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Can the Key Signature, Mode, and the Beats per Minute of a Song Predict the Emotional Tone of Popular Music Lyrics?

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Abstract: *The Dictionary of Affect (Whissell, 2009) was used to analyze the lyrics in popular music to determine if the emotional tone of the lyrics (pleasantness, activation, and imagery) was associated with various components of the popular music (key signature, mode, and beats per minute). The first analysis (N = 80 songs; 21,176 words) examined the relationship between the key signature (for example, the keys of A, B, C, D, E, F, or G; disregarding the major or minor mode) and the emotional tone of the lyrics, but no significant associations were noted. In the second investigation (N = 60 songs; 17,281 words), the song's mode (major or minor key signatures) was related to significant differences in the lyrics' pleasantness (p = .028). Song lyrics written in major modes (M = 55.5) were significantly more pleasant than those written in minor modes (M = 52.8); however, the mean pleasantness of the minor song lyrics was still in the pleasant range for the Dictionary of Affect.*

Keywords: *key signature, mode, music, lyrics, emotional tone*

1. INTRODUCTION

The enjoyment of music is a very social experience. Music contributes to many ceremonies that mark significant events in people's lives, such as weddings, funerals, bar mitzvahs, parties, dances, church services, Thanksgiving, Christmas, concerts, rallies, and sporting events.People also listen to music in the hopes of evoking emotions as well as providing an opportunity for a change intheir emotional state. Music can evoke many emotions, including happiness and sadness, creating an opportunity for tears of joy and tears of sadness (Kawakami et al., 2014). Music can also have therapeutic value, assisting in mental and physical well-being (MacDonald, Kruetz, & Mitchell, 2012).

Affect is a broad term encompassing many human mental reactions and states that are not traditionally viewed as intellectual. Feelings, emotions, and moods are central manifestations of emotion. They are also invariably associated with music. Although the field of music psychology is relatively new, its essential aim is to understand the mechanisms relating the perception of the sound of music and the emotion being experienced or detected by that listener as a result of hearing the music. There has been much debate about whether affect is necessary or even relevant to properly understanding a piece of music. Stravinsky (1962), for example, denies any relevance of affect to the process of creating, understanding, or interpreting music. He contends that any emotion is an unhelpful extrinsic by-product of music. Leonard (1956), in contrast, suggests that affect is a natural and intrinsic component of music perception and a part of the formal properties of a piece of music.

There are two distinct relationships between musical structures and emotional responses: iconic and symbolic. Iconic relationships come about through some formal resemblance between a musical structure and some event or agent carrying an emotional tone. Loud music, for example, shares features with high-energy events and suggests a high-energy emotion such as excitement. The expectancies are based on properties of human perception, such as the Gestalt laws of perception, and lead the listener to expect a movement of one note to the next scale step after already hearing one movement previously (Narmour, 1990). Listeners familiar with Western tonal music will come to expect certain harmonies and melodic sequences. It is a confirmation and violation of these expectations that are contended to account for some emotional reactions to music.

In general, research on the social influence of music does revolve around emotion. Bruner (1990) reviewed the literature on musical characteristics that induce mood. His findings summarized 63 mentions of distinct mood, which included exhilarating, exciting, brilliant, peaceful, happy, joyful, sad, mournful, and others. From these findings, Bruner contends that excitement is produced by music in the major mode, fast, medium pitch, uneasy rhythm, dissonant harmony, and loud volume. Tranquility is produced by music in the major mode, slow tempo, medium pitch, flowing rhythm, consonant harmony, and soft volume. Happiness is induced by the major mode, fast tempo, high pitch, flowing rhythm, concert in harmony, and medium volume. Serious music is in a major mode, slow with low pitch, consonant harmony, and medium volume, while sadness is induced by the minor mode, slow tempo, low pitch, firm rhythm, and dissonant harmony. Konečni (1982) believed that music is used to attain an optimal, moderate level of arousal. This author contends that individuals, who feel more aggressive than usual, will choose less aggressive music to reach that optimal level of arousal.

Researchers of music and emotion have placed more weight on self-report than on biological and behavioural indicators, and the research on self-report is vast. For example, Madsen et al. (1993) developed a method where listeners indicate their estimation of moment-to-moment emotion while adjusting the settings on a dial. Waterman (1996) asked his subjects to listen to a piece of music and press a button every time they felt something. He attempted, without success, to place a location of a high emotional response when his subjects pressed the button.

2. Lyrics, Music, and Emotion

While research on music is vast, the study of music with lyrics or language attached to it is surprisingly sparse and mixed. Galizio and Hendrick (1972) were among the first to examine the role of lyrics by asking participants to listen to folk songs composed of vocals and guitar music. The researchers broke up the groups into those with and without the guitar and those with sung lyrics and spoken lyrics. The researchers reported that the guitar consistently increased positive emotional responses to the songs, regardless of whether the lyrics were sung or spoken. While Galizio and Hendrick (1972) concluded that lyrics were not as powerful as the music, Stratton and Zalanowski (1994) used a variety of lyrics, music, or lyrics plus music and found that the lyrics appeared to influence mood more than the music did significantly. Sousou (1997) used the Stratton and Zalanowski (1994) study as inspiration but decided to include more obvious sad or happy music with combinations of happy and sad lyrics. Their study found that the music was the significant factor for the emotional ratings. Ali and Peynircioğlu (2006) had participants rate various emotions in either instrumental music or the same instrumental music paired with lyrics. Their findings were more complex: adding negative lyrics increased or enhanced the perception of negative emotions while adding positive lyrics decreased the perception of positive emotions. Fiveash and Luck (2016) concluded that the emotional tone of lyrics could be processed differently. The researchers asked subjects to detect errors in either sad or happy lyrics while playing sad or happy music. The authors found that significantly more errors were detected when sad music was played in the background, indicating that processing might differ for sad lyrics.

3. Key Signatures

This study will examine key signatures to determine if they are related to the emotional tone of the lyrics. A key signature is the tonic or central note of a song or piece of music (Kamien, 2000). Helmholz (1954/1885) described various key signatures (see Table 1) but suggested caution in translating specific emotions to specific key signatures as the emotions we feel might be anecdotal and dependent on many other musical variables such as pitch.

Table1. *Description of Emotions Associated with Various Key Signatures (Helmholz, 1885)*

Key	Description
A	Confidence, hope, love, and pleasantness.
B	Open, clear, and bright.
C	Expressive feeling of purity, certainty, and decisiveness
D	Grandeur, pomp, triumph, festivity, and stateliness.
E	Joyful, splendor, and brilliant.
F	Peace and joy.
G	Youth, expressive, quiet love, calm medication, humorous, and brightness.

3.1. Mode

This study will also examine key signatures related to the song's mode. Each piece of music has a mode, and while there are seven specific modes (Ionian, Dorian, Phrygian, Lydian, Mixolydian, Aeolian, and Locrian, this research will focus on major (Ionian) and minor (Aeolian) modes. For brevity in defining a major and minor mode, a song in a major key uses chords or notes of a major scale and comes to rest on the tonic of the major key. Opposingly, a song in a minor key uses chords or notes of the minor scale and comes to rest on the tonic of the minor key (Boone & Schonbrun, 2017).

Various studies have found that happy or pleasant music is characterized by a fast tempo and major key signatures, while sad music is typically played with slow tempos and minor key signatures (Dalla Bella et al., 2001; Pallesen et al., 2005). Research has concluded that songs with a major key signature tend to create positive emotional responses, while songs with minor key signatures tend to create negative emotional responses (Juslin & Västfjäll, 2008).

3.2. Text Analysis of Lyrics

This study used The Dictionary of Affect (DOA; Whissell, 2009) to analyze the emotional tone of the lyrics. Whissell has employed the instrument to analyze lyrics and key signatures previously, specifically for the music of the famous band, The Beatles. In Whissell (1996), the researcher analyzed 155 song lyrics by writers McCartney and Lennon and found that the latter wrote less pleasant lyrics than the former and that "the cheerfulness of the Lennon/McCartney songs decreased across time, most notably between the first and final stages of the Beatles' careers" (p. 264). In the follow-up, Whissell and Whissell (2000) looked at whether key signatures were related to the emotional tone of the lyrics. The authors found that lyrics from songs in a minor key were less pleasant and less active than lyrics from songs written in major keys. Concerning specific key signatures, extremely low pleasantness, activation, and imagery were found in lyrics from songs in the key off. Three other keys (C, D, and G) had lyrics that were active in emotional tone. Instead of using a single band (The Beatles), this paper will examine the emotional tone of song lyrics from random popular musical artists.

3.3. Method

Two separate analyses were conducted: the first was to determine whether the emotional tone of the lyrics can predict a specific key signature (for example, keys of A to G), disregarding whether the song is in a major or minor mode. The second analysis examined the emotional tone of the lyrics in major and minor modes. Both analyses examined the beats per minute (BPM): beats per minute is a term in music used to describe the tempo or speed of music, with higher numbers usually associated with faster tempos (Dalla Bella et al., 2001). The emotional tone of the lyrics was analyzed using the Dictionary of Affect (Whissell, 2009). The Dictionary of Affect (DOA) uses means scores from hundreds of participants who rated words out of context on three scales: pleasantness/unpleasantness, activation/passivity, and imagery. High imagery scores were associated with words that participants could easily picture in their minds, while scores low in imagery were associated with more abstract words. The DOA has an expected matching rate of 90% for everyday English texts (Whissell, 2009) and a normative mean score of 50 (SD = 17), so averages above or below indicate emotional tone differences in one direction. The DOA matching rate for the lyrics in the first analysis (key signatures) was 91.4% and 90.5% for the second analysis (mode – major v. minor).

3.4. Song Selection

Song selections were randomly chosen from Billboard Top 10 Charts with 20 songs per four-decade categories (the 1960s, 1970s, 1980s, and 1990s). The four-decade categories were chosen as the 1960s are widely considered to be the start of sales charts, which could influence the popularity and listenership of the songs, and the advent of radio and television, allowing for easier access to music (Jones, 2002). The lyrics, key signatures, and modes were transcribed/determined from official print music books. All songs selected had a single key signature. As beats per minute (BPM) were stated in the official print books, they will be included in both analyses.

3.5. Method: Key Signatures

A total of 80 songs were randomly selected, with most of the key signatures in G (26.3%), along with C (17.5%), E (17.5%), A (16.3%), F (10.0%), and a small percentage in D (6.3%) and B (6.3%). While mode (major or major) will be analyzed separately, most of the songs in this analysis were in the major (77.5%) and minor (22.5) modes.

Most (75%) of the song's main instrument was guitar (60%) or piano (15%), with almost half having no instrumental solo (48.8%) and 41.3% having a guitar solo. Most of the lyrics were credited to a single individual (42.5%), while some were credited to pairs (37.5%), three writers (11.3%), and four writers (7.5%). One song was credited to five lyricists (1.3%). Most of the song writers' gender were male (90%), and the singers were also male (77.5%). Finally, a considerable majority of the songs were written or co-written by the singer (72.5%).

3.6. Method: Major v. Minor Mode

This analysis did not include the 1960s-decade category due to the lack of popular songs written in minor modes in this timespan, thus decreasing the number of songs to 60.A total of 60 songs, 30 major and 30 minor modes, were randomly selected within three-decade categories: the 1970s (45% of the songs), the 1980s (28.3% of the songs), and the 1990s (26.7% of the songs). Most of the song's main instruments were guitar (65%) and piano (16.7%), with 35% having no instrumental solo and 45% having a guitar solo. Most of the lyricists were solo (50%), along with two writers (33.3%), with three (6.7%) and four (6.7%) writers tied for third, and one song had five writers (3.3%). Most of the song writers' gender (91.7%) and singers (80%) were males. Finally, most of the songs were written or co-written by the singer (83.3%) of the song or band.

4. RESULTS

Overall, the words in both the analysis of key signatures (N = 21,176 words) and mode (N = 17,281 words) were slightly more pleasant (M = 54.2, 54.1), active (M = 52.4, 51.7), and imagined (M = 51.9, 51.7) than everyday English (M = 50; see Table 2). The average BPM for both analyses lands in the allegro (109-132) range (Fernández-Sotos et al., 2016), suggesting a tempo described as 'fast, quick and bright'. No significant associations were found for the decade categories and both specific key signatures or modes.

Table2. *Mean Scores – Key Signature and Mode*

	Key Signature (n = 80) Mean (SD)	**Major v. Minor Mode (n = 60) Mean (SD)**
Song Pleasantness (*)	54.2 (4.7)	54.1 (4.7)
Song Activation (*)	52.4 (3.4)	51.7 (2.8)
Song Imagery (*)	51.9 (6.9)	51.7 (6.5)
Song Length (# Words)	264.70 (112.8)	287.78 (117.7)
Song Length (Time)	4:48 (1:24)	4:38 (1:21)
Beats Per Minute	111.30 (27.2)	106.65 (24.0)

(*): The Dictionary of Affect has a mean of 50 for everyday English.

4.1. Results: Key Signatures

Across various analyses, no significant relationships were found for specific key signatures. A one-way analysis of variance was conducted to explore the emotional tone differences in the song lyrics associated with its key signature (disregarding the mode of the songs), but no significant differences were noted for any of the three DOA scales: pleasantness ($p = .97$), activation ($p = .09$) and imagery ($p = .12$).

To evaluate whether the number of words in the songs was related to the emotional tone of the lyrics, a Pearson correlation analysis was conducted, and none of the emotional scales were associated with the number of words: pleasantness ($p = .78$), activation ($p = .38$), and imagery ($p = .82$).

To evaluate whether the song length (temporal) was associated with the emotional tone of the lyrics, a Pearson correlation analysis was conducted, and none of the emotional scales were related to the song's temporal length: pleasantness ($p = .45$), activation ($p = .26$), and imagery ($p = .82$).

A one-way analysis of variance was conducted to explore the emotional tone differences in the song lyrics associated with the decade category of its release, but no significant differences were noted for any of the three DOA scales: pleasantness (p = .29), activation (p = .19) and imagery (p = .21).

4.2. Results: Major v. Minor

An independent-samples t-test was conducted to compare the emotional tone of the lyrics and the modes (major, minor) of the songs. A significant difference was noted, with the major mode song lyrics (M = 55.5, SD = 4.92) being more pleasant than the minor mode song lyrics (M = 52.8, SD = 4.14; t = 2.26, p = .028, eta squared = .09); however, the mean of the minor mode lyrics is still in the DOA's pleasant range and the effect size is weak. An independent-samples t-test found no significant differences between mode and number of words in the song (p = .949).

When analyzing the song's temporal length, an independent-samples t-test noted a significant difference between major and minor songs and length (t = -2.2, p = .032, eta squared = .08): songs in the minor key (M = 5:01, SD = 1:29) were longer than those in a major key (M = 4:16, SD = 1:06) and the effect size was weak.

A one-way analysis of variance was conducted to explore the emotional tone differences in the song lyrics associated with the decade category of its release, but no significant differences were noted for any of the three DOA scales: pleasantness (p = .35), activation (p = .24) and imagery (p = .31).

4.3. Results: Beats Per Minute (BPM)

A one-way analysis of variance was conducted to explore if the BPM of the songs was associated with their key signature (disregarding the mode of the songs), but no significant differences were noted (p = .72). Similarly, an independent-samples t-test noted no significant differences between the mode (major or minor) of the song and BPM (p = .27).

To compare the emotional tone of the lyrics and BPM, a Pearson correlation analysis was conducted for both analyses (key signature, mode), and a significant relationship was between mode and the song lyric pleasantness: pleasantness (p = .17, .04), activation (p = .33, .82), and imagery (p = .35, .58). In the analysis on the mode of the song, the pleasantness of the lyrics was significant associated with BPM, suggesting that as BPM increased, the pleasantness of the lyrics decreased (r = -.26, n = 60). The lack of consistent significant findings between the two analyses could suggest that BPM may not be a strong predictor of the emotional tone of the lyrics.

5. DISCUSSION

The inspiration for this paper came from the author's admiration of the famous rock band Led Zeppelin. It is documented (Cross, 1991) that guitarist Jimmy Page would write some of the music and bring it to the band's singer, Robert Plant. Page would play the tune, and Plant would have a book of lyrics from which it was reported he would choose or spontaneously create the lyrics. Would Plant listen to a certain key signature and find or create certain words that would fit? Would Plant listen to a more positive key signature and choose more pleasant words? The results of this research might suggest no.

The number of insignificant results in this paper might be the biggest finding. This study used hit songs from various musical acts and found that the key signature and its lyrics were not associated with any of the emotional scales (pleasantness, activation, and imagery in the DOA). While pleasantness was noted to be significant in the analysis of mode (major v. minor), none of the other emotional scales (activation and imagery) were noted to be significantly associated with the lyrics. The lack of significant associations with the DOA calls into question whether the lyrics are a factor in determining the emotional tone of the songs.

Another takeaway of this study is that the emotional tone of the lyrics, even in minor modes, was not unpleasant, according to the DOA. The second analysis (major v. minor) noted that words in the minor modes were still in the DOA's pleasant range, not dropping below 50. The lack of unpleasant lyrics in the minor mode songs could be due to the writer wanting the song to have both sad and optimistic lyrics. For example, one of this study's most famous minor key songs is "Stairway to Heaven" by Led Zeppelin. While the mode might make the music sound sad, and some of the lyrics

could be interpreted as unpleasant, the song has optimistic lyrics, especially after the drums enter the song and the guitar solo near the end of the piece. The same can be said of the song "Total Eclipse of the Heart" by Bonnie Tyler. The song begins by referring to loneliness, fatigue, nervousness, and terror but, as the song goes on, there are messages of togetherness and the relationship being positive. Perhaps songwriters (or producers) believe that a consistent, very sad song may not sell and, while they have unpleasant lyrics in some parts, the majority point to the pleasantness of the story they are telling, thus explaining the emotional tone of the lyrics being in the pleasant range regardless of key signature or mode.

Conceivably, the lack of unpleasant lyrics in songs interpreted as sad due to their minor mode means that the listener's interpretation of the emotional tone of the song might be driven by the music and not lyrics, which would correspond with the conclusions of Galizio and Hendrick (1972) as well as Sousou (1997). Feasibly, society believes that minor mode songs are sad due to the music and not necessarily due to the lyrics. A limitation of any study that asks subjects to identify the emotional tone of lyrics is the lack of certainty whether the subjects can identify the exact words being spoken/sung and the message or story behind the lyrics. Another challenge might be how participants process the words while hearing additional lyrics and music as the song continues to play or be performed.

Another interesting finding was the lack of association between BPM and activation. A strong hypothesis going into this study would be that the faster songs might have more active lyrics, but that was proven not to be true as activation was not associated with BPM. Perhaps the lack of association between BPM and the activation of its lyrics has something to do with a certain BPM being more marketable or more within musicians' comfort zone. The average BPM was 111.30 and 106.65 for both analyses, respectively, with an overall average of 109. In the key signature analysis, the average BPM was higher for the minor mode songs (M = 118.71) than the major mode songs (M = 1110.89). In the second analysis (major v. minor), the means for the major songs were 111.13 and 103.17 for the minor songs. Music divides tempos into 12 different categories (Fernández-Sotos et al., 2016), but we will focus on those near our samples (see Table 3):

Table3. *Tempo Terminology*

Term	BPM	Explanation
Moderato	86–97	moderately
Allegretto	98–109	moderately fast
Allegro	109–132	fast, quickly and bright
Vivace	132–140	lively and fast

Both study BPM mean scores were within a defined 'fast' category, with Study One's average being 'fast, quick and bright.". In the key signature analysis, the BPM of the minor modes was faster than the major modes, putting them into the 'fast, quick and bright' category. In the mode analysis, both major and minor modes were in the allegro category, also defined as 'fast, quick and bright'. The overall average of both studies was 109, also within the allegro category. Therefore, even minor mode songs in this study could be interpreted as 'moderately fast' and, for some of the songs, described as 'fast, quick and bright'.

6. Limitations and Future Research

First, it is important to state that the words in the DOA were evaluated context-free by the participants, and background is important for assessing the meaning behind the lyrics in this study. Second, in both analyses, the study only analyzed the key signature and lyrics as a whole, not examining the lyrics within specific chords to see if there were any emotional tone changes. Concerning future research, examining the emotional tone of lyrics between two opposite genres (for example, death metal and folk rock) might reveal more significant differences as most songs in this paper might be considered 'rock' music.

7. CONCLUSIONS

An analysis of lyrics was conducted to determine whether their emotional tone was related to the key signature, mode, and BPM. The emotional tone of the lyrics was not associated with the key signature (disregarding the mode), the number of words in the song, and the length of the song. The mode of the song had significantly lower pleasantness than songs in a major mode, but the average pleasantness of the minor songs (M = 52.8) was still considered to be pleasant (> 50) by DOA. The lack of associations between key signature, mode, and BPM, suggests that the emotions coming from a song might be due to the music more so than the lyrics.

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