

WHAT IS THE COLOR OF THAT MUSIC EXCERPT?

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Abstract

This study will investigate how the expressive quality emotion in a music excerpt can be associated to different colors. Research has shown that music can induce different emotions depending on acoustical features such as pitch, tempo and timbre. Other studies have shown that colors can be associated with emotions, and that people tend to match color association with the perceived emotion in music. In this study, a test was conducted where 12 participants got to rate how well 24 colors of different hue, saturation and brightness was associated with 8 music excerpts of jazz music. The test was conducted using a form where 8 colors was shown at once together with a slider for rating. The music was played through headphones in randomized order in between the participants. The results show that some hues are rated significantly higher than others for different emotions, meaning that different hues are associated with different emotions. Further, a correlation was found between some emotions and the color property brightness.

1 Background

1.1 Introduction

This study is a remake with modifications of Roberto Bresin's study (Bresin, R., 2005, September) *what is the color of that music performance*. In his test, subjects rated how well each of eight colors and three nuances of it corresponds to each of twelve music performances, expressing different emotions; all performances recorded with the help of professional musicians, playing different instruments. Results show that subjects associated different hues to different emotions. Also, dark colors were associated to pieces written in minor tonality and light colors to major tonality ones.

1.2 Colors

One way of describing colors is by using the HSB-system where H stands for Hue, S stands for saturation and B is for brightness. Hue represents the actual color, or the tone of the color, and is presented in degrees where 0 is red, 30 is orange, 60 is yellow and so on. Saturation is how pure a color is, or "rich" if you will, presented in percentage. 100% is the purest possible version of that color, and 0% is the gray version of that color on a scale from back to

white (if it's light gray or dark grey is depending on the brightness). Brightness is simple how bright the color is, but it's not quite that simple. 0% brightness is black, no matter what the hue or saturation is. But 100% brightness is white only if saturation is 0%, otherwise it's just the brightest version of that specific color (Erik D Kennedy, Jan 29, 2018).

1.3 Previous research

In previous studies researchers have found that there is a difference between induced and recognizable emotions in music. From the study by (Egermann, H., Fernando, N., Chuen, L. and McAdams, S., 2015) they investigated the subjective and psychophysiological emotional responses to music from different cultures, Canadians and an isolated population from the Congolese rainforest. The two groups had no awareness of the other group's music nor culture. Each participant emotion was measured. Both groups reacted similar with high arousal to several low-level acoustical features such as tempo, pitch and timbre.

Based on this result they found that the subjective emotion of valence might be affected by the culture and the arousal is universal and can be perceived by anyone no matter the background nor demographics.

This study shows that emotions in music can be individual making it more as a recognizable emotion and at other times it can be universal and therefore be an induced emotion.

In Another study made by (Jaquet, L., Danuser, B. and Gomez, P., 2014) they

investigated how the systematic pitch level variations in classical piano excerpt affect the experience pleasantness and arousal. Although the main effect of pitch level variation on felt pleasure depends on the music excerpt and the musical structure the study proves that the pitch level has an impact on felt valence and arousal in a smaller degree.

An increasing pitch level of an excerpt in fast tempo and in minor mode induced a linear increase of felt valence and for an excerpt in low tempo in major mode it resulted in a linear and quadratic increase of felt valence.

Research (Lindborg, P. and Friberg, A.K., 2015) showed that *happy* music was associated with lighter colors than *anger*, *fear* or *sad* music was, and it was also associated with more yellow colors than *tender*, *fear* and *sad* music. *Anger* music was similarly associated with more yellow colors than *tender* and *sad* music and more red colors than *tender*. Additionally, the results also indicated that color might be used as a response method to identify well-defined discrete emotions and provided evidence of a correspondence between music and emotion, where people tended to match color association with the perceived emotion in the music.

A study (Palmer, S.E. and Schloss, K.B., 2010) of an ecological valence theory of human color preference suggests, with strong support, that people's color preferences are affected by the color's

ecological association. For example, people tend to like colors that are associated with things they like, e.g. blue colors are associated with clear skies and clean water, and contrary people dislike colors associated with things they don't like, e.g. brown colors are associated with feces and rotten food.

A correlation between color saturation and loudness have been found (Giannakis, K. and Smith, M., 2001), where quiet sounds were associated with colors of low saturation and louder sounds with colors of high saturation.

1.4 Long time average spectrum

A last noticeable tool can be found in R. Bresin's original research (Bresin, R., 2005) as well, consisting of the Long-Term Average Spectrum (LTAS) analysis. It demonstrated how the spectrum plotting of music excerpts supposed to be happy had a higher sound level for high frequencies than sad ones, which usually have very low, when not null, sound level in that frequency range.

2 Method

In order to investigate how subjects associated jazz music excerpts of different emotions to different colors a test was set up.

2.1 Music excerpts

A set of 8 different jazz music excerpts were chosen, two of each of the emotions Anger, Happy, Tender and Sad. All the excerpts

were looped so that they created a track of about ten minutes each, thus the participants could hear it properly, as long as they liked.

2.1.1 Angry music excerpts

- "Boogie Stop Shuffle", Charles Mingus (0:11 - 0:45)
- "Drum and Drone", Justin Hurwitz (0:11 - 1:34).

These songs were chosen in the first place for the frenetic use of percussion instruments, and this is related to both the pieces - in particular, the second piece is actually a long drum solo, basically a one and a half minute long crescendo -; as far as it concerns Mingus's excerpt, the "angry" features were the minor blues tonality, which, mixed to an upbeat tempo, generates an effect of frenetic feelings; this is put together with the alternation of staccato notes with quick flow of tones, ending in a dissonant chord.

2.1.2 Happy music excerpts

- "Better git it in your soul" by Charles Mingus (0:16 - 0:43)
- "Devil's rag" by Jean Matitia (0:07 - 0:31)

What makes these songs be considered as "happy" is an upbeat tempo as well, but mixed with major tonality. The first song in particular recalls a kind of religious happiness, since it was composed according to the canons of the spiritual songs, as an echo of Mingus's afro-american origins (Wikipedia, August 14, 2019 Mingus Ah Um). The second one is a bright rag-time style song, even if it was written by a

classical composer, with some tense chords in the piece; e.g. the G^7 chord, composed by the notes G, B, D and F, used to resolve the music tension on the most stable C^{maj} main chord, is usually played modifying the D in a D^\sharp , augmenting the third chord tone, which gives a whole-tone-scale shade to an otherwise very simple chord structure, hence a “lighter” characterization.

2.1.3 Tender music excerpts

- “Freddie Freeloader” by Miles Davis (0:00 - 0:21)
- “Lonely star” by Chet Baker (0:00 - 1:09)

The tenderness in these songs comes from a slow tempo perception, together with soft harmony, low volume and long, relaxed tones; more specifically, “Lonely star” is a ballad, so an actually slow tempo song - 58-60 bpm; Freddie Freeloader, even if quicker - 120 bpm ca. -, is softly played. A peculiar characteristic is the use of trumpet in both songs, an instrument which is usually associated with sound power and strong intensity, but which, in the hands of an expert musician, such as Miles Davis, can evoke a completely different range of feelings, like tenderness, for instance.

2.1.4 Sad music excerpts

- “Miss you”, Bill Frisell (0:00 - 0:36)
- “Sad piano music”, Rosanna Francesco (0:00 - 0:31)

These two songs show sad characteristics like slow tempo, minor harmony, long and held vibrato notes and simple chords - commonly minor triads and chord

turnarounds. Besides, differently from all the previous ones, there is just one instrument playing in each song: a guitar in “Miss you”, and a piano in “Sad piano music”.

2.2 Subjects

For this study we used a total of 12 participants, 11 swedish and 1 italian. The ages were spread between 22-28 years.

There were 7 male and 5 female participants. None of the participants had a considerable musical history and had not participated in a test like this before.

2.3 Colors

The colors used in the experiment was red, orange, yellow, green, cyan, blue, violet, and magenta. Three different palettes were set up, each containing all 8 hues but in different saturation and brightness. One palette had 100% brightness and saturation (neutral), one had 100% brightness and 50% saturation (light) and the last one had 50% brightness and 100% saturation (dark). This resulted in a total of 24 colors (8×3). For a list of all the colors used in the experiment (*see Table 1*).

Color	HSB
Red	HSB(0,100,100)
Light Red	HSB(0,50,100)
Dark Red	HSB(0,100,50)
Orange	HSB(30,100,100)
Light Orange	HSB(30,50,100)
Dark Orange	HSB(30,100,50)
Yellow	HSB(60,100,100)
Light Yellow	HSB(60,50,100)
Dark Yellow	HSB(60,100,50)
Green	HSB(120,100,100)
Light Green	HSB(120,50,100)
Dark Green	HSB(120,100,50)
Cyan	HSB(180,100,100)
Light Cyan	HSB(180,50,100)
Dark Cyan	HSB(180,100,50)
Blue	HSB(240,100,100)
Light Blue	HSB(240,50,100)
Dark Blue	HSB(240,100,50)
Violet	HSB(270,100,100)
Light Violet	HSB(270,50,100)
Dark Violet	HSB(270,100,50)
Magenta	HSB(300,100,100)
Light Magenta	HSB(300,50,100)
Dark Magenta	HSB(300,100,50)

Table 1. List of all colors and their HSB values.

2.4 Procedure

We conducted the experiment in a soundproof room with four participants at a time. The participants sat in front of the computer wearing headphones. The computer used were Imacs with the same screen calibration. The headphones that were used were all Beyerdynamic model DT 770 pro, circumaural and soft, designed for not harming the user's ears, with external noise cancelation, for guaranteeing the user a perfect and total isolation, hence concentration on the music excerpts.

For visual representation of the colors and the storage of data we used Jotform which is a framework for constructing forms.

We designed a unique program for this test (*see appendix 1*).

The participants were handed out a paper with instructions for the test (*see appendix 2*).

The subjects got to listen to 1 song at a time in a randomized order. For each song they were presented with all 3 palettes and rated how much of each color they believed that the song corresponded to on a scale from 0 to 10. If they didn't know or couldn't tell how well an excerpt corresponded to one song they rated it to 0. The procedure was repeated for all 8 songs.

2.4 Analysis of results

The results from the tests were analysed by comparing the mean values of the ratings for each excerpt and color. To reveal any significant correlations between emotion and color properties a correlation analysis of the mean ratings for each color and the colors' properties hue, saturation and brightness was conducted.

3 Result

The result of the study showed significant correlations between some emotional intentions in jazz music excerpts and rating of color properties (see Table 2). The excerpts with emotional intention anger had a significant negative correlation to hue, indicating that the highest rating of the angry songs are for a specific hue.

Also, the excerpts with emotional intention sadness had a significant negative correlation to brightness, meaning the darker color the higher rating (see Table 2).

EMOTION	HUE	SATURATION	BRIGHTNESS
Happy	-0.29	-0.20	-0.28
Anger	-0.42*	0.30	-0.30
Tender	0.04	0.15	-0.38
Sadness	0.23	-0.05	-0.57*

Table 2. Correlations between emotional intentions in the music excerpts and the color properties hue, saturation and brightness. The significant correlations are marked with * ($p < 0.05$).

Below sections will discuss above results in more detail.

3.1 Hue

The correlation between the ratings of the angry excerpts and hue can be seen in detail in below graphs (see Figure 1 and 2). A paired T-test showed significant differences between the ratings of the red hue and all other hues ($p < 0.05$). The red hue is rated higher than all other hues for both angry excerpt 1 (see Figure 1) and angry excerpt 2 (see Figure 2). The negative correlation mentioned above is also visible - the dark red hue is rated higher than the light- and neutral red for both angry excerpt 1 and 2.

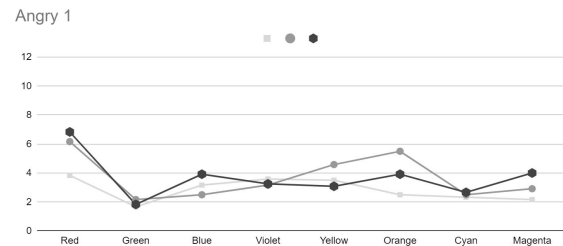


Figure 1. Mean ratings of all colors for angry excerpt 1. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

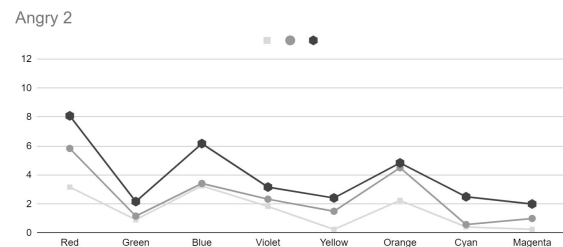


Figure 2. Mean ratings of all colors for angry excerpt 2. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

In order to analyze the results in relation to hue value, the mean rating values for each emotion was calculated. The happy excerpts

had its highest mean rating for yellow, the angry excerpts for red, the tender for violet and the sad for blue (see Table 3).

Emotion	Hue
Happiness	60 (Yellow)
Anger	0 (Red)
Tenderness	270 (Blue)
Sadness	240 (Blue)

Table 3. List of hue values that received highest mean rating for each emotion.

When conducting a T-test to see what hues that significantly differed in rating for all emotions it showed that for both sadness (see Figure 1 and 2) and tenderness (see figure 5 and 6) violet and blue hues were rated significantly higher ($p < 0,05$) than other hues, except for red. It also showed that red is rated significantly higher for anger than all other hues, which corresponds to the result of highest mean rating (see Table 3).

3.2 Brightness

The negative correlation between sadness and brightness can be seen in below figures. For both sad excerpts all dark colors were rated higher than the neutral and light colors (see Figure 3 and 4).

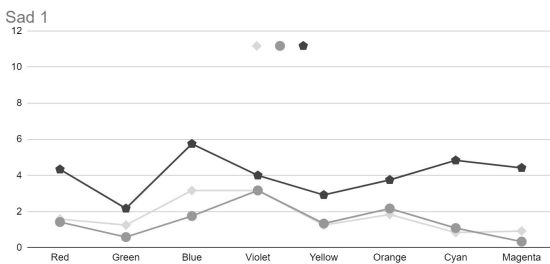


Figure 3. Mean ratings of all colors for sad excerpt 1. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

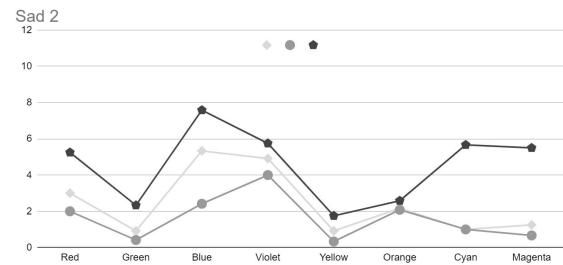


Figure 4. Mean ratings of all colors for sad excerpt 2. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

3.3 Other observations

There is a tendency of darker colors being rated higher for both tender excerpts (see Figure 5 and 6) however not significantly.

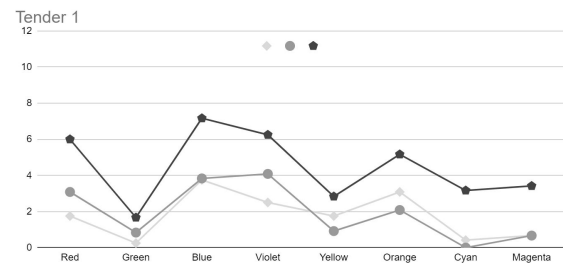


Figure 5. Mean ratings of all colors for tender excerpt 1. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

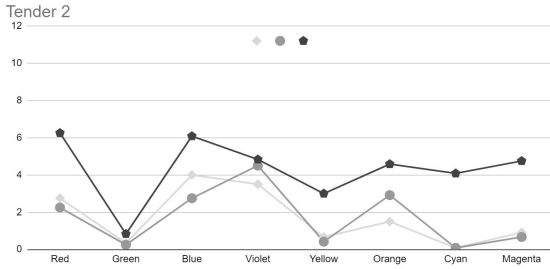


Figure 6. Mean ratings of all colors for tender excerpt 2. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

Additionally, the results for happy excerpt 1 and 2 are varied (see Figure 7 and 8) and very different from each other. However, the mean ratings for happy excerpt 1 show tendencies of low ratings for dark colors (see figure 8) and higher ratings for light and neutral colors.

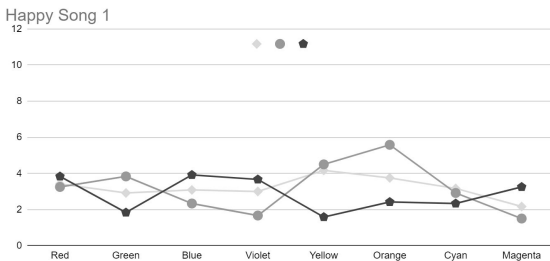


Figure 7. Mean ratings of all colors for happy excerpt 1. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

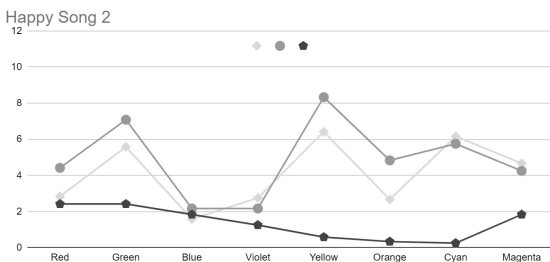


Figure 8. Mean ratings of all colors for happy excerpt 2. Light grey curve indicates light colors, medium grey curve indicates neutral colors and black curve indicates dark colors.

4 Discussion

Few participants participated in the study and the results could have been more accurate if they would have been more. However, the results are similar to the original research (Bresin, R., 2005). They both suggest that red hue was rated highest for angry songs, yellow hue for happy songs and that sadness had a significant correlation to brightness.

4.1 Similarities tenderness-sadness

The color results for tender and sad songs gave a similar response, being the blue and violet nuances highly rated for both emotions; this could be explained by thinking of the respective wavelengths.

First of all, the long-term average spectrum analysis of both the sad songs and the tender ones showed how the sound level in low frequencies is definitely higher than the one for higher frequencies (see Figure 9 and 10); in the tender excerpts, the diminution of sound levels at the increasing of frequencies is more gradual (see Figure 10), even though the excerpt from “Freddie Freeloader” shows a peculiar second increasing at pretty high frequency values, while the sad excerpts’ sound levels fall down quickly, and no frequencies above 3 MHz have sound levels (while, for instance, the graphic of a happy song goes past far above 7 MHz). All of this to state that sad and tender songs have their highest sound levels at low frequencies, hence with wide

wavelength sounds. Blue and violet light are low frequency light waves, hence endowed with wide wavelength as well. This suggests a bond between these two physical quantities, for further research.

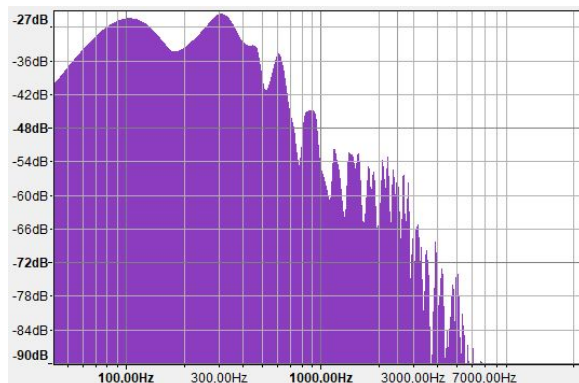


Figure 9. Example of sad music excerpt spectrum plotting, related to sad excerpt 1. As stated in the paper, the sound level decreases rapidly at the augmentation of frequencies' values.

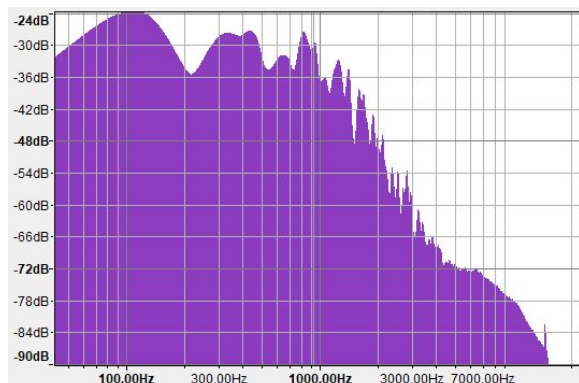


Figure 10. Example of tender music excerpt plotting, related to tender music excerpt 2. Similarly to the sad one, there is a pretty fast decrease at the increase of high frequencies, even if the frequencies' values reached are higher than the ones in the sad excerpt.

The results that dark colors were rated higher for the sad, tender and angry excerpts than the happy excerpts are in line with

previous research (Lindborg, P and Friberg, A.K, 2015) where it was shown that happy music was associated with lighter colors than anger and sad music was.

4.2 Differences in happy excerpts

The two happy songs had dissimilarities in how they were rated which we didn't expect; happy excerpt 2 was rated with lighter colors than 1.

The preferred instrument for happy emotion is either flute or trumpet (Bresin, R. and Friberg, A., 2011). The lack of both in the two happy excerpts we chose may have affected the result: the emotions might not have been conveyed fully because of the absence of both flute and trumpet which has a strong band to happy emotions in music.

In deeper, the motivation according to which these two songs ratings differentiated, as happy excerpt 1 was rated with darker colors and 2 was rated with lighter ones, might be grounded in staccato and legato. High activity emotions are performed in more staccato and low activity emotions are performed in legato (Bresin, R. and Friberg, A., 2011.). Since happy excerpt 1 is way more legato than happy excerpt 2, which instead is staccato, the results match with this assertion.

Another interesting difference between the two happy excerpts is the fact that the first one has been largely associated with green

hue, while the second one is more linked to yellow. As presented in the report *What is the color of that music performance?* (Bresin, R., 2005), the result of the happy songs was similar to the result we got for happy excerpt 2, with yellow being the highest rated color, but not for happy excerpt 1, since green was not pointed as the most important hue for any emotion in the original research. A possible explanation could be that green is usually associated with nature and biology, such as a human voice. The ecological valence theory of human color preference (Palmer, S.E. and Schloss, K.B., 2010), that suggests that people's color preferences are affected by ecological associations, could support above explanation. In his original research (Bresin, R., 2005), Bresin chose no vocal pieces, since a text, especially if understood by the user, can influence and alter the results. We stuck to this conviction, but, in the happy excerpt 1 there is, though for a very quick moment, one vocal sound; it is thus possible that this small human voice can have influenced the users' taste in choosing the color green.

5 Conclusion

The results show that music with emotional intention anger were correlated to hue and that the color red was significantly higher rated than the other colors for that emotion. Both sad and tender was most associated with the colors blue and violet as they were

significantly higher rated. There were tendencies for negative correlation between both sad and tender with brightness, but only emotional intention sad were significantly correlated to brightness. Due to differences in articulations of the sound and the lack of specific instruments in the two happy excerpts, the results from the two excerpts was not in line and therefore no conclusions could be drawn.

See all data from the tests and statistical analysis here:

<https://drive.google.com/drive/folders/1zgLyPQHztFRAGezWKBLOKc3wEsQ9yTT0?usp=sharing>

6 Personal Assessment

What worked well in the project?

- Tests worked very smooth once conducted.
- The cooperation spirit was good in the group.
- The collaboration with other groups worked well once we got a hold of each other, we could help each other so it was like a give and take situation.

In hindsight, what would I/we have done differently?

- Collected more background of the participants.
- Timeplan didn't really work out since we had to relate on many other

people. However it didn't affect the outcome of the study.

- We had to spend a lot of time creating the form for the tests. That was a waste of time since it didn't contribute to the subject.

What was the major learning outcome for me/us of the project work?

- How to conduct research and writing a report.

Was the contribution of the team mates in accordance with the project plan?

- We didn't have specific roles, however the roles played out themselves and were pretty natural. The work was evenly divided in the team.

7 References

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APPENDIX 1

SONG 1 – page 1/3

			
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Nästa

SONG 1 – page 2/3

			
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Tillbaka

Nästa

SONG 1 – page 3/3

			
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Tillbaka

Nästa

APPENDIX 2

Instructions

You will listen to 8 music pieces.

For each piece you will rate how well it corresponds to different colors, presented on the screen. The colors are divided into three pages of 8 colors each, resulting in a total of 24 colors.

Under each color you will see a slider, use the slider to rate how much the color correspond to the music piece. You rate the color from 0 (doesn't fit at all) to 10 (fits very well). Don't be afraid to rate it with extreme numbers (0 and 10)!

If you don't know or can't tell how well the piece corresponds to a certain color, rate it with 0.

The test will follow this order:

1. Start the music by clicking the play-button on the keyboard
2. You will hear a music piece that will run in a loop but you can choose to pause it at anytime by clicking the pause-button.
3. Rate the 8 colors on the first page, then click on *next* to go to the next page. Repeat for 3 pages.
4. When you have completed the three pages for one music piece, click on *next* and use the forward-button on the keyboard to play the next music piece.



5. Repeat step 2-4 for all 8 music pieces.
6. When your done with all 8 pieces, click "skicka in" to submit

Thank you for participating!