terms of the test the form automatically took them to the end of the survey so that they would not participate in the study. In this study over 140 participants filled out a response sheet through a Google Form, shown in Appendix A, created to analyze the correlation between a variety of musical variables and color choices. Young musicians ranging from sixth to twelfth grade participated in this study, many of whom have been involved in music for multiple years. To acquire these responses, the survey was posted and endorsed by the choir, band, and orchestra teachers at two middle schools and a high school through a shared classroom page. Before the teacher posted the link to the form they were asked to take the survey, not for data collection purposes but to have the opportunity to ask the researcher questions they thought the participants may have, and to gain clarifications before students participated in the study. While the survey was encouraged and advertised by teachers, no credit was awarded in the class for participation in the study.

The survey included eighteen pieces to cover a range of musical variables. The pieces selected were not considered common pieces of classical music, as they were not used in nursery rhymes or movie themes, so that subjects would not have previous emotional associations with the music presented. However, a previous association was still possible as the subjects were musicians who may have been familiar with less popular pieces of classical music such as the ones in the survey. These eighteen pieces all fit within the three primary eras of classical music and, although not mainstream in modern culture, were all from a variety of composers that contributed to defining these primary eras. By using songs from influential composers, it is more likely that the selected songs represent the defined time period of 1750 to 1910 appropriately, as these composers were fundamental to the period and established many common styles in classical music. Additionally, each selected song was from years in which the composer was considered most active in classical music to further attempt to form a well representative song list. The list of these songs can be found in Appendix B. All combinations were used with key, tempo, and instrumentation categories. Keys included major and minor keys that varied in what notes were used within the piece. Tempo, defined in beats per minute and with descriptions in Italian, were slow (20-60 bpm) with tempos classified as grave and largo, medium (60-100bpm) covering adagio and moderato, and fast (100bpm and above) including allegro and presto. There were also three instrumentation categories, including symphonic that consists of both string and wind instruments, pure string, and piano. The clips were twenty seconds long when presented to subjects and were attached to the survey as a video with audio and a blank, black background. Within these clips, the variables were kept constant and included sections of the song that were well representative of the entire piece. For example, the medium speed songs maintained a medium pace through the entire twenty-second clip, and did not slow down or speed up. The clips also often included the main theme from the piece or a repetitive section. All clips were also recordings from professional groups so that the sound quality was kept consistent. The style of this survey, including the song clip length and color choices, was modeled after the previously mentioned University of California, Berkeley study that had kept instrumentation constant. The study by the university primarily analyzed tempo and key variation using single melodies from piano pieces by Bach (Whiteford et al., 2018). This was used as a reference for choosing the parts of songs to include; as single,

consistent melodic lines were used in this study as well. The study by the university included the entire medley regardless of its length. This survey however included 20-second clips so it would be more feasible to complete for school-aged children.

Before taking the survey subjects were asked if they had any hearing problems, color blindness, or synesthesia, a phenomenon in which one links senses, such as sight and hearing, with each other. After listening to the clip the subjects were presented with fourteen colors consisting of both primary and secondary colors, shown in Appendix C, and black and white in 60x60 pixels squares, the order of the presentation of the colors was kept constant and the colors were offered as multiple choice answers in which only one could be chosen. These fourteen colors were chosen to provide a variety of choices for the listener while also being limited so that data for individual colors could be more efficiently observed. Other studies similar to this one have utilized a more comprehensive color wheel or a customizable color option for participants, however, due to the large sample size and concern of focus level, limited color choices were a more efficient option. Additionally, this assortment of fourteen colors offers choices that are warm, cool, neutral, light, and dark, allowing for an analysis of color families in addition to an analysis of individual colors. All of the colors could be viewed at the same time and a participant could relisten to the song clip if they chose.

The survey was administered with several instructions to avoid confounding variables. Subjects were asked to take the survey in a quiet area and use earbuds or headphones to avoid background noise that may hinder one's ability to best assess the song clip and choose a color. Participants were also asked to maximize their devices' brightness setting and keep the devices on the standard daytime display mode so that the colors could be clearly analyzed as well. Most surveys were taken individually in class or on the student's own time. Two middle school choir groups (consisting of approximately 45 participants) completed the survey as a group in order to keep them on task. In these cases, the teacher played the clips for the class and had students individually choose colors that they believed correlated with the clip. This was done to facilitate more focused results as the teacher administering the survey had concerns that younger groups may have been more likely to get distracted from the survey without supervision.

Due to concerns of focus and response rate, the survey was created to maximize efficiency without sacrificing thoroughness. The clips were twenty seconds long so the subject could gather a good understanding of the piece but they were no longer so that the subjects would not lose focus. In addition, a Google Form was used for this survey as the intended subjects would be comfortable and familiar with this format. This easily accessible format facilitated a viable response rate as the survey was sent to approximately seven-hundred students and over one hundred forty responses were recorded. In addition, all subjects who began the survey finished it and completed all the questions within the survey. The survey took approximately sixteen minutes on average with a range from seven minutes to twenty minutes. This indicates that all subjects also listened to all the clips in full as this would take six minutes.

After answering the survey, the results were recorded automatically in a Google Spreadsheet associated with the survey form. The names and emails of subjects were not recorded with the results in order to keep anonymity among participants. The name of each piece was not included in the survey. Instead, each song was labeled with a song code in the survey to keep the name of the piece from causing any bias from the titles. Refer to Appendix B for songs and corresponding codes. The song codes with their respective titles and the categories they represented were kept separately so that the results for each piece and their corresponding variables could be analyzed effectively. The Google Form was open to responses for three weeks and individual responses were recorded after participants completed the form to be evaluated and categorized.

Results

Approximately 20% of those who had access to this study participated as 147 responses were recorded and an estimated 700 students received the survey. With this sample size each key level had 1323 data points as there were 9 songs of each key and tempo. Instrumentation had 882 responses as there were 3 levels for these variables. One participant reported having synesthesia and two reported color-blindness. All participants who started the study finished

it, indicating that the Google Form format was positively received by participants. Additionally, all participants took longer than 7 minutes, indicating that they had time to listen to all of the clips in full.

When evaluating the initial raw data pertaining to each piece and individual colors there are many notable color results. For this evaluation a color result is considered notable if over 21 participants associated the color with a clip as this would indicate that one color was associated with a piece by 15% or more of participants. If the distribution were purely random an estimated 10 or 11 participants would pick each color, thus a color receiving over 21 associations is notable with approximately twice the expected random value of the color. These cases are worth recognizing because they will strongly influence the results for larger color groups. For example, if many participants associate a Minor-Piano-Slow piece with blue, this association contributes to a stronger correlation between these variable levels and the color categories that blue is included in, cool and dark.

Table 1. Individual Color Frequency for String Instrumentation Group

	Minor String			Major String		
	Fast	Medium	Slow	Fast	Medium	Slow
White	2	8	6	15	19	14
Red	54*	5	30*	18	5	4
Red-orange	16	6	8	20	10	3
Orange	5	10	3	10	13	9
Yellow-Orange	4	17	5	12	11	8
Yellow	9	8	5	12	12	4
Yellow-green	4	19	7	8	14	13
Green	9	6	6	9	11	13
Blue-Green	6	19	6	6	14	18
Blue	5	17	6	4	9	19
Blue-violet	9	13	16	6	7	13
Violet	3	9	5	8	8	12
Red-violet	10	5	5	13	11	9
Black	10	4	38*	5	3	7

* Indicates notable color results greater than 21

The String Instrumentation Group, shown in Table 1, had far fewer notable color association choices than others. Both the Minor-String-Slow and Minor-String-Fast clips were strongly associated with the color red, having 54 and 30 participants select this color for the respective groups. This may not strongly support the influence of tempo on color association but it does contribute to an association between the String Instrumentation Group and the color red along with its color groupings, including dark and warm colors.

Table 2. Individual Color Frequency For Piano Instrumentation Group

	Minor Piano			Major Piano		
	Fast	Medium	Slow	Fast	Medium	Slow
White	8	18	7	6	19	12
Red	18	3	4	3	2	1
Red-orange	6	3	6	9	6	4
Orange	5	3	3	12	6	3
Yellow-Orange	0	17	4	14	20	6
Yellow	3	36*	2	59*	16	1
Yellow-green	2	12	4	8	18	3
Green	7	10	1	6	12	6
Blue-Green	4	16	4	9	13	14
Blue	9	5	48*	3	8	37*
Blue-violet	17	3	27*	3	5	21
Violet	10	5	3	4	5	9
Red-violet	4	13	1	7	11	7
Black	53*	2	32*	3	5	22*

* Indicates notable color results greater than 21

Table 2 shows the colors for the Piano Instrumentation Group. In this instrumentation group 48 participants associated the Minor-Piano-Slow piece with blue and 27 associated it with blue-violet, indicating a possible link between these three variable levels and cool, dark colors. 36 participants associated the Minor-Piano-Medium clip with yellow which is interesting as a strong association with a light color contradicts the hypothesis that links minor keys to dark colors, instead indicating that the instrumentation and tempo influence the listener to choose a lighter color, despite the minor key. The Major-Piano-Fast clip was even more so associated with yellow as 59 participants chose this color for the clip. A higher association with yellow in this clip may demonstrate that the presence of a major key and fast tempo led to an increased association with light, warm colors. In contrast the Minor-Piano-Slow piece was strongly associated with blue, having 37 participants select this color. With the same instrumentation but different keys and contrasting tempos, the Major-Piano-Fast was most associated with a warm, light color yellow while the Minor-Piano-Slow was most associated with a cool, dark color blue. Such a difference reveals that these variables, tempo, and key have a significant influence on color association.

Table 3. Individual Color Frequency for Symphonic Instrumentation Group

	Minor Symphonic			Major Symphonic		
	Fast	Medium	Slow	Fast	Medium	Slow
White	7	11	9	13	7	12
Red	32*	8	4	27*	2	8
Red-orange	18	6	6	8	4	5
Orange	13	4	4	9	11	4
Yellow-Orange	5	2	6	8	13	8
Yellow	6	5	11	26*	20	4
Yellow-green	7	1	10	18	27*	10
Green	8	6	16	11	12	6
Blue-Green	13	14	25*	3	12	20
Blue	5	24*	12	2	7	20
Blue-violet	5	29*	11	5	3	18
Violet	9	11	12	4	12	13
Red-violet	12	3	11	9	8	6
Black	6	22*	9	3	8	12

* Indicates notable color results greater than 21

The Symphonic Instrumentation level, shown in Table 3 yielded eight notable results, the same number as the piano instrumentation level. The only notable points in the same color were under Minor-Symphonic-fast at 32 and Major-Symphonic-Fast at 27 both for the color red. This is an interesting notable result as these greater frequencies for the color choice of red support a possible correlation between a fast tempo and the color red. This possible correlation is supported by the notable data point in the Minor-String-Fast category as well. This instrumentation level also had the most notable results under one category including 24 for blue, 29 for blue-violet, and 22 for black under the Minor-Symphonic-Medium category. All of these dark, cool colors include notable values supporting a possible correlation between these three variables and the color categories of the notable values. Additionally, these values may reinforce previous studies relating dark and cool colors to minor keys.

Table 4. Frequency and Percentage Distribution of Variable Groups for All Color Groupings

	Key		Tempo			Instrumentation		
	Minor	Major	Fast	Medium	Slow	String	Piano	Symphonic
Cool	570 (43.34%)	551 (41.93%)	688 (52.36%)	854 (64.99%)	484 (36.83%)	795 (60.50%)	810 (61.64%)	860 (65.45%)
Warm	492 (37.44%)	579 (44.06%)	496 (37.75%)	335 (25.49%)	651 (49.54%)	389 (29.60%)	318 (24.20%)	336 (25.57%)
Neutral	252 (19.18%)	185 (14.08%)	131 (9.97%)	126 (9.59%)	180 (13.70%)	131 (9.97%)	187 (14.23%)	119 (9.06%)
Light	508 (38.66%)	757 (57.61%)	406 (30.90%)	536 (40.79%)	323 (24.58%)	408 (31.05%)	430 (32.72%)	427 (32.50%)
Dark	806 (61.34%)	557 (2.39%)	908 (69.10%)	778 (59.21%)	991 (75.42%)	906 (68.95%)	884 (67.28%)	887 (67.50%)

In order to evaluate broader trends in the data, colors were organized by both tonality, including cool, warm, and neutral, and by brightness, including light and dar. The organization of colors within these categories can be viewed in Appendix D. When initially analyzing the effects of each variable on the color choice between light and dark colors, key had the greatest influence, followed by tempo. Instrumentation did not appear to have much effect on the choices between light and dark colors as the differences across the levels were only a maximum of about 1.5 %. Overall it was also observed that participants generally favored darker colors within these comparison groups.

Results varied slightly when analyzing the difference of proportions of warm, neutral, and cool color associations among the variables. The key difference in proportions averaged 4.38%, however tempo averaged a difference of 12.96% overall and 10.35% when only comparing fast and slow tempos, indicating that when organizing through this color system tempo has greater variation and influence than key. The instrumentation difference averaged to be 3.45%, indicating that instrumentation and key had similar amounts of influence on color decisions between warm, cool, and neutral. The slow tempo was the greatest link to dark colors by 6% and the medium tempo resulted in the lightest colors, perhaps due to fast tempos being interpreted as aggressive. Slow had the largest percentage of warm and neutral associations while medium had the coolest color responses.

The influence of each variable was also compared. Major keys are nearly 1.5 times more likely to result in association with light colors than minor keys and minor keys are linked to dark colors by a similar factor around 1.5. There was little difference with the influence each key had on cool color association but major keys were more associated with warm colors than minor keys by approximately 8% and minor keys were more so linked to neutral colors by about 5%. The difference between light and dark across all three instrumentations was less than 2%.

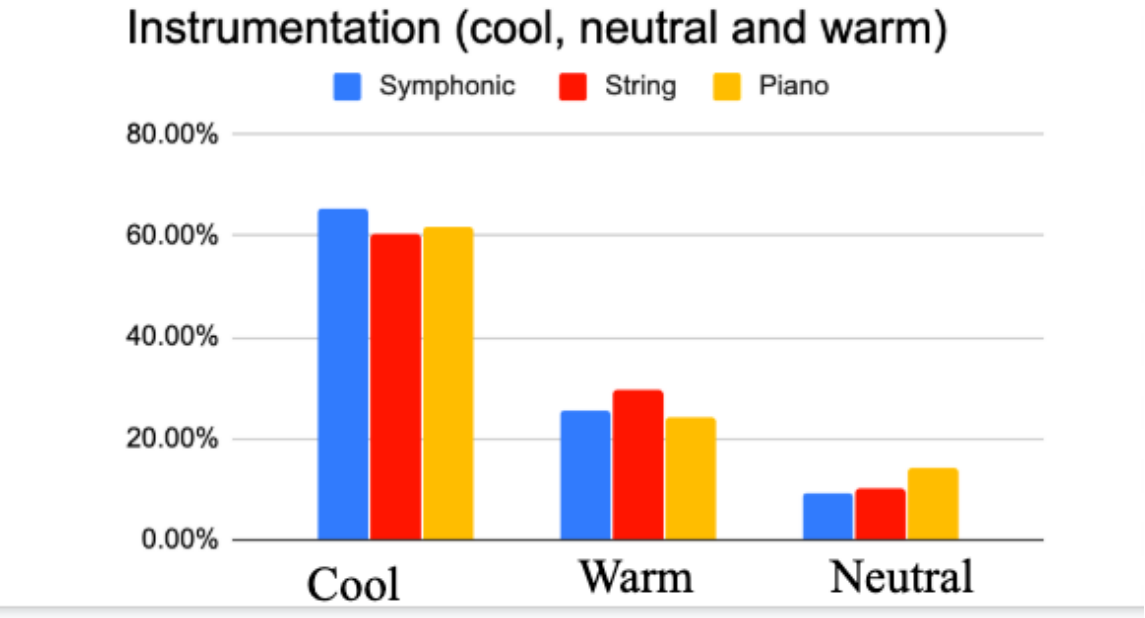

Figure 1. Instrumentation Variable Levels Comparison Among Cool, Neutral, and Warm Colors

Within the instrumentation category, shown in Figure 1, Symphonic music had the most cool responses (by 4.26%), Piano had the most neutral responses (by 3.81%) and String yielded the most warm responses (by 4.08%).

Analysis

A Chi-Squared test was run through an online calculator to determine if the influence of each variable group including key, tempo, and instrumentation, on color brightness and tonality was statistically significant (Chi-Square Test Calculator, n.d.). The influence of both key and tempo on the tonality and brightness of color choice was statistically significant when tested at a .01 significance level. The p-value for these categories, shown in table 5 below, were all less than .01. The influence on instrumentation on the tonality of colors chosen was statistically significant with $p<.01$ but the influence of instrumentation on the brightness of colors chosen was not statistically significant at .01, .05, or .1 significance levels as $p= .61$.

Table 5. P Values for Chi-Squared Test on Influence of Variable Categories on Tonality and Brightness of Color Choices

	Key	Tempo	Instrumentation
Tonality	$p = .00015$*	$p = .00011$*	$p = .00017$*
Brightness	$p = .00012$*	$p = .00012$*	$p = .61$

* Indicates significant at significance level .01 since $p<.01$

Tempo was found to influence choices between light and dark colors less than key but more than instrumentation. In addition, tempo was also found to be the variable that had the greatest influence on the tonality of color choices. The slow tempo category was mostly associated with dark, warm, and neutral colors while the medium tempo category was associated with light and cool colors. The fast tempo category did not have a notable color group that it was most associated with compared to the other two categories.

Key was found to influence choices between light and dark colors more than tempo and instrumentation. Key was also found to be the second most influential variable for color choice tonality. The minor key category was most associated with dark and neutral colors while the major key category was most associated with light and warm colors. The cool color percentages between these two variables were similar indicating that this color category was not heavily affected by key.

Instrumentation was found to be the least influential in association across both color categorizations. In addition, a few trends were identified within string variable levels as the Pure String category was mostly associated with warm colors; the Symphonic category was associated most heavily with cool colors; and the Piano category was most associated with neutral colors.

Although most of the data is statistically significant in evaluating the influence of individual variable levels and comparing them, these findings are only applicable to school-age student musicians as this was the population studied. Adults and non-musicians did not participate in the study, thus the findings involved with the variable levels in question may not be applied to these populations. Additionally, even though there were participants with synesthesia and color blindness, there was not a significant number of these participants, therefore findings of this study can not relate to these groups.

Other limitations to these findings are present as the environment in which the form was completed varied for participants. It was suggested that participants use earbuds and complete the form in a quiet environment to best hear and reflect on the music clips. However, the environment was not controlled by a supervisor in most cases, in order for the survey to be more accessible. Some participants may have used earbuds while others did not. Some participants completed the form at home, others in classroom environments, thus the level of distraction likely varied among participants. This may have inhibited participants' ability to reflect on the clips they listened to and perhaps also allowed for outside influence from nonparticipants or those who had already completed the survey. In the future, the environment should be controlled to limit the influence of outside sources and distractions.

There was also only one example for each variable group, and one version of this survey administered. It is possible that the pieces chosen for this experiment were not fully representative of their classification categories. The results of this specific survey likely do not represent all classical music. Moving forward with these findings one may only use this data as a baseline for comparison involving classical music from the eras studied. Observations about instrumentation, key, and tempo may not be applied to music outside the genre of classical music or the time periods studied. However, this study could provide inspiration for similar studies in other genres.

Conclusion

Through studying the relationship between musical variables and the tonality and brightness of color choices, in addition to analyzing the influence of these variables on color choice, this study yielded findings to answer the question: to what extent do tempo, key, and instrumentation affect variation in colors associated with classical music created from 1750 to 1910?

Findings relating to tempo within this study support previous studies that link slow tempos to dark colors. Another notable finding within tempo variable levels included a high amount of variation within fast tempo color associations. This was most likely more varied than other tempo levels because fast tempos may be interpreted as angry (red) or bright and cheerful (yellow), thus these varying interpretations of speed most likely caused internal variation.

These findings relating to key support the heavy psychological association between major keys and happiness or light colors and the parallel association with minor keys and darkness. This is one of the oldest accepted connections between color and music, as key is used to set the mood of a piece. The results between light and dark colors confirmed this further.

Instrumentation findings have not been explored previous to this study and so these findings hold the newest contribution to the fields of music, art, and psychology. Based on the data collected instrumentation was overall less influential than other variables. Although this variable was the least influential of the three, the differences in the color association tonality are still notable due to the statistically significance of the relationship. The texture of instrumental voices that instrumentation alters within a piece of music, is likely responsible for this influence and should be explored further.

In a world in which marketing and entertainment play a central role in economy and culture, these findings may be utilized in such industries and their media creation. For example, these conclusions are useful to those creating advertisements, movie scores, and music streaming apps. In the entertainment industry these associations between color and musical variables may be employed for a more cohesive overall effect (Morris and Boone, 1998). Movies working to create a light atmosphere may couple bright colors with music in a major key and a fast tempo. Similarly, the music and color themes within ads may also be more carefully targeted for the audience. This study especially yields data useful for children's movies and advertisements for products targeted at younger populations, as this was the age group examined in this study. Furthermore, music streaming apps that often offer personalized playlists based on emotions and daily moods may create algorithms that weight musical variables based on their level of influence on the perception of a piece of music. Based on these findings it would be recommended that keys be most considered when working to create music that facilitates a certain emotional or creative environment.

In addition to media creation, these findings may also be utilized in music therapy. Music therapy serves children with ADHD, autism, and general anxiety by supporting them in better communicating and expressing their feelings through music. Music therapy is often coupled with art therapy to create a calming atmosphere through music, most often classical or instrumental, that facilitates creativity for children through art, such as painting (Sausser and Waller, 2005). Since this study's participants were all school-aged children and it focused on classical music, findings could fit this field especially well. Therapists could choose songs based on their variables such as tempo, key or instrumentation, in order to create the desired environment. If a therapist is assisting a child in expressing frustration through red and black paint or sadness through dark, cool colors, music that matches this atmosphere and artwork may be an important aspect of creating a more cohesive environment for the child to express themselves.

In the future the influence of these three variables could be studied in relation to other reactions in survey participants or the influence of other musical variables on color association could be further explored. A very similar study could be pursued with other genres such as rock or pop music while still studying the same variables to determine if the patterns found within this study hold true within other genres. Additionally, other variables such as sound quality or note density could be studied in multiple contexts. Classical music could also be studied in relation to colors but instead of altering the composition variables of a piece, specific composers could be studied to determine if specific composers, or eras of classical music, produce music that is associated with similar colors. An identical song selection could also be presented to participants but instead of color association, emotional reactions or connections to art could be studied. For example, a participant could be asked to match a piece of artwork with a musical clip or comment on the level of cohesiveness they feel is present between a musical clip and an image or piece of artwork.

With new findings relating to instrumentation and a more in-depth comparison of each variable's influence levels, future researchers will be able to expand their understanding of the way music influences human perception of color. The exploration of a new musical variable, instrumentation, creates prospects for companies and musicians to intertwine the instrumental auditory aspects of music with visual perceptions of media and art.

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