Match in emotional content in lyrics and melody enhances likeability

Manuela Skov Thomasen (202107872@post.au.dk)1

1School of Communication and Culture, University of Aarhus, Denmark

# **Abstract**

**Keywords:** emotional content, lyric, melody, music, enhanced likeability, BOLD, fMRI

# **Introduction – Assignment #2**

* Research question
  + Should be stated in bold and after the question this should be put in parentheses **(Research Question Statement: Assignment #1)**
* Hypothesis
* Literature that motivates research
* Design table (see below)

Melodies of major and minor mode will be paired with lyrics with either a more positive or negative sentiment. Earlier experiments showed that music in major mode evokes a positive emotional response while music in minor mode evokes a negative response, based on self-report on a valence scale. A functional MRI will be used to measure the blood oxygen level-dependent signal.

**The hypothesis is that the blood oxygen level-dependent signal in the liking network is enhanced when the sentiment of the lyrics is matched with melodies of corresponding valence.**

This will be research by participants listening to music while getting a fMRI scan, further the participants will self-report on their emotional response. The functional MRI is used to measure the BOLD signal in the liking network so the signal can be compared when listening to matched and mismatched valence. The self-report is used to control if the songs we expect to be experienced with higher or lower valence is experienced like that.

fMRI looking at the liking network (Putkinen et al., 2021), based on this paper I will look at whether or not the participants like the music or not (WERE SPECIFICALLY DO WE EXPECT TO SEE ACTIVITY)

Key and tempo = the sound of the melody (happy/sad)

Sentiment analysis, [Python | Sentiment Analysis using VADER - GeeksforGeeks](https://www.geeksforgeeks.org/python-sentiment-analysis-using-vader/)

Preference in music

Predictive coding

## Design table

* + Mandatory
  + Number of rows depend on number of research questions
  + If analysis strategy is dependent on results this should be stated clearly (if-then)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **question** | **hypothesis** | **Sampling plan** | **Analysis plan** | **Interpretation given different outcomes** |
|  |  |  |  |  |

# **Methods – Assignment #3**

All referenced code and data are available in the Code availability and Data availability section.

## Ethics

If the study were to run it would be conducted in accordance with relevant ethical regulations and approval from the Research Ethics committee would be sought. Before the experiment all participants would be presented with a written consent form and informed written consent would need to be given for further participation. The participants would be informed withdrawal of consent is always possible, but after data anonymization it would no longer be possible to remove specific data. The participants would be compensated for their participation.

## Pilot study (Cog com exam)

A pilot study was conducted with 33 participants, 66.67% were female, had a mean age of 22.45(sd=5.97) and their ages ranged from 15-52. The experiment was conducted through Google survey, where the participants were presented 8 sound clips. The experiment was a with subject design. The songs used as stimuli were collected from Epidemic Sound (<https://www.epidemicsound.com/music/featured/>) from the genre Indie Pop with a mean tempo of 100.5 BPM (sd = 2.673). The 8 songs were edited using Win Movie Maker (Microsoft, 2021) and ended up having a mean duration of 1 minute and 4 seconds (sd =6.22 seconds). Table 2 Show how the songs were divided into 4 conditions (the appendix is available in GitHub as Appendix\_pilot\_study.doc).

**Table 2**

Table

Description automatically generated

After being presented with each sound clip the participants had to report on the valence of the clip on a scale from -5 to 5, the scale was thoroughly explained before the experiment. Key, either major or minor and type, instrumental or lyrical were the predictor variables and the valence were the outcome. I expected the music I major mode would evoke a more positive emotional response compared to music in minor mode, further I expected lyrics to intensify this effect. Figure 1 is a visualization of the data from the pilot study

Chart, line chart

Description automatically generated

To perform linear mixed effect analysis on the relationship between valence and key and type I used R (R core Team, 2019) and lmerTest (Kuznetsova, Brockhoff and Christensen, 2017). Model 1 and 2 were build with the following R syntax:

Model 1, and model 2,

In both models the participant ID was added as a random effect because I expected the participant to have individual baselines.

The output of model 1 showed significant results, with an intercept of when the key of the song is major. The estimate for when the song is in key minor was . Both fixed and random effect accounted for of the variance in the valence variable.

The output of model 2 showed valence was significantly modulated by the two predictors key and type and with an intercept when the song was in major key and had lyrics of .

## Design

* + Experimental procedure
  + Linked code and data (reference data and code availability)
  + Randomization
  + Within or between subjects
  + Blinding???

The Stimuli is picked based on various criteria. The songs will all be lyrical and in English. They will be selected from various genres to make the results more general (Hunter et al., 2008)and to minimize the effect of musical preference on the results (Kreutz et al., 2008)*.* Further the songs are picked based on key, tempo of the melody and sentiment of the lyrics and sorted into 4 conditions (table 1). The key and tempo of the melody is what determines whether the melody is perceived as sad or happy(Gagnon & Peretz, 2003). To determine the sentiment of the lyrics a sentiment analysis will be made on all lyrics (see sentiment\_analysis\_example.ipynb in GitHub). The sentiment analysis example was made using python (author, year) and vaderSentiment (author, year).

Example song: My Valentine by Roy Edwin Williams (130 BPM, C Major)

Tempo

* Fast 120-156BPM
* Slow 66-76 BPM

**Table 1**

Experiment conditions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Tempo | Melody key | Melody sound | Lyric sentiment | Match |
| Condition 1 | Fast | Major | Happy | Positive | Matched |
| Condition 2 | Fast | Major | Happy | Negative | Mismatched |
| Condition 3 | Slow | Minor | Sad | Positive | Mismatched |
| Condition 4 | slow | Minor | Sad | Negative | Matched |

*Note:* experiment conditions, based on tempo, key and sentiment

## Participants

## Stimuli

## Procedure

## Sampling plan

* + Evt. Power analysis (sample size), based on the lowest available/meaningful estimate of the effect size, priori power 0.95 or higher
    - Effect size based on other findings, my pilot study and the decoding of emotions experiment
  + Bayesian hypothesis testing encouraged
  + List data inclusion and exclusion

## Analysis plan

* + Include all pre-prosesing steps
  + All planned analysis
  + Is analysis strategy dependent on the results and how

Outcome: the difference in activation between the conditions

Difference\_activation~melody\_sound + lyric\_sentiment + (1|ID)

Mixed effect model???

# **Data availability**

All future data and materials will be made available upon acceptance of the stage 2 manuscript. Data for the pilot study and other referenced material and data is already available in the following GitHub repository in the ‘data\_and\_material’ folder (<https://github.com/mthomasen/cognitive_neuroscience_of_music_and_language>).

# **Code availability**

All code will be shared publicly upon acceptance of the stage 2 manuscript. Code for the pilot study and other referenced code is already available in the following GitHub repository in the ‘code’ folder (<https://github.com/mthomasen/cognitive_neuroscience_of_music_and_language>).

# **References**

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to “happy-sad” judgements in equitone melodies. *Cognition and Emotion*, *17*(1), 25–40. https://doi.org/10.1080/02699930302279

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2008). Mixed affective responses to music with conflicting cues. *Cognition & Emotion*, *22*(2), 327–352. https://doi.org/10.1080/02699930701438145

Kreutz, G., Ott, U., Teichmann, D., Osawa, P., & Vaitl, D. (2008). Using music to induce emotions: Influences of musical preference and absorption. *Psychology of Music*, *36*(1), 101–126. https://doi.org/10.1177/0305735607082623

Microsoft. (2021). *Win Movie Maker* (2021.1.0.1).

Putkinen, V., Nazari-Farsani, S., Seppälä, K., Karjalainen, T., Sun, L., Karlsson, H. K., Hudson, M., Heikkilä, T. T., Hirvonen, J., & Nummenmaa, L. (2021). Decoding Music-Evoked Emotions in the Auditory and Motor Cortex. *Cerebral Cortex*, *31*(5), 2549–2560. https://doi.org/10.1093/cercor/bhaa373

# **Acknowledgement**

The author received no funding for this work.

# **Author contributions**

The main author, M.S.T., contributed to all sections.

# **Competing interests**

The author declares no knowledge of any competing interests

# **Presentation – Assignment #4**

* Slides (ca. 8), the texts on the slides count as characters