What is the color of this musical excerpt?

Martin Kihl
Kungliga Tekniska Högskolan
Stockholm, Sweden
mkihl@kth.se

Philip Berrez
Kungliga Tekniska Högskolan
Stockholm, Sweden
pberrez@kth.se

Tiago Maranhao
Kungliga Tekniska Högskolan
Stockholm, Sweden
tiagomp@kth.se

Abstract

This project explores how a synesthetic experience related to music perception and color association varies across cultures, and whether music with more energetic expressions elicit richer color responses. A total of 206 participants took part in a survey using a customized web page. The results showed differences in color preferences for each emotional expression studied across different groups. Furthermore, a correlation between the subjective intensity of the excerpt (considering that, in terms of intensity, Joy > Tender > Sorrow) and the variety of colors chosen by the participants was observed.

Introduction

Color psychology is an underdeveloped area of research but there are findings that are consistent and give an insight into how the brain works (Voong & Beale, 2007). One of these insights is a connection between color and emotions where a person can be affected emotionally by color and color can convey an emotion (Lindborg & Friberg, 2015; Voong & Beale, 2007; Zentner, 2001). Studies have shown that people tend to follow certain patterns when associating emotions to colors which could be attributed to multiple factors like cultural coding and associations (Voong & Beale, 2007; Zentner, 2001).

Music is also connected to emotions according to findings that suggest that people generally create playlists based on moods (Voong & Beale, 2007).

Patterns are also present when associating music to colors, where brighter colors were matched with positive emotions and darker colors were matched with negative ones. This was then confirmed to correspond with music sounding sad due to being in a minor key and music sounding happy by being in a major key (Bresin, 2005).

A related study that touches on connections between emotions and music is called *Colour Association with Music Is Mediated by Emotion: Evidence from an Experiment Using a CIE Lab Interface and Interviews.* It was written by Per Magnus Lindborg and Anders K. Friberg and had 22

participants. The participants matched musical excerpts with a colored circle. They used a joystick and a drawing tablet to choose color and change the size of the circle based on what they were hearing. They found that happy music was associated with the color yellow, angry music with large red circles and sad with small blue circles. The study also found that preferences for color had no significant effect on the results. A significant difference between genders was found when choosing the size of the circle but no other significant differences were found (Lindborg & Friberg, 2015).

Another similar study called *A Comparison of Methods for Visualizing Musical Genres* by Jukka Holm and Harri Siirtola did a similar study where the participants in multiple online questionnaires indicated their preferences for different visualization methods such as colors, icons, fonts and avatars. In the questionnaire about color, the participants heard music from different genres like blues, classical, latin, jazz, metal, etcetera. They were then presented with a color and three genres and they had to select which one fitted the most with the color. A majority of the participants were from Finland but some were from various parts of Asia. The results showed major differences between participants from different parts of the world and therefore color-genre mapping should be considered an impossibility. The results also showed that except for blues and metal which had strong color associations, color is not enough of a visualization method to have consistent results. Generally the strongest color associations only had 26-38% of the participants choosing the same color, e.g Latin had 20% of the test subjects choose the color yellow (Holm & Siirtola, 2012).

Studies of association between music and colors can lead to new possibilities of representing musical information in a visual, graphical, non-verbal way. This in turn can be used in the construction of engaging interfaces for composing and studying music, or exploring and managing musical collections and databases (Holm & Siirtola, 2012; Poast, 2000).

This study investigated the connections between certain songs and colors, and focused on the Brazilian instrumental genre “Choro”, also known as “Chorinho”. The differences in perception between Brazilians and non-Brazilians was of particular interest.

Method

Six excerpts of Choro songs were selected, two for each of the emotions "joy", "sorrow" and "tender".

A digital form was implemented by means of a customized webpage. In this form, the participants were invited to provide some basic information, such as:

- country of origin
- age
- whether the participant had any experience playing an instrument
- whether the participant had any experience creating music

After the basic information, participants were presented to an interface where they could listen to the excerpts and select among eight colors (magenta, pink, blue, cyan, green, yellow, orange, red), depending on how much they felt their selection matched the music. Multiple colors could be chosen, and the background changed with the choices in a checkered pattern, allowing the participants to experiment freely with different colors or color combinations. The participants could only send the data after a system validation that checked if at least one color was selected for each excerpt, and if the basic information was properly filled.

Participants were not told that the study was related to emotions, and no mentions of emotions were ever made to them.

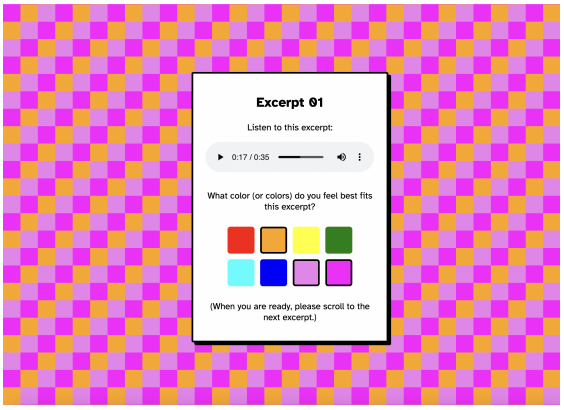


Figure 1 - An example of the interface for color selection while listening to the excerpt. The participant could experiment and play with the color combination and the background would update to match the selection.

Participants

A total of 206 people took part in the experiment, completing the test and sending valid responses. Table 1 summarizes the number of participants according to their country of origin and gender.

Their age varied from 7 to 76, with a median age of 43 and a mean of 43.8. Of all participants, 43.7% reported experience playing a musical instrument, and only 12% reported experience creating music.

Country of Origin	Male	Female	non-binary	Total
Brazil	43	116	1	160 (77,7%)
Other	19	26	1	46 (22,3%)
Total	62 (30%)	142 (69%)	2 (1%)	206

Table 1 - Participants demographics

Results

Overall results in color preferences according to country of origin

The chart summarizes normalized color preferences for each expression (Joy, Sorrow, Tender) across the groups (Brazilians and non-Brazilians).

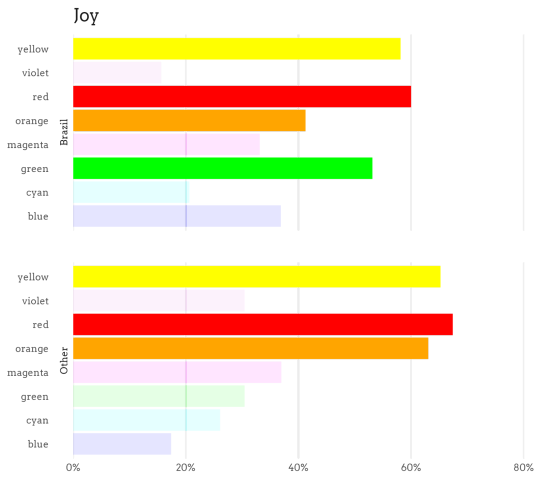


Figure 2 - Percentage of users that chose a given color to a "Joy" excerpt (colors picked by

less than 40% of the users are transparent to highlight the most picked colors)

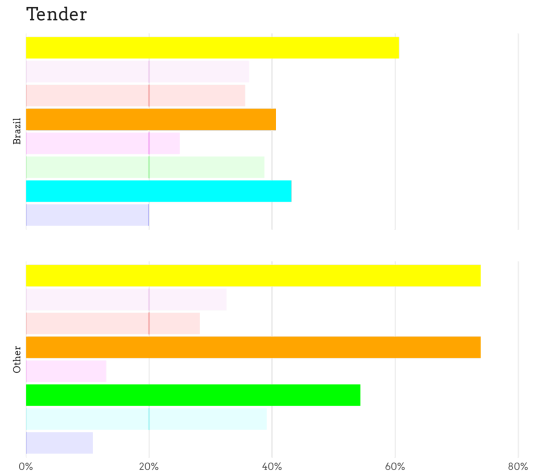


Figure 3 - Percentage of users that chose a given color to a "Tender" excerpt (colors picked by less than 40% of the users are transparent to highlight the most picked colors)

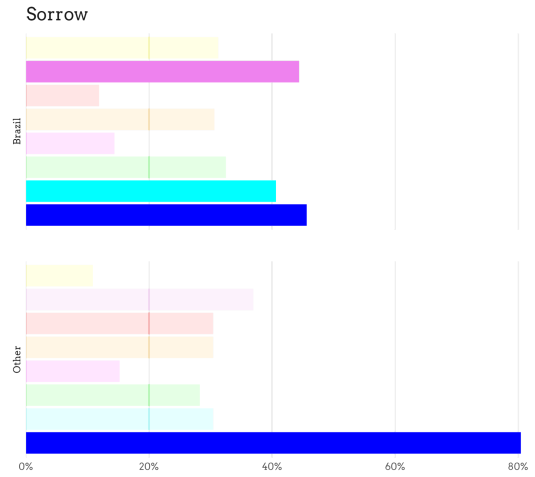


Figure 4 - Percentage of users that chose a given color to a "Sorrow" excerpt (colors picked by less than 40% of the users are transparent to highlight the most picked colors)

Since it can be difficult to compare color preferences across groups by comparing the two sets of bars, we introduce below a "preference difference" chart, where, for each color, in each expression, an arrow represents the difference, in percentage points, of preference between the two groups.

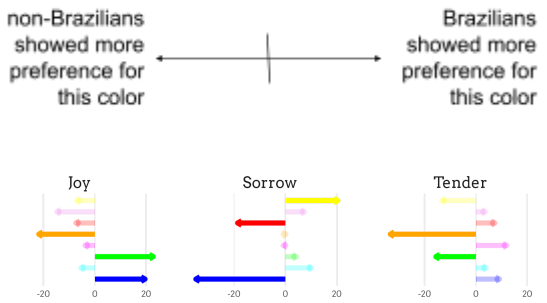


Figure 5 - Differences in color association for different expressions between country of origin groups. Arrows indicate preference difference in percentage points. Differences below 15pp are transparent.

In this way, the chart highlights the relative differences in preferences across these two groups. We can notice, for example, that non-Brazilians showed more preference for orange in "Joy" excerpts than Brazilians. For these kinds of excerpts, Brazilians showed more preference than non-Brazilians for the colors green and blue.

For the "Sorrow" excerpts, non-Brazilians showed more preference for red and significantly more for blue than Brazilians. On the other hand, Brazilians picked more yellow than non-Brazilians for this emotion.

Finally, for the "Tender" excerpts, the most important difference was in the choice of orange, for which non-Brazilians showed much more preference.

We applied the same approach for other groupings.

Gender

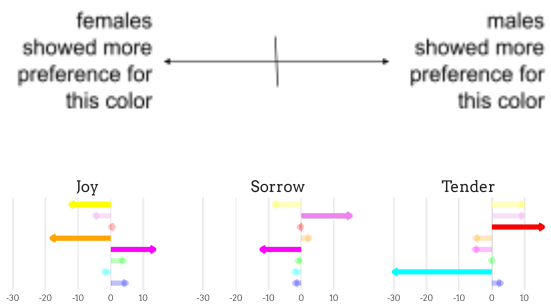


Figure 6 - Differences in color association for different expressions between genders. Arrows indicate preference difference in percentage points. Differences below 10pp are transparent.

In this comparison, regarding the "Joy" excerpts, women showed more preference for orange than men, while men showed more preference for magenta.

For the "Sorrow" excerpts, men showed more relative preference for violet, while women showed for magenta.

The most relevant difference lies in the "Tender" excerpts, where women strongly showed more preference for cyan than men, and men showed more preference for red.

Experience playing an instrument

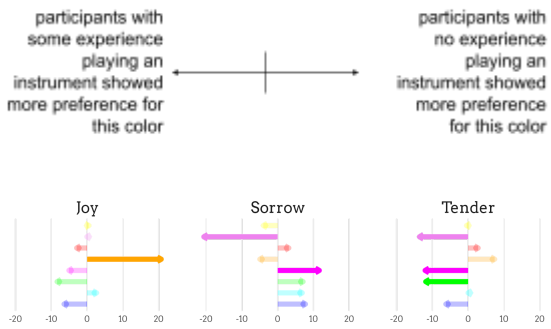


Figure 7 - Differences in color association for different expressions between participants with and without experience playing an instrument. Arrows indicate preference difference in percentage points. Differences below 10pp are transparent.

In this grouping, the most relevant differences are the greater preference for orange in "Joy" excerpts demonstrated by participants with no experience playing an instrument, and the greater preference for violet in "Sorrow" excerpts by participants who have played some instrument at some point in their life.

Age

Figure 8 - Differences in color association for different expressions between participants under 43 and over 43 years old. Arrows indicate preference difference in percentage points. Differences below 10pp are transparent.

Finally, when comparing across the groups of participants under the age of 43 (the median age of our sample) and over 43, the most remarkable fact is a relevant difference between the groups' preferences for yellow in all emotions.

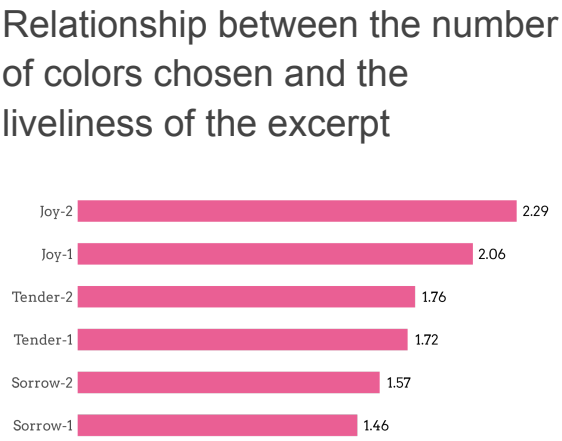


Figure 9 - Average number of different colors chosen by participants for each excerpt

Regardless of the country of origin, on average, participants tended to choose a greater number of distinct colors the more energetic the excerpts were.

Discussion

Overall, the results somewhat followed previous findings regarding the association of hues to emotions (Lindborg & Friberg, 2015), albeit with differences: in our study, preference for red surpassed yellow in "Joy" excerpts, and preferences for blue surpassed violet in "Sorrow" excerpts. For "Tender" excerpts, yellow was overall the most chosen color.

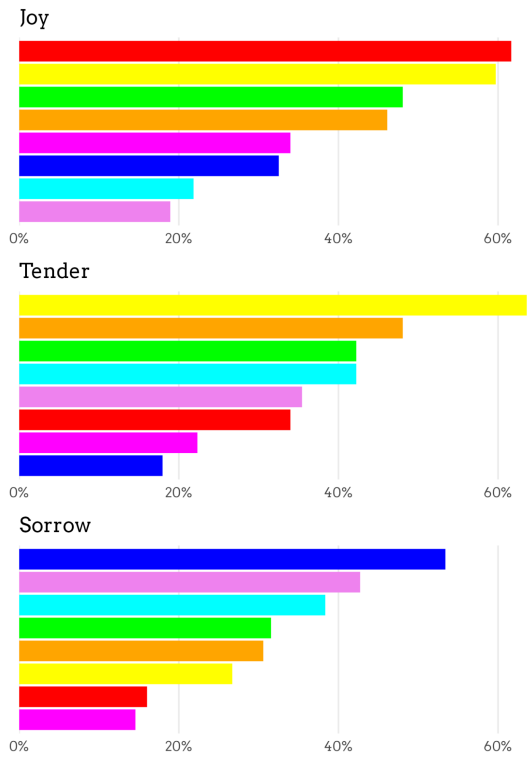


Figure 10 - General color preferences for excerpts of each emotion (percentage of participants that chose the color for at least one of the excerpts of a given emotion)

These differences may reflect some of the limitations of our study, namely the limited set of colors from which participants could select their preferences, and the classification of the excerpts in the three different emotions, which was based solely on our impressions and opinions. It would have been interesting to collect user ratings of the excerpts in terms of emotions.

However, these limitations made the survey simpler and quicker to answer, and that may be part of the reason for the large number of participants, alongside the playful character of the interface. Participants related that they "had fun" taking part in the experiment, and felt spontaneously compelled to share the survey with friends.

To assess the consistency of our excerpt classification into emotions, we can compare the number of times each color was chosen for each excerpt of the same emotion.

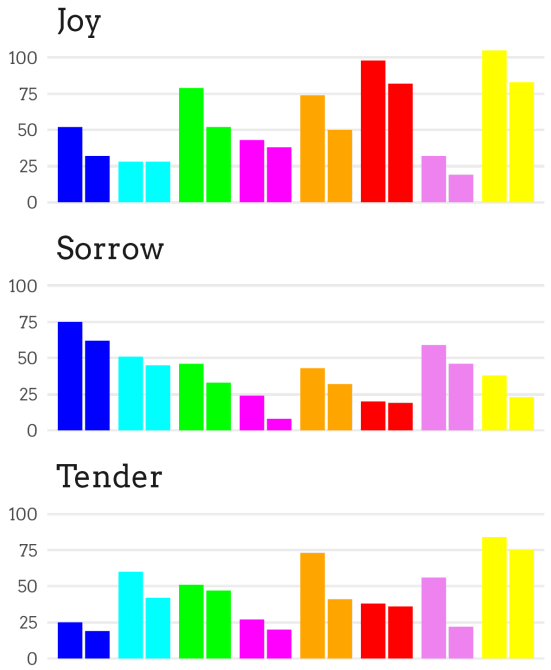


Figure 11 - Comparative color preferences for each emotion's pair of excerpts

Evaluating the relative difference between these frequencies gives us a clear insight into the inconsistencies of our classification.

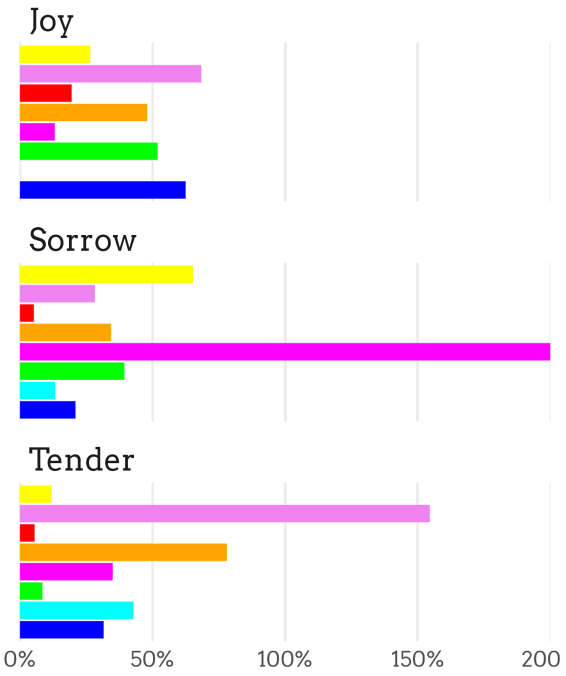


Figure 12 - Relative difference in color preferences between the excerpts of each emotion

For a further study, we should rely on more robust methods for extracting the perceived emotion of a musical excerpt, or, as mentioned, collect this information from the participants.

An indication of the role of shared cultural references in color preferences

Another limitation of our study was the fact that the chosen genre and some of the excerpts were probably well-known among the majority of the participants. This may "contaminate" the music-color associations with past personal experiences related with the excerpts. This contamination may hinder the generalization of the results to the general population.

On the other hand, for a group of people from the same culture, or with

common experiences, the associations might arise from shared cultural references, and those could possibly be generalized for particular groups.

With that in mind, one difference in color preference comparisons across groups that caught our attention was the greater presence of green for "Joy" among Brazilian participants.

It is relevant to mention that one of the excerpts chosen for "Joy" came from one of the most beloved Brazilian songs, "Brasileirinho" ("little Brazilian"). Our hypothesis is that color preferences among Brazilians for this song might reflect the association of this song with their country and their national colors (green and yellow). Since participants could pick more than one color for each excerpt, we investigated the number of green-yellow combinations for the two "Joy" excerpts.

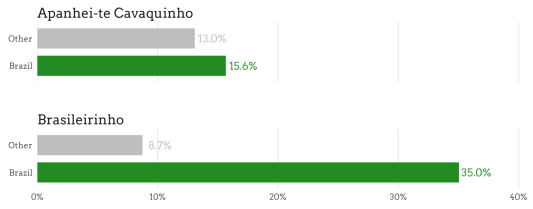


Figure 13 - Percentage of users that chose green and yellow together for the "Joy" excerpts

Figure 9 shows that there was no big difference between the frequency that the green-yellow combination was chosen by Brazilians or non-Brazilians for the other "Joy" excerpt ("Apanhei-te Cavaquinho"). On the other hand, this combination was much more frequent among Brazilians for "Brasileirinho", when compared with non-Brazilians. It was also twice as frequent among Brazilians for "Brasileirinho" than for "Apanhei-te Cavaquinho".

Age and preference for yellow

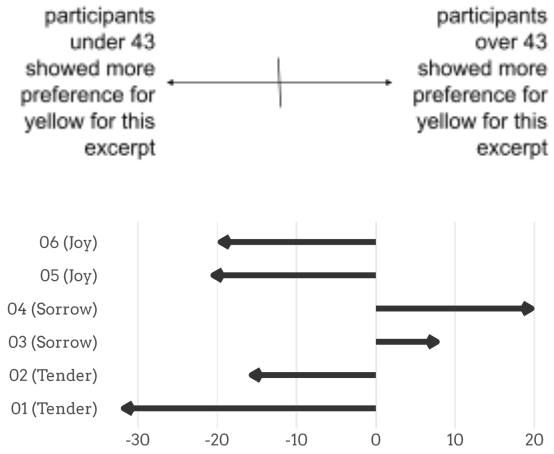


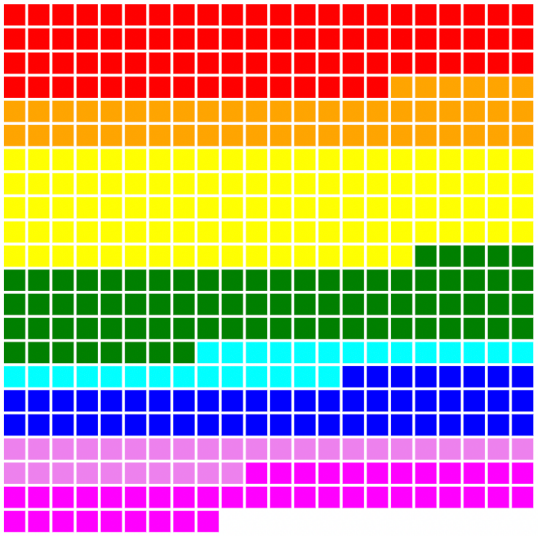
Figure 14 - Differences (percentage points) in preferences for the color yellow between participants under and over 43

Number of colors chosen according to the liveliness of the excerpt

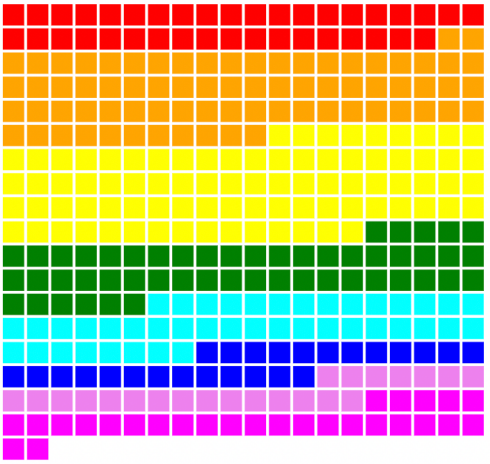
As mentioned in the Results, we noticed that participants chose a greater number of different colors, on average, for the more energetic excerpts. Here we present an alternative visualization of those results, as suggested by our supervisor.

Each little square represents a color chosen by a participant for that excerpt. In this way, every single color picked by our 206 participants are represented in one of the figures below.

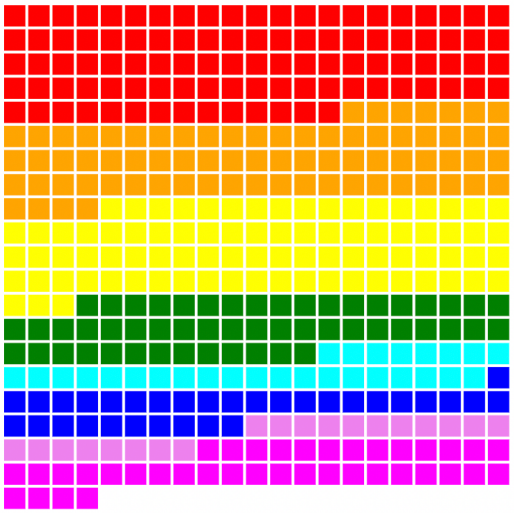
Brasileirinho (Joy)
471 colors (average: 2.29 per participant)



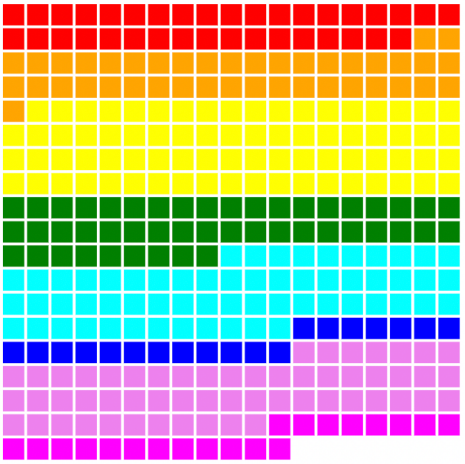
Gosto que me enrosco (Tender)
362 colors (average: 1.76 per participant)



Apanhei-te Cavaquinho (Joy)
424 colors (average: 2.06 per participant)



Carinhoso (Tender)
354 colors (average: 1.72 per participant)



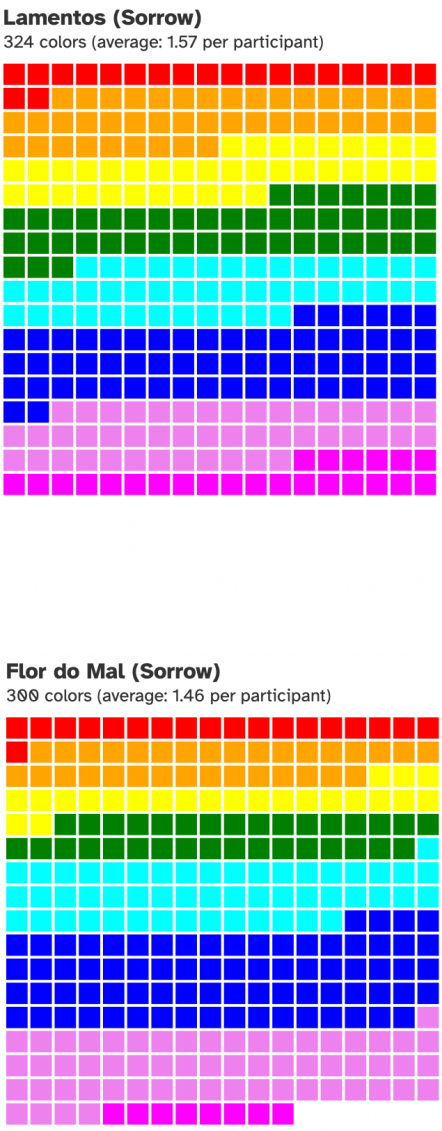


Figure 15 - Representations of the individual colors chosen by all users for each excerpts

Conclusion

In this study, we observed that the same excerpts taken from a particular regional musical genre seem to elicit different color associations from people of that region compared with people from other regions, sometimes very significantly so. We also observed a correlation between the number of different colors chosen by the participants and the subjective energy, liveliness of the excerpt.

Having a large number of participants in a study such as this opens fascinating possibilities of groupings and comparison across groups, to study and understand how some personal traits, characteristics and experiences might influence music-color association.

Understanding of these relationships may be relevant for the development of more customized experiences and interfaces in the mentioned applications.

The engagement of participants with the study indicates that it was (and is) worth developing a customized interface that makes participants interact with the survey in a fun, lighthearted way.

Finally, the rich data collected in this study offers many interesting possibilities for visualizations in the future. All data and code used in the analysis and preparation of all the charts presented in this report, as well as the code used for the development of the survey's custom interface is available on the following repository: https://github.com/tiago-kth/human-perception

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