The emotional content in music perception

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Abstract

The pleasurable feelings you experience when listening to music can be based on your music preference, how good you are at predicting where the music is going and the alignment we make with the emotional state in the musical piece. By getting a better understanding on how we respond to music and which musical characteristics that evoke emotions, we can find ways to apply it as a tool in different areas. To look at the relationship between the emotional response of the listener and the songs mode, a study was conducted. Participants (N=33) listened to 8 song clips in major or minor mode and with or without lyrics. After each clip participants reported om their emotional response on a valence scale, ranging from negative (-5) to positive (+5). Trough linear mixed effects analysis it was found that responses to songs in major mode was rated more positive compared to songs in minor mode, the difference was significant. Further an additive effect of lyrics was found, for both songs in minor and major mode the emotional response to songs with lyrics were more positive compared to songs without lyrics. For a more reliable results regarding lyrics in the songs, you could look into how the sentiment score of the lyrics effect the emotional response.

Keywords: Music perception, emotions, valence, linear mixed effects analysis

Introduction

Most people find pleasure in listening to music, even though they prefer different kinds: from Mozart to Nirvana (Gebauer et al., 2012). People's enjoyment of music is due to the association with specific music or music in general, and this is what shapes these preferences. These music preferences can be used to enhance what we are feeling or alter our current mood, this is due to the characteristics of the music and the thoughts and feelings the music evokes (Greasley & Lamont, 2006). Studies have shown that in most cases people experience mood changes when listening to music, the effect being lager when participants choose the music themselves. Music is viewed as a resource that can alter or express a person's emotional state (Sloboda et al., 2001).

People engage in activities involving music and apply it in various areas, such as gaming, films, advertisement and music therapy (Eerola & Vuoskoski, 2013). When perceiving music during these activities we generate hypotheses about how the music will further unfold: we use predictive coding. By using predictive coding when retrieving stimulus we can compare our hypotheses with the actual outcome which gives us prediction errors that help us make better predictions in the future (Koelsch et al., 2019).

For both predictions about music and language we base it on how we might generate it ourself. When perceiving language, we make predictions about content and context, the expectations to what we will hear and the confidence in those expectations. When listening to or reading a sentence our brain will try to predict what the next word in the sentence will be, by predicting the content of the word and its predictability, we deem any other word to be highly unlikely. We do the same when listening to music by trying to predict the next chord (Koelsch et al., 2019). Beside music and language perception being similar there have also been found a link by the processing of language and music in the brain. That when the brain processes music and language in certain contexts it relies on some of the same cognitive processes and tactics (Vuust, 2007).

The listeners expectations made by predictive coding and the actual music structure has been proposed to be what the pleasure of music depends on. Through alert signals music activates the brain's reward system, when the brain has successfully predicted the upcoming musical structure, we find it pleasurable, but when we experience a small prediction error it gives rise to an even greater dopamine release. The reason we perceive these small unexpected structures as pleasurable is because it gives us an opportunity to learn from them, our brain rewards our engagement in the learning opportunity (Gebauer et al., 2012). There has been found direct evidence that the pleasure we experience when listening to music is due to dopamine activity, because the musical stimulus is perceived as rewarding by the listener (Salimpoor et al., 2011). As earlier discussed, prediction plays a key role in our experience of pleasure when listening to music, but alongside tension, resolution, delay, surprise, expectations and anticipation, prediction is what helps evoke the emotions that can be induced by music. In response to abstract pleasure, such as music, we can experience emotional expectation, prediction and anticipation which leads to a dopamine release in the dorsal striatum. In other situations, right before the climax of an emotional response dopamine is released in the caudate: a subregion of the striatum.

Research suggests that if we get better at prediction a reward the response will appear in the dorsal region of the striatum instead of the ventral. It is suggested that this is due to contextualized cues that make us more able to make accurate predictions, so when listening to music the tones act as contextualized cues that lead to a reward response in the dorsal striatum of the brain (Salimpoor et al., 2011).

As previously described, different characteristics of music can help evoke emotions in the listener, but it can be difficult to say exactly which emotions specific music evokes because it depends on the listener. There are some characteristics that people have associated with specific moods that the music can induce. Songs with a fast tempo is seen as highly-energetic and happy where as slower tempo song is associated with low-energy and sadness, high pitch gives a feeling of happiness and lighter moods where a lower pitch indicates a dark and serious tone. The difference in these characteristics will most often lead to either a positive or negative emotional response and the combination of these characteristics can then induce more specific emotions (Nuzzolo, n.d.). Some claim that the emotions induced by music are different than the emotions we experience in other circumstances, there has not been found evidence for a set of music specific emotions. It is more likely that some emotions are just more common to be experienced when listening to music. That different types of stimuli evoke emotions differently and we experience them at degrees and intensity suitable to the stimulus. What can be seen as unique is that music is often intentionally made to induce emotions (Vuust & Frith, 2008).

The most used framework when talking about emotions is by the dimensions valence and arousal, where valence range from positive to negative and arousal from calming to agitating. Studies have found that positively and negatively valanced but nonarousing stimuli can help memory performance, because the information related to positive or negative valence is better remembered. It's been suggested that this is because individuals are more likely to think about the valenced items meaning and how it relates to themselves (Kensinger, 2004). When people experience a type of emotional response to music it is linked to everyday activities and the emotional response can come from the reminder of past events of the listener. When reporting on the mood induced by music people are able to say if their response to the music is positive or negative but have a hard time distinguishing between specific emotions, especially if the emotions have the same valence. It is likely that musical characteristics play a role when evoking emotional responses and studies that are able to link these

characteristics to emotional responses can help give a better understanding about the connection between them (Västfjäll, 2001).

By getting more information about what it is in music that evokes emotions it will be easier to use and apply in e.g., psychology. Music have been recognized to have positive effects on different aspects of our health and well-being which could be due to the emotions induced by the music (Vuust & Frith, 2008). It's even been suggested that daily listening to music can increase sleep quality for insomnia patients. In the studies conducted relaxing and sedative music was used but it is not clear if some types of music are more effective than others (Jespersen et al., 2015). MacDonald, 2000 completed a study about therapeutic effects of listening to music, where patients listened to self-selected music before, after and during operations. MacDonald found that the overall effect of the music had an anxiety reducing effect, without genre and piece influencing this. Interviews with the patients revealed that the self-selected aspect of the process could be what gave this effect because the music then served as a reminder of happy memories leading to a relaxed feeling (Greasley & Lamont, 2006).

When listening to music we tend to associate music in minor mode with negative fellings like sadness where music in major mode is associated with positive feelings like happiness (Green et al., 2008). Some people will experience pleasant emotions while listening to sad music, which have been suggested to be due to their higher empathy traits. They will experience a more intense response to and a greater enjoyment of sad music, which forms the preference for it. Because of their empathy traits the listener is able to relate to the music and understand the perspective of the singer but also differentiate between the singer and themselves, viewing the music more objectively and experiencing the pleasantness of the music, not just the sadness (Kawakami & Katahira, 2015). When feeling empathy for and communicating with other people the mirror neuron system plays a role. It makes us able to represent and mirror the action or feeling of someone else while observing them, we do this by using the same neural system as they are using. When listening to music we use this to make a representation of a person or group and their physical and emotional state, the mirror neuron system gives a feeling of not being alone and we experience the emotional state of the person or group ourselves. We align our own emotional state with the emotional state we experience by the tones in the music and the lyrics (Overy & Molnar-Szakacs, 2009).

The aim of this study is to test if music categorized as being in major or minor mode will induce different emotional responses. This will be done by people listening to the first minute of a musical piece and then ranging their emotional response to the music on the valence scale, from negative to positive. The hypothesis is that music in major mode will evoke a more positive emotional response compared to music in minor mode that will evoke a negative response. An additional hypothesis is that lyrics will intensify this effect, so music in minor mode containing lyrics will be ranged more negative compared to music in minor mode without lyrics.

Materials and Methods

The study was conducted through a Google survey, using the option for testing. The survey consisted of 8 sound clips with following questions about the participants emotional response to the clip. The survey also contained questions about the participants demographic information like ID, gender and age. The participant's ID was anonymized right after collection. The sample was collected within a group of folk high school students and within my social network.

Participants

The study was conducted on 33 participants who all gave written consent. 66.67% was female and the participants had an age range from 15-52 years and with a mean age of 22.45 years ($sd = 5.966$). People who did not understand English were excluded.

Materials/Stimuli

The stimuli (the songs) used in the survey were collected from Edidemic Sound (https://www.epidemicsound.com/music/featured/) and were selected within the genre Indie Pop and with a mean tempo of 100.5 BPM ($sd = 2.673$). The songs were edited into 8 sounds clips with Win Movie Maker (Microsoft, 2021) and uploaded to YouTube to be used in the survey. The sound clips had a mean duration of 1 minute and 4 seconds ($sd = 6.22$ seconds) and fitted into 4 conditions (*table 1*). Key and type are my two predictor variables and the ones manipulated in the 4 conditions; my measured outcome variable is valence.

Table 1

Experiment Stimulus

Condition	Key	Type	Song 1	Song 2
1.	Major	Lyric	Particle House, *Guardian Eyes*	Chasing Madison, *Summer City*
2.	Major	Instrumental	Arch Tremors, *Eventually (Instrumental Version)*	Lars Lowe, *It Ain't the Way I Want It (Instrumental Version)*
3.	Minor	Lyric	Gamma Skies, *You Drift Away*	Particle House, *We Need to Calm Down*
4.	Minor	Instrumental	Johannes Bornlöf, *Monsoons (Instrumental Version)*	Can't Find Ollie, *Obsessions (Instrumental Version)*

Note: for each song the artist is mentioned first and then the song title, see the appendix for copyright attribution and link to the edited songs.

Procedure

The participants were instructed to bring a computer and headphones to the experiment. First, the participants were sent the link to the survey where they were presented with a consent form. After giving consent to participating in the experiment they were met with an explanation of the procedure, that they would be listening to eight sound clips and after ranging their emotional response to the music. The valence scale ranging from negative (-5) to positive (+5) was thoroughly explained, so the participants understood that a strong negative emotional response would result in a low score on the valence scale. The sound clips and the scale the participants needed to give their answer were all gathered in the same survey, so each participant could go trough them unbothered. After the data was collected, the participants were presented my hypothesizes and how I expected the data to support those.

Analysis

I used R (R core Team, 2019) and lmerTest (Kuznetsova, Brockhoff and Christensen, 2017) to perform linear mixed effects analysis of the relationship between valence and the key of the song. As fixed effect, I entered the key of the song and as random effect the participants ID because I expected the participants to have their own individual baseline and way to use the valence scale. The model (model 1) was built with the following R syntax:

$$valence \sim key + (1 \mid ID)$$

To look at the effect of lyrics in the song I made two models to compare. The first was a linear mixed effects analysis with valence as the outcome variable and as predictor variables both key and type, type being whether the song had lyrics or not. Here I also added the random effect with intercepts for each participant. The model (model 2) had following syntax:

$$valence \sim key + type + (1 \mid ID)$$

The second was also a linear mixed effects analysis but here an interactive effect was added between the two predictors key and type, therefore the model (model 3) had following syntax:

$$valence \sim key * type + (1 \mid ID)$$

Model 2 and 3 was compared with ANOVA.

All three models' residuals meet the assumptions for linear mixed effect analysis, homoscedasticity as the residuals is evenly linear distributed and linearity as the residuals is evenly distributed around the line.

Results

The output of model 1 showed significant results, with an intercept of $2.6211\ (SE = 0.1896, t = 13.824, p < 0.001)$ when the key of the song is major. The estimate for when the song is in key minor was $-2.6061\ (SE = 0.2650, t = -9.834, p < 0.001)$. Both fixed and random effect accounted for 27.2% of the variance in the valence variable.

The output of model 2 showed valence was significantly modulated by the two predictors key $(\beta = -2.6061,\ SE = 0.2624,\ t = -9.930,\ p < 0.001)$ and type $\beta = -0.5606,\ SE = 0.2624,\ t = -2.136, p < 0.05)$ and with an intercept when the song was in major key and had lyrics of $2.9015\ (SE = 0.2299, t = 12.623, p < 0.001)$.

Model 3 gave an output with an intercept of $2.8939\ (SE = 0.2647, t = 10.934, p < 0.001)$, an estimate for key minor with lyrics of $-2.5909\ (SE = 0.3711, t = -6.981, p < 0.001)$ and for key major and no lyrics $-0.5454 (SE = 0.3711, t = -1.470, p > 0.1)$. The interactive effect for key minor and no lyrics was $-0.0303\ (SE = 0.5249, t = -0.058, p > 0.1)$.

The ANOVA comparison showed model 2 had an AIC of 1161.1 and BIC of 1179.0, model 3 had an AIC of 1163.1 and a BIC of 1184.6.

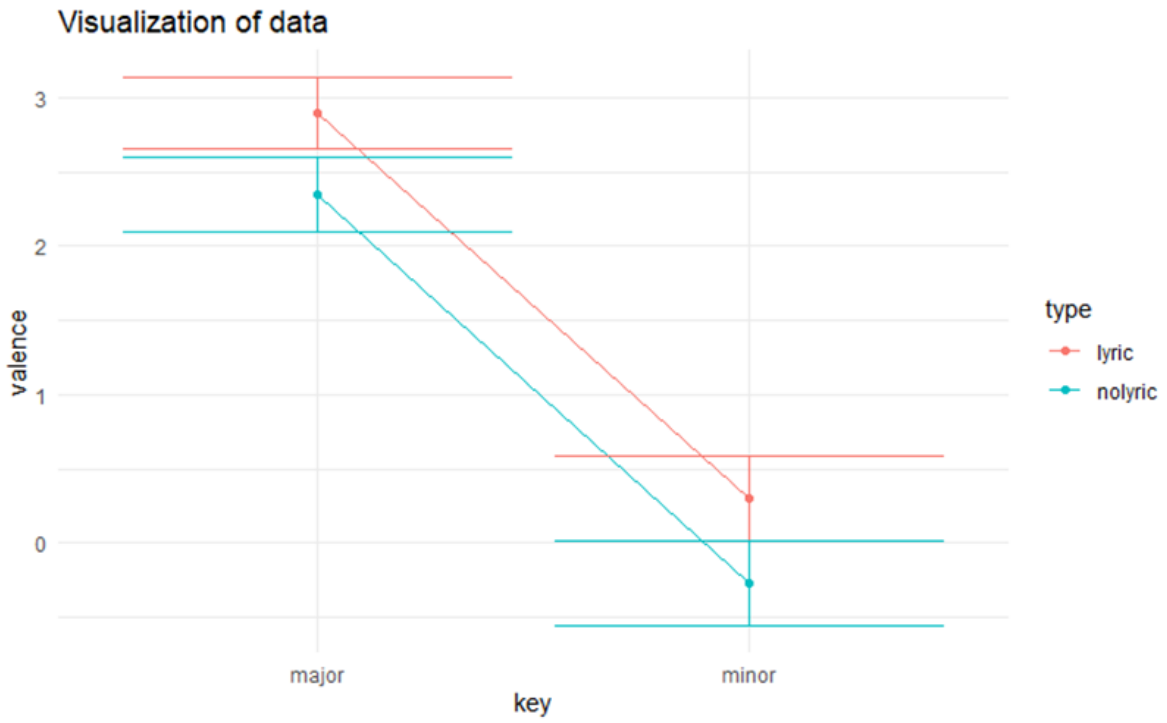

Figure 1: Visualization of data, the mean valence of each condition with belonging error bars

Discussion

The study found that when hearing a song in major mode participants rated their emotional response to be more positive than their response when listening to a song in minor mode. The difference in valence is significant, therefore it supports my first hypothesis that music in major mode will evoke a more positive emotional response than music in minor mode. The second hypothesis, that lyrics would intensify this effect was tested by an interactive effect. I predicted that songs in minor mode with lyrics would be rated more negatively and songs in major with lyrics would be rated more positively compared to songs without lyrics. These results were not significant. A significant difference was found, compared to instrumental pieces songs with lyrics evoked a more positive the emotional response, disregarding the mode. Lyrics had an additive effect and not an interaction effect on the emotional response. AIC and BIC confirmed that the model where lyrics were added as an additional predictor without an interactive effect was a better model for the data.

That lyrics had an additive effect on the emotional response could be due to a preference for sad music, as discussed in the paper by Kawakami & Katahira, 2015. Some participants could experience pleasant emotions when listening to the songs in minor, but this doesn't explain that the response is more positive when listening to pieces with lyrics. The mirror neuron system makes a representation of the singer and their emotional state when listening to music. When the piece is instrumental, we can only make this representation based on the tones, but when lyrics are added our representation has more content to be based on. We can align to both the tones and lyrics, the reason the emotional response is more positive when the songs have lyrics could be due to the lyrics being more positive. People could simply align more to the lyrics than the tones, because we are more skilled in aligning to words. To account for this, you could make sentiment analysis on the lyrics and get a feeling of how positive or negative the lyrics are.

Even though you accounted for the sentiment in the lyrics it is difficult to fully control things that effect people's emotional response to music.

> *"Thus, our engagement with music is enmeshed in a social and cultural world where we can "forget" or become unaware of the grounds on which our feelings and behaviours are based. This "forgetting" is the product of years of training, socialization, and the institutionalization of music. Not only have our musical practices become routine and invisible, but as musicians and psychologists we are limited in our ability to describe musical materials in a way that is free of the assumptions and biases associated with our own experiences and training."* (Sloboda et al., 2001)

As Sloboda here touches upon, our feelings associated with music are based on training, if you are a musician, but also experiences because music is everywhere in the social and cultural world. Therefore, no one able to explain their emotional response to music without the bias they have created towards it influencing them. This bias could be due to a specific preference for a type of music or how we make predictions about musical structure, but also the fact that we connect music and experiences together. The way we make experiences music is tied to everyday life and therefore music can function as a reminder of past events and happy memories.

Limitations and suggestions for further research

There are some issues with how the study is done and things to consider before further research. When participants listened to the songs, they all heard them in the same order, the order was however picked at random. This could affect the results because you could imagine the participants emotional responses from the song before, affecting the response on the next song. A randomized order would not fully solve this, so instead a delay could be put between each song where participants heard a neutral song. This might get the participants to have a more neutral emotional state before hearing each song and this way be sure the emotional response is only from the song.

In the model for the data, I accounted for each participant to have an individual baseline because they might experience the emotional content of the music and use the valence scale differently. It could make the data less reliable if the participants did not fully understand the valence scale. I tried accounting for this by thoroughly explaining it beforehand and giving the participants the change to ask if they at any point during the experiment were in doubt. Further I chose to only use the emotional dimension valence and excluded arousal, to be able to better find a connecting between the characteristics of the music and emotional response. To fully understand how the characteristics are connected to the emotional response you could add a arousal scale to the experiment.

As earlier discussed, we relate music to our experiences and everyday life and therefore the mood of the participants before participating in the study could affect how they response. If the study started with a small questionnaire to determine the mood of the participants, participants with especially high or low moods could optionally be excluded or there could be played some music to neutralize their mood beforehand. This could also remedy the fact that if the song contradicts too much with their current mood it could be experienced as annoying. It’s been shown by Small et al., 2001 that people eating chocolate between each fMRI scan stopped having a pleasurable response to it after eating a certain amount. It is possible the same thing could happen in the study, that people stop finding the music enjoyable and pleasurable. A delay and a randomized order of songs for each participant could solve this, participants wouldn’t get tired of listening to music and if they did the randomized order would account for this.

People experience more happy, relaxing and pleasurable emotions when listening to music they prefer, as all participants listened to the same music selected by me it could affect, their responses. If the

music falls into a category the participants like, they will experience more pleasure when listening to the music compared to other types of music. However, if the participants music preference is very different from music in the study, they might not experience pleasurable emotions when listening to this.

The study could also have included an examination of the effect of the sentiment of the lyrics in the songs, see how lyrics with positive sentiment score effects a song in minor mode, compared to songs in minor mode without lyrics or with lyrics with a negative sentiment score. As seen in Small et al., 2001 experiment the pleasurable experience of eating chocolate can fade, so it would be interesting to make fMRI scans while the participants listened to music to see if we experience the same effect with pleasure fading after a certain time of listening. Further you could use fMRI to study how memory and music work together, are brain areas associated with memory active when listening to music and can some music evoke a more intense memory activation? This information could be used to optimize our memory, if we could use certain songs to function as a reminder of information or events it could be used to retrieve information of our long-term memory.

The more information we can get about how music effects our emotions and what it is in music that evokes emotional responses, the better we can get at applying it in a useful matter. Like MacDonald, 2000 who found music could decrease anxiety for patients going into minor operations. The research of music and emotions can be used to apply music as an anxiety reducing tool in various areas or even for people with chronical anxiety. It’s even been found that people diagnosed with autism spectrum disorder have the same brain activation, emotion recognition and experienced the same emotional affect when listening to music as neurotypical people (Gebauer et al., 2014). Music could be applied as a tool for people diagnosed with autism spectrum disorder to help them recognize emotions in social settings, by comparing the emotions they recognize in music with their everyday life and own emotions.

Appendix

Clip 1: Particle House / Guardian Eyes / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=ynytX85Uumo&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=1

Clip 2: Arch Tremors / Eventually (Instrumental Version) / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=r_ZARdOlerM&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=2

Clip 3: Lars Lowe / It Ain't The Way I Want It (Instrumental Version) / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=2VwnipLyC7E&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=3

Clip 4: Johannes Bornlöf / Monsoons (Instrumental Version) / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=2HlvIY5EWyY&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=4

Clip 5: Can't Find Ollie / Obsessions (Instrumental Version) / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=ICGAhYa4XKc&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=5

Clip 6: Particle House / We Need To Calm Down / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=ltWsZZrIT9c&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=6

Clip 7: Chasing Madison / Summer City / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=Ud6I0ZeWC1A&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=7

Clip 8: Gamma Skies / You Drift Away / courtesy of www.epidemicsound.com
https://www.youtube.com/watch?v=FtO1YHGlGDI&list=PLy88w2r7OwFcAkqHCeyc1NZJYMfRgOJi7&index=8

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