The Influence of Rhymes and Beats on Perceived Emotions in Rap Music

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This research investigates the influence of rhyme density in rap song clips that are processed to contain only the beat and the vocal on the perceived emotions of listeners, specifically focusing on sadness, anger, and pride. Previous research has examined elements such as rap flow and the impact of rhyme density on emotional intensity in German poetry. However, no studies have specifically investigated how the flow of rap music and its quantifiable features, like rhyme density, influence emotional intensity. A total of 24 rap songs were selected based on their emotional content, and audio clips were processed to remove vocal characteristics that could influence perception. Participants rated the emotional intensity of each clip on a scale of 1-5 for all three emotional categories, while rhyme density was computed using strict and lax counting systems. Notable patterns emerged, indicating that lower lax rhyme density might be associated with heightened sadness. In contrast, pride ratings remained stable across varying rhyme types, suggesting that factors beyond rhyme density contribute to emotional engagement. Findings suggest no observable pattern exists between the calculated rhyme density and emotional intensity for all three emotional categories under the current investigation. All statistical approaches adopted failed to show a significant relationship as well. This research has suggested no direct relationship between rhyme density and emotional intensity. Thus, further numerical investigations into the flow of rap music and its effect on emotional intensity should quantify the flow of rap as integrity instead of focusing solely on rhyme density. Further research is needed to explore these nuanced interactions and deepen our understanding of the emotional landscape within rap music.

Keywords: rap music, emotional perception, rhyme density, sadness, anger, pride.

Introduction

Rap music is renowned for its lyrical sophistication and emotional depth, often expressing complex feelings such as sadness, anger, and pride. These emotions, deeply embedded in both the lyrics and rhythm, have been explored across different music genres, but research focused specifically on rap music remains limited. Theoretical frameworks on emotional expression in music often highlight elements such as pitch and rhythm as key contributors to emotional intensity (Schellenberg et al., 2000)[1]. Pitch, for instance, plays a dominant role in shaping emotional responses: high pitches are often associated with feelings of happiness or excitement, while low pitches convey sadness or serenity. Additionally, variations in pitch within a melody contribute to emotional expressiveness by manipulating the tension and resolution dynamics of the music. However, controlling for pitch effects becomes essential when investigating the relationship between rhyme density and emotional intensity, as pitch influences emotional responses independently and thus was removed from the clips used in the study. By controlling or standardizing pitch, the study can isolate the effect of rhyme density, ensuring that any observed variations in emotional intensity are due to rhyme density and not pitch-related cues.

Building upon these considerations, Brevity and Expectancy Theory offers a compelling framework for understanding the role of rhyme density in rap music. This theory posits that music creates emotional engagement by generating and manipulating listener expectations through recurring patterns (Meyer, 1956)[2]. Rhyme density, a rhythmic and structural feature of rap, plays a central role in setting these expectations. Higher rhyme density increases the frequency of patterns and resolutions, which demands greater cognitive engagement and intensifies emotional responses. This conceptual framework directly informs the current study's approach, as this study aims to explore how variations in rhyme density impact the perception of emotional intensity in rap music.

While research into rhyme's emotional impact has been conducted across different genres, much of the existing work, such as Obermeier et al. (2013)[3], has focused on poetry. Their findings suggest that meter and rhyme enhance emotional engagement and aesthetic appreciation. However, Obermeier et al.'s research is grounded in poetry and does not account for the high rhyme density, dynamic rhythms, vocal complexity, or the genre-specific context of rap music, which has a distinct interplay between rhyme density and rhythm. Although the specific statistics of rhyme density of the poems are not men-

tioned, poems, which are generally more focused on aesthetic appreciation and express emotions through constructing images and exquisite word choice, are less dependent on rhymes to demonstrate emotions and have a relatively low rhyme density. Furthermore, rap music is defined by rapid and intricate rhyme patterns that interact with a more complex rhythm structure, often accompanied by a vocal delivery that includes heightened emotional intensity and a broader range of vocal timbres. These differences in the musical and vocal environment necessitate a distinct exploration of rhyme's role in emotional perception within rap music. Moreover, Obermeier et al. primarily focused on rhyming versus non-rhyming stimuli in a controlled, static format. This study explores rhyme density as a dynamic variable, assessing how it correlates with perceived emotional intensity in a musical genre where rhythm and vocal delivery are central to emotional engagement.

Thus, the gap in Obermeier et al.'s work that this study addresses is the limited exploration of rhyme's role in emotional perception within a dynamic musical environment like rap, where rhythm and vocal delivery significantly modulate emotional intensity. Additionally, while Obermeier et al. explored rhyme and meter in isolated linguistic stanzas, this study will examine how rhyme density—interacting with rhythm and pitch—affects emotional engagement in rap, providing deeper insights into the relationship between structural features and emotional perception in music.

To address this gap in the literature, this study investigates the relationship between rhyme density and the perceived emotional intensity in rap music, focusing on three emotions—sadness, anger, and pride—commonly expressed in rap songs. These emotions were selected because they are distinct and prevalent within the genre, and understanding how rhyme density affects their perception will provide deeper insight into the emotional dynamics of rap music. The primary objective is to explore how variations in rhyme density influence the emotional perception of these three emotions while controlling for other variables like pitch and vocal style. By manipulating song clips to reduce pitch variation, the study isolates the effect of rhyme density on emotional interpretation, ensuring that any observed emotional intensities can be attributed to rhyme density alone.

This study employs a cross-sectional, observational design, allowing us to examine how rhyme density correlates with emotional intensity based on participants' responses to selected song clips. A total of 120 participants, aged 18-30, consisting of 63 males and 57 females, were recruited. Participants were non-native English speakers who listened to rap music less than once daily to control for prior exposure and potential bias. The emotional categories of pride, anger, and sadness were chosen based on their prominence in rap music, and clips were sourced from songs labeled expressing these emotions on QQMusic and Spotify. The clips were edited for consistency and processed with AI tools to isolate vocals and drums, ensuring uniformity across versions.

Rhyme density was calculated using a formula that measures the ratio of rhyming syllables to the total number of syllables in each clip. This calculation follows the framework proposed by Tsur (1992)[4], which suggests that rhyme density influences emotional engagement by focusing attention on specific sounds, thereby evoking emotions. Two rhyme-counting systems were applied: a strict system, which includes specific syllabic distance rules, and a lax system, which excludes them. These systems were tested for their alignment with participants' emotional ratings to assess which method reflects their perception of rhyme density more accurately.

While the study aimed to control for pitch and vocal differences, limitations include the reliance on self-reported English proficiency, which may introduce variability in participants' understanding and emotional interpretation. Additionally, the use of AI-manipulated clips, though effective for isolating specific emotional elements, may not fully capture the nuances of the original tracks, potentially affecting the authenticity of the listening experience. These limitations suggest avenues for future research to further explore the emotional dynamics in rap music.

In conclusion, this research will explore the following objectives: (1) to analyze the correlation between rhyme density and perceived emotional intensity in rap music, (2) to determine whether specific emotions are more influenced by rhyme density than others, and (3) to provide insights into the broader implications of these findings for understanding emotional expression within music.

Results

While traditional poetry often relies on structured end rhymes, creating predictable emotional rhythms, rap music showcases a more intricate approach with continuous rhyming patterns and diverse lyrical techniques. The study found that the emotional intensity conveyed in rap songs does not correlate with rhyme density, contrasting with established understandings of poetry. This result may be due to the complex rhyme structure of rap songs, a characteristic that poetry does not contain. Moreover, stereotypes associating rap with themes of anger and pride may also influence the perceived emotional intensity.

Additionally, the perception of emotion in rap is further complicated by societal stereotypes that may lead to an oversimplified understanding of the artist's intent. Unlike poetry, which is less susceptible to preconceived notions, the themes present in rap can skew emotional ratings, often emphasizing more aggressive emotions over nuanced feelings like sadness.

This study recognizes the limitations of its approach, particularly in quantifying rhyme density without fully considering the complexity of rap's rhyming techniques. Future research should delve deeper into the interactions between lyrical content, musical composition, and audience perception to better understand

the emotional dynamics at play in rap music.

Discussions

It is shown that in the previous analysis, based on the participants recruited in our experiment, who are all Chinese college students, the emotional intensity of rap songs is not directly correlated with the rhyme density of songs. However, the base of the study, which is the conclusion that rhyming can intensify emotions, focuses mainly on the study of poetry (Obermeier et al., 2013)[3]. Thus, this could be due to the complex rhyming pattern, the flow of rap songs, which are exclusive to rap, and the stereotypes of rap songs compared to poetries. The study contains two limitations, which are an oversimplification of rhyme density in rap songs and the difficulty in accurately determining the perceived emotions of rap songs without a thorough understanding of their lyrics, may also affect the result.

Firstly, rap songs typically involve rhyme chains, a concept first defined by Walter Herbert (1937)[5]. A rhyme chain involves developing a series of words that are not perfectly rhymed. For instance, /trash→dash→dad→damp→lamp→limp/ is a rhyme chain. In this series, there are only two perfect thymes, yet they constitute a rhyme chain in which the words seem to rhyme in a sequence. However, poetries typically do not contain rhyme chains because the number of lyrics that are separated by stanzas is far lower than that of rap songs, which makes it unnecessary to lay out a complex rhyme chain. The most commonly mentioned technique of rhyming in poetries is end rhyme, which refers to rhyming the last syllable of each line. Poets often create rhyme schemes based solely on end rhymes, including patterns such as AABB (the first two lines of each stanza share the same ending syllable, whereas the last two sentences share another ending syllable), ABAB. Other techniques, such as alliterations, consonance, and assonance, are also frequently adopted in poetries. However, for most poetries, the position of a rhyming syllable is often fixed. The poem "A Day Away" exemplifies it.

> Some feelings are shallow, some feelings are deep.
> Some make us smile, some make us weep.
>
> Some we love, some we don't. Some we'll savor, some we won't.
>
> Some grounding, some uplifting, Some long-lasting, some constantly shifting.
>
> No matter what feelings I'm feeling today, I know tomorrow is only a day away.

The poem mainly adopts end rhyme, each stanza containing two lines with the same ending syllable. It also adopts anaphora, repeating "some" at the beginning of each sentence and after the comma. However, the rhyming syllables do not evolve as the poetry progresses; instead, each end rhyme is independently chosen. Thus, rap songs generally have a more continuous rhyming pattern as the rhyme chain progresses, which gives rap songs a more intricate rhyming pattern.

Secondly, rap music is an art form that involves the accent of the rap artist (which is the pattern of accentuation in a rap song), music and drums, and the rhyme pattern of lyrics. Together, they form a flow unique to the rap artists, or in some cases, unique to the song. For instance, in Fuck Tha Police (N.W.A., 1988)[6], Young adopts the fierce demeanor characteristic of his work with N.W.A., utilizing a flow that features off-beat accents and syncopated rhythms (Adams, 2009)[7]. The verse comprises three distinctive types of lyrics. The first two measures, along with measures four to eight and seventeen to twenty, feature "doing" lyrics that detail Young's experiences as someone on the run from law enforcement. Conversely, the lyrics in measures three and nine through thirteen can be categorized as "being" lyrics, reflecting his observations and feelings. Lines thirteen to sixteen diverge from this narrative, where Young breaks character to speak directly to the audience. The musical beat complements these different lyrical functions; the first part, dominated by "doing" lyrics, is supported by a consistent drumbeat and melodic layers sustained throughout the initial verses. The "being" lyrics in measures nine to twelve are distinguished by introducinga higher-pitched, beeping C-natural, which adds to the sense of instability through its unexpected placement and dissonance with the bass note C-sharp. In measures thirteen to sixteen, the transition from Young's portrayal of a character in distress to his role as a rapper addressing his audience is reflected by a shift from the bass note C-sharp to G-sharp, the dominant note. The concluding measures return to the original beat, representing a synthesis of the preceding elements. As pointed out by Ken Adams, the sophisticated flow of rap songs contributes significantlyto the expression of emotions, which adds to the complexity of rap songs (Adams, 2009)[7].

Thirdly, people's stereotypical impressionsof rappers may affect the perception of emotion. Rap music has long been associated with specific stereotypes—particularly aggression, rebellion, and a glorification of material wealth. These stereotypes may influence listeners' emotional perception of rap songs, particularly when it comes to emotions like anger and pride. As Rose (1994)[8] observed, rap music is often viewed as the soundtrack of defiance, crime, and violence, and these themes have been linked to the emotional experiences of aggression and empowerment.

Stereotypes about rap and rappers might cause listeners to overestimate the intensity of emotions like anger and pride in rap music based on their expectations of what rap music "should" express. This pattern of emotional perception aligns with findings from Juslin (2000)[9], who highlighted how listeners' expectations, shaped by cultural stereotypes, play a significant role in how emotions in music are recognized. Juslin argued that when

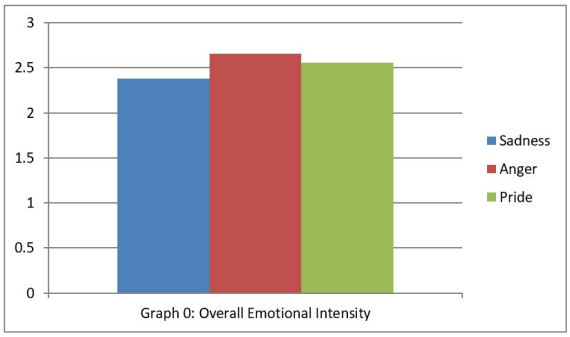


Fig. 1 Graph gives the average of the rating of emotional intensity of the three emotional categories of all songs

listeners bring preconceived notions to their interpretation of music, those expectations strongly influence their emotional judgments. In rap music, listeners might anticipate emotions such as aggression and pride due to the genre's association with these traits and thus rate songs as more intense in those emotions.

Furthermore, research has shown that the genre's stereotypical cultural associations can influence music's emotional perception. Balkwill and Thompson (1999)[10] found that cultural context plays a critical role in how emotions are perceived in music. In their study, listeners from different cultural backgrounds had varying emotional responses to music based on their preconceived cultural associations with the genre. This suggests that rap music's stereotypical associations with aggression, power, and rebellion may lead listeners—especially those with limited exposure to the genre—to rate rap songs as expressing stronger emotions like anger and pride, even when the lyrics may not explicitly convey these emotions.

A Limitations of the Experiment

Apart from the difference between poems and rap songs, there are certain limits in this study that may affect the result of the experiment. The rhyme density of the experiment is designed to focus solely on the quantity of rhymed syllables over the total syllable of the clip. However, although this is proven to be the case for poetry, rap songs have a more complicated rhyming pattern.

Specifically, as presented in MCFlow: A Digital Corpus of Rap Flow, rap songs involve three different categories of rhyming: rhyme by similarities, rhyme by position, and rhyme by stress (Condit-Schultz, 2016)[1]. Rhyming by similarity is two words containing identical or similar syllables, and rhyme by position is two words having the same position in a rap song that rhymes. The research primarily counts the quantity of rhyming syllables through the first two types. However, some syllables are stressed and rhymed, whereas some are merely stressed and not emphasized. The perceived density of rhymed must also be considered to determine a ratio of perception for the stressed rhyming syllables to the unstressed rhymed syllables, a task that has not currently been accomplished.

Secondly, rap songs' perceived emotions are challenging to determine. For songs labeled to convey sadness, the average perceived emotional intensity of sadness is 2.48, whereas that of anger is 2.64, and that of pride is 2.82. For each category, the average emotional intensity of pride is always the highest, followed by anger and sadness. Thus, rap songs conveya complex mix of emotions which mainly consists of pride and anger, and for certain songs, sadness is also involved. It is therefore unlikely to determine the emotion that one song is conveying without understanding its lyrics.

Moreover, the methodology of the experiment can be improved. A potential methodology for the experiment involves having participants listen to a longer musical clip, for instance, one that consists of 12 bars. During the listening session, participants will rate their emotional experience by indicating any perceived changes in emotional intensity. If they sense an increased emotional intensity, they can click a designated button to signal this, while a decrease can be indicated with a different button. This approach allows for real-time tracking of emotional responses. This study will then compare the frequency of increases and decreases in rated emotional intensity with the rhyme density that is calculated from the clip. This implicit measure may yield more nuanced results regarding the relationship between rhyme density and emotional response.

Furthermore, the self-reported confidence level reflects participants' subjective perception of their understanding, which may not always align with their actual linguistic abilities. This subjective measure can be influenced by factors such as familiarity with the language or media, personal biases, or overconfidence. Without objective measures of participants' linguistic abilities or their actual comprehension of rap lyrics, it is challenging to draw definitive conclusions about their understanding of rap music based solely on these ratings. Additionally, participants may be able to identify rhymes without fully understanding the lyrics, as rhyme recognition is a distinct skill that does not necessarily depend on complete language comprehension. Therefore, while the confidence rating provides some insight into participants' self-assessed language proficiency, it is not an accurate or comprehensive measure of their ability to understand the nuanced and fast-paced language typically found in rap lyrics.

Lastly, this study uses a straightforward attention check, asking participants "1+1=?" to ensure they were paying attention. While this approach effectively filters out inatten-

tive responses, it may not be ideal for maintaining engagement with the study's content. A subtler attention check, potentially linked directly to the study's emotional focus, could enhance participant engagement while ensuring attentiveness. For example, participants could be asked to identify the previous clip's emotional tone, which would verify their attention and tie directly to the study's content, fostering a more natural and relevant way to assess focus level.5.

Methodology

The overall structure of the study is cross-sectional and observational. It aims to assess the emotional responses of participants to a selected set of rap songs at a single point in time rather than manipulating variables or following participants over an extended period. This approach allows for the examination of relationships between rhyme density in the lyrics and the emotional intensity experienced by listeners, capturing their perceptions in a natural and unaltered context. By collecting data simultaneously from participants, the study seeks to identify patterns and correlations without any experimental interventions.

Participants

All participants are not native speakers of English, and they are between 18 and 30 years old, consisting of 63 males and 57 females. The specific music preference was not asked, but only participants who do not frequently listen to rap music (less than once a day) are selected since familiarity with rap music may cause participants to have accidentally heard the chosen clips and may affect their perceptions of the clips. The participants were recruited from emails that contained questions regarding whether they were non-native English speakers and if they were frequently exposed to rap, and only participants satisfying all two criteria were included.

Material Preparation

To prepare the study material, the study focused exclusively on cutting clips from songs that were labeled as evoking pride, anger, or sadness across at least five playlists on QQMusic and Spotify. The two platforms were chosen due to their large, engaged user bases and robust community contributions to music recommendations. Reddit's user discussions reflect a broad consensus on emotional resonance, while QQMusic and Spotify provide expertly curated playlists organized by emotional labels such as "Songs for Anger," "Pride Anthems," and "Melancholy Tracks."

The choice of pride, anger, and sadness as the emotional categories for the study are grounded in their distinct and common occurrences in rap music. According to sources such as Wikipedia, rap frequently explores themes of love, materialism, politics, crime, and emo, with materialism often showcasing feelings of pride as artists highlight their wealth and success. Love is a complicated emotion, and rap music related to rap often contains multiple emotions, such as the guilt for not being able to accompany, the anger for those who hurt the singer's loved ones, which will create difficulties for participants to rate the emotional intensity of love exclusively. Political rap typically integrates emotions of anger and pride while discussing social injustices, which can complicate participants' ability to accurately assess emotional intensity. Similarly, crime rap often conveys both pride and anger, reflecting the motivations behind criminal behavior. Emo rap, on the other hand, primarily expresses sadness, with no other emotions attached. Thus, this study only selects songs that suggest pride, anger, and sadness.

Next, this study cuts a four-bar clip from each song using the software Audacity. Clips were chosen to embody an explicit emotional inclination through both lyrics and tones and ideally, each bar would have the same end rhyme. However, the explicit version of the song Czar could not be found through copyrighted means, so the clean version was adopted, which resulted in one erasure being included in the clip. Clips were cut to avoid a sense of abruptness by trimming at the timestamp that had a relatively lower voice intensity than its adjacent voice intensity, so each clip all had end rhymes to symbolize the end of the sentence.

After obtaining the clips, this study used Splitter AI (https://vocalremover.org/splitter-ai) to split each clip into vocal, drum, bass, and music. The volume of the drum and vocal was turned to 100, and that of the music and bass was turned to 0 to obtain a clip with only the beat and vocal. The mixed versions were then exported. Audios were imported into Lala AI to alter the vocal of each clip (http://lalal.ai/voice-changer/). The purpose of this was to eliminate the effect of vocal characteristics of MCs and the stereotypes of the MC on the perceived emotion. The audios were altered so that the vocal traits of the MC were replaced with other vocals and other elements related to flow, such as accentuation, are retained. This study chose four vocals to replace the original vocals. The four vocals were 21 Savage, Louis Armstrong, Elvis Presley, and SZA. They were chosen because they were not exceedingly renowned in China, as the number of followers for each of them on QQ Music ranged from 128k to 158k (by contrast, Taylor Swift had 12.8 million followers). In addition, the pitch range of each vocal was different; 21 Savage had a relatively flat range of pitch since he was a rapper, Louis Armstrong primarily covered the low-pitch range because he was a jazz musician, Elvis Presley had a broad vocal range as a pop music singer, and SZA covered the high pitch as a female pop music singer.

Although altering vocals can impact on the emotional perception of clips, each four-version clip are replaced with the same four vocals, ensuring that there is no difference in vocal for each

clip, and thus there is no need to further expound on vocal's effect on emotional intensity.

Calculation of Rhyme density

The study's independent variable is the rhyme density of each rap song, and the dependent variable is the perceived emotional intensity of each song. To calculate the rhyme density, this study used the formula:

$$\text{rhyme density} = \frac{\text{(number of rhyming syllables)}}{\text{(total number of syllable in the clip)}}$$

rounded to the nearest hundredth. The justification for calculating rhyme density, rather than simply counting the quantity of rhyming syllables, is based on Tsur's (1992)[4] theoretical framework. Tsur suggests that rhyme evokes emotions by creating unusual repetitions of syllables that draw attention to sounds. In typical speech, people do not focus on every syllable, but rhyme forces listeners to focus on certain syllables, which triggers emotional responses. Thus, rhyme density—the frequency with which rhyme occurs relative to the total syllables—becomes crucial for evoking emotions.

Building on this principle, this study devised specific rules for counting rhyming syllables, which are detailed in the appendix. The key rules for counting rhyme density include:

1. Rhymes were determined by how they were pronounced.
2. IPA phonetics was not used as a reference.
3. Words repeating because they were in a phrase were not considered rhymes, for example, "as...as."
4. Assonance could only be counted as rhyme if another rhyming syllable occurred within five syllables and could not cross lines (included five).
5. Consonance could only be counted as rhyme if another rhyming syllable occurred within two syllables and could not cross lines (included two).
6. End rhymes and other categories of rhyme by positions were always classified as rhymes.
7. Perfect repetitions were considered rhymes.

Rules five and six were implemented to ensure that only syllables perceived as rhyming due to their frequency of occurrence were included in the calculation. A syllable can only be perceived as rhyming when its frequency exceeds the normal level, and if assonant or consonant rhymes occur outside the set distances, they are not perceived as rhymes. However, it is important to note that these syllabic distances are arbitrary, as there is no empirical evidence to definitively support the specific thresholds.

In light of this uncertainty, a lax rhyme-counting system was also used, which excludes the above distance-based rules. The lax system was introduced to determine whether a more rigid approach to counting rhyme density (without these specific thresholds) better aligns with participants' perceptions of emotional intensity. While the lax system generally yields lower rhyme densities, there is no clear relationship between lax rhyme density and emotional intensity, suggesting that the arbitrary distances may not be crucial. Thus, both the lax and strict rhyme-counting systems were retained in the study, as it was uncertain which system would more effectively capture the perceived emotional impact of rhyme density. These two systems were used exclusively to calculate rhyme density and were intended to serve as explanatory variables, not influencing participants' emotional intensity ratings, which were the dependent measure.

To determine which rhyme-counting system should be adopted, this study included two additional songs—*Gucci Gang* (Lil Pump, 2017)[11] by Lil Pump and *Brain Damage* (Eminem, 1999)[12]—in the questionnaire. Participants were asked to rate the perceived rhyme frequency of these two audio clips on a scale of 1 to 5, with 1 indicating a very low perceived rhyme frequency. The rhyme-counting system that most closely aligns with the rated rhyme density will be adopted for our analysis.

Experiment Design

There was a total of 12 questionnaires, each answered by 10 participants. The questionnaires were made on Google form and comprised of one information sheet and one question about their rated English proficiency by rating their confidence in watching an English TV series on a scale of 1-5, indicating very low confidence. The average of 2.9 suggests that they have a basic understanding of the English language and thus can successfully recognize rhymes in a clip, yet cannot infer the intended emotions of the clips through lyrics. Two questions rating the rhyme density of the presented clip on a scale of 1-5, 1 indicating very low rhyme density, were asked, and eight questions rating the emotional intensity of the presented clip for all sadness, anger, and pride on a scale of 1-5, with 1 indicating very low emotional intensity, and a focus-check question ("One plus one equals A. one B. two C. shoe") to filter out inattentive responses. The order of questions was randomized for each questionnaire.

The information sheet stated the potential cussing and lyrics related to violence, and all participants could withdraw from the process if offended, construed rhyme density as the frequency of rhyme, and asked specifically that all clips should only be heard once and participants should answer the questionnaire in a continuous process. No two clips in one questionnaire were cut from the same song, and among the eight questions related

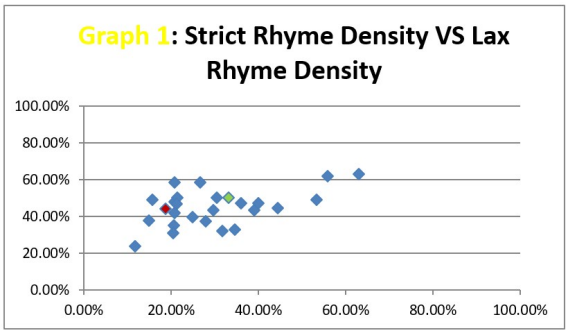
to rhyme density, the participants will hear all four vocals twice, and the order is presented in the form below, in which VA-B suggests the clip was placed in questionnaire A question B. The order of the rating bar of anger, sadness, and pride was randomized.

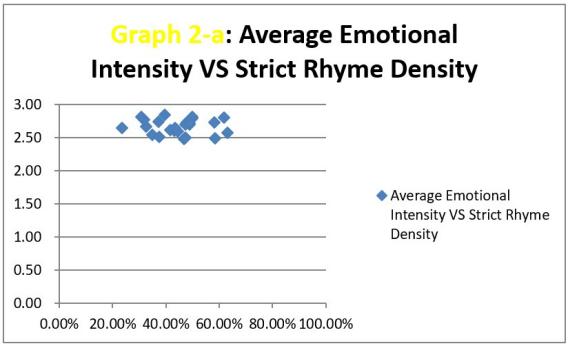
Data Analysis

A power analysis was conducted based on the following parameters: a sample size of 120 participants, a significance level (α) of 0.05, a desired power of 0.80, and a small effect size (Cohen's $f^2 = 0.02$). Using GPower, the required sample size to achieve 80% power for detecting a small effect size with three groups was found to be 128 participants. Given that the current sample size is 120 participants, it is just slightly below the optimal threshold, suggesting that the study is adequately powered to detect a small effect. While a larger sample size would be ideal, the current sample size still provides sufficient statistical power to detect moderate or more significant effects. The sample size of 120 is adequate for achieving reliable conclusions, especially considering the nature of typical effect sizes in social science and music psychology research, which tend to be small to medium in magnitude.

With a sample size of 120 participants, the potential for significant outliers to distort the results is minimal. The emotional intensity ratings are constrained within a 1–5 Likert scale, eliminating the possibility of extreme outliers outside this range. The data screening process detected no outliers across the three emotional categories—anger, pride, and sadness. Given the robust sample size and the tightly constrained nature of the rating scale, the influence of any potential outliers is doubtful. If outliers are detected, they would be addressed using standard data cleaning procedures, such as winsorizing or removing extreme values. While no outliers were found in this study, future research could consider adopting a finer rating system (e.g., a 1–7 or 1–10 scale) to provide more nuanced data and reduce the risk of measurement biases. Therefore, it is reasonable to conclude that outliers will not significantly impact the overall results or the conclusions drawn from this study.

In analyzing Graph 1, the visualization may suggest a polynomial or linear trend between Average Sadness Intensity and Strict Rhyme Density; however, the R^2 values reveal a lack of a statistically significant trend. The linear regression model yields an R^2 of 0.249, indicating that only 24.9% of the variance in Average Sadness Intensity is explained by Strict Rhyme Density, which is relatively weak. A quadratic polynomial regression slightly increases the R^2 to 0.266, while a cubic polynomial regression raises it to 0.369. Despite these increases, they remain modest and do not demonstrate a meaningful relationship, as adding polynomial terms inflates the R^2 value without implying a substantial connection. Therefore, it is doubtful that such a complicated relationship exists between strict and lax rhyme density, concluding that the data do not support a meaningful correlation.





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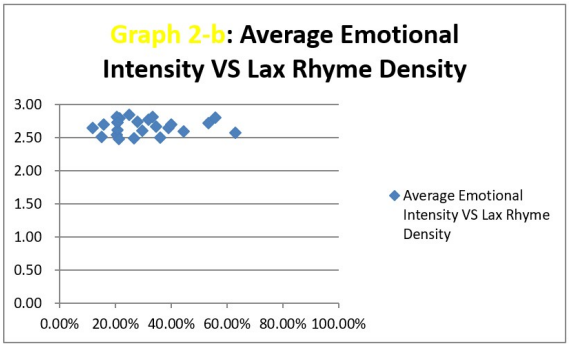
In analyzing Graph 2-a (Average Emotional Intensity vs. Strict Rhyme Density) and Graph 2-b (Average Emotional Intensity vs. Lax Rhyme Density), it is evident that all data points are clustered with an average total emotional intensity ranging from 2.5 to 3 across three emotional categories. This close clustering of values indicates a lack of discernible trends in both graphs, making further statistical analysis unnecessary. The absence of a clear relationship can be readily identified through visualization, reinforcing the conclusion that the emotional intensity does not significantly correlate with either type of rhyme density.

In Graph 3-a (Average Sadness Intensity vs. Strict Rhyme

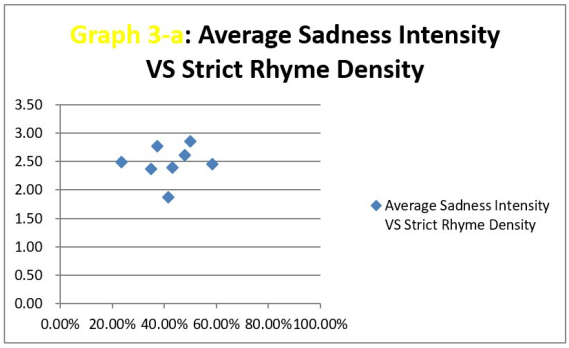
Song/Vocal	21 Savage	Elvis Presley	Louis Armstrong	SZA
Beautiful	V3-7	V4-7	V1-7	V2-7
Like Toy Soldiers	V7-3	V8-3	V5-3	V6-3
Time	V9-5	V10-5	V11-5	V12-5
Kurt Kobain	V11-7	V12-7	V9-7	V10-7
So Many Tears	V4-2	V1-2	V2-2	V3-2
You Never Know	V7-7	V8-7	V5-7	V6-7
Dance with the Devil	V8-6	V5-6	V6-6	V7-6
Suicidal Thoughts	V10-8	V11-8	V12-8	V9-8
The Blacker the Berry	V9-1	V10-1	V11-1	V12-1
Fuck Tha Police	V10-4	V11-4	V12-4	V9-4
Kim	V8-2	V5-2	V6-2	V7-2
When Will They Shoot	V5-5	V6-5	V7-5	V8-5
I Don't Like	V1-5	V2-5	V3-5	V4-5
Kill Shot	V5-1	V6-1	V7-1	V8-1
Go to Sleep	V4-6	V1-6	V2-6	V3-6
Czar	V2-4	V3-4	V4-4	V1-4
California Love	V1-1	V2-1	V3-1	V4-1
Majesty	V12-6	V9-6	V10-6	V11-6
Ballin'	V11-3	V12-3	V9-3	V10-3
Niggas in Paris	V6-8	V7-8	V8-8	V5-8
In Da Club	V3-3	V4-3	V1-3	V2-3
Venom	V6-4	V7-4	V8-4	V5-4
Bussiness	V2-8	V3-8	V4-8	V1-8
Still Ballin'	V12-2	V9-2	V10-2	V11-2
Gucci Gang	V1-9, V5-9, V9-9	V2-9, V6-9, V10-9	V3-9, V7-9, V11-9	V4-9, V8-9, V12-9
Brain Damage	V1-10, V5-10, V9-10	V2-10, V6-10, V10-10	V3-10, V7-10, V11-10	V4-10, V8-10, V12-10

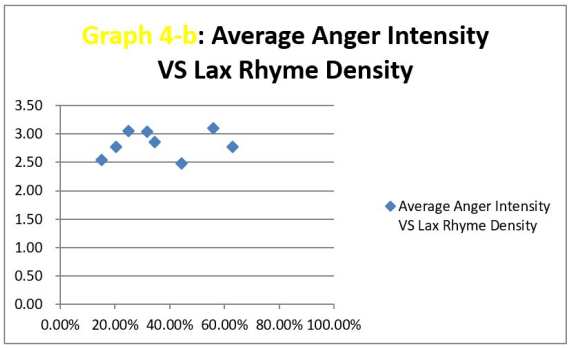
Table 1 Song and Vocal Data

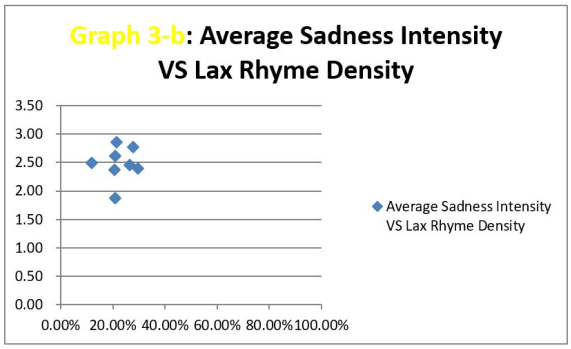


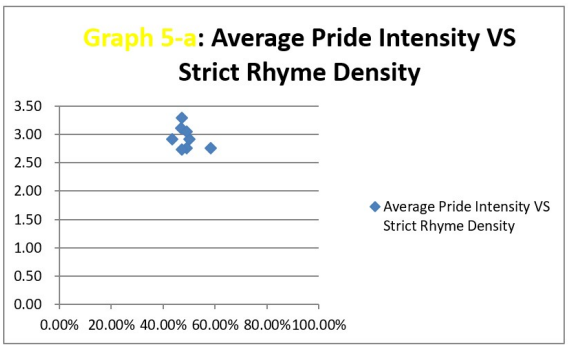
Density), the points are distributed randomly with an average sadness intensity ranging from 2 to 3. While there might be a visual suggestion of a linear relationship, the calculated R^2 value of 0.04 indicates that there is virtually no correlation, reinforcing the lack of relationship. Similarly, in Graph 3-b (Average Sadness Intensity vs. Lax Rhyme Density), the data points cluster between 10% and 30% rhyme density, exhibiting a varied emotional intensity ranging from 1.75 to 3. This random distribution further suggests the absence of any significant statistical trends. Overall, both graphs indicate that there is no meaningful relationship between Average Sadness Intensity and the two types of rhyme density.

For Graph 4-a (Average Anger Intensity vs. Strict Rhyme Density), the plot suggests a potential linear relationship; however, the R^2 value of 0.01 indicates that only 1% of the variance in Average Anger Intensity is explained by Strict Rhyme Density, demonstrating a negligible correlation. In contrast, Graph





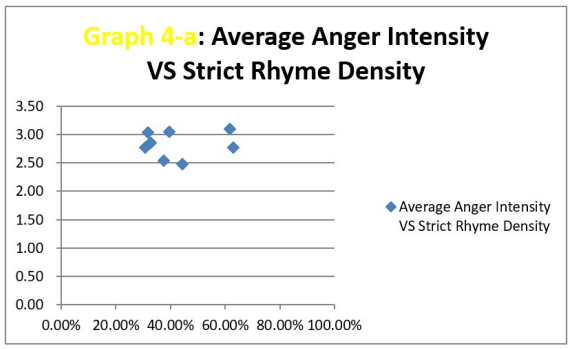


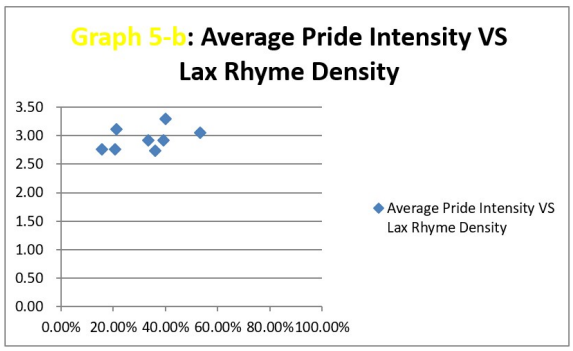


4-b (Average Anger Intensity vs. Lax Rhyme Density) displays a curvy trend that appears indicative of a polynomial distribution with an odd power. The cubic polynomial regression results in an R^2 of 0.271, suggesting a moderate fit; however, the explanation of variance remains limited. Importantly, there is no theoretical framework or empirical evidence supporting the use of a complex third-power polynomial regression in this context, rendering the findings in Graph 4-b statistically insignificant. Overall, while Graph 4-b presents a more complex trend, neither graph provides strong evidence for a significant relationship between Average Anger Intensity and rhyme density.

In Graph 5-a (Average Pride Intensity vs. Strict Rhyme Density), all data points cluster between a rhyme density of 40% to 60% and an emotional intensity ranging from 2.5 to 3.5. This tight clustering suggests no discernible trend, indicating that further statistical analysis is unnecessary. In Graph 5-b (Average Pride Intensity vs. Lax Rhyme Density), there appears to be a linear trend; however, the R^2 value of only 0.175 indicates that just 17.5% of the variance in Average Pride Intensity is explained by Lax Rhyme Density. This limited explanation further supports the conclusion that there is no significant relationship between Average Pride Intensity and the two types of rhyme density.

In each of the scatter plots, both linear regression and nonlinear regression (including power regression for Figures 2 and 3) were applied to explore potential relationships between rhyme density and emotional intensity. However, the R^2 values from both the linear regression and power regression consistently remained below 0.3 across all graphs. This suggests that no clear direct relationship exists between rhyme density and emotional





intensity.

If any other non-linear relationships were present in the data, they should have been captured by polynomial regression. Polynomial regression can represent the Taylor expansion of a more complex non-linear relationship. If such a relationship existed, the polynomial regression would show a significant improvement in the model fit, reflected in a higher R^2 value. However, despite applying polynomial regression, the R^2 values did not substantially increase, further supporting the conclusion that there is no clear or strong non-linear relationship between rhyme density and emotional intensity.

Conclusion

The study investigated the relationship between rhyme density and emotional intensity in rap music, focusing on the emotions of sadness, anger, and pride. Our findings revealed that rhyme density did not exhibit a clear correlation with the perceived emotional intensity of the songs, regardless of whether strict or lax rhyme-counting systems were applied. The emotional intensity ratings for all three categories—sadness, anger, and pride—remained consistent across different rhyme densities, suggesting that other factors, such as flow and musical composition, may play a more significant role in shaping the emotional experience of listeners.

This research contributes to the growing body of knowledge on emotional perception in music, specifically within the context of rap. While rhyme density has been shown to influence emotional engagement in poetry (Obermeier et al., 2013)[3], this study challenges the assumption that the same holds true for rap music. The results suggest that the complex interplay of rhythm, flow, and cultural stereotypes may overshadow the impact of rhyme density in influencing emotional intensity. These findings provide a nuanced understanding of how rhyme works within the broader framework of rap, highlighting the need for further research into the role of vocal traits, rhythm, and audience perception in music's emotional impact.

The primary objective of the study was to determine whether rhyme density could serve as a predictor of emotional intensity in rap music. While the hypothesis was not fully supported, the findings suggest that rhyme density alone may not be a significant determinant of emotional perception in rap. This raises important questions about the multifaceted nature of rap music and its emotional complexities. The study's exploration of rhyme density in isolation has provided valuable insights, but also points to the need for a more holistic approach that considers various musical and lyrical elements in combination.

Future research should consider incorporating a broader range of musical features, such as rhythm, vocal delivery, and instrumental composition, to gain a more comprehensive understanding of how emotions are conveyed in rap music. Additionally, a more detailed exploration of the relationship between rhyme types—such as rhyme chains, stress patterns, and rhyme by position—could provide deeper insights into how these features influence emotional responses. It would also be beneficial to expand the participant pool to include listeners from diverse cultural backgrounds, as cultural influences may significantly shape the emotional interpretation of rap music. Finally, exploring the impact of listener familiarity with rap culture and its lyrical themes may help clarify the role of stereotypes in shaping emotional perception.

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12 Eminem, *Brain Damage [Song]. On The Slim Shady LP*.

Appendix: Selected lyrics and rhyme count

In this section, colors are randomly assigned to each song, and syllables that are labeled with the same color within a song are rhymed. All lyrics are pasted from QQ music. The coloring of each song reveals only the number of strict rhyme, yet the results of both types of counting system are presented.

Sadness

1. Beautiful Eminem
I think I'm starting to lose my sense of humor
Everything so tenseand gloom
I almost feel like Igotta check the temperature
Of the room just as soon as
Strict:16/37
Lax:11/37

2. Like Toy Soldiers Eminem
And even though the battle was won I feel like we lost it
I spent so much energy on it honestly I'm exhausted
And I'm so caught in it I almost feel I'm the one who caused it
This ain't what I'm in hip-hop for it's not why I got in it
Strict: 22/63
Lax: 13/63

3. Time NF
And I know I make you feel like you're at the end of your road
That's when I look at you and tell you I'd be better alone
Just the pride talking isn't it 'cause both of us know
I'm the definition of wreck if you look into my soul
Strict: 23/48
Lax: 10/48

4. Kurt Kobain Proof
My hearts melting, tell the truth, I need help man
My hearts big but my sins bigger
Fuck the world, I don't feel like I can win niggas
It's like I'm lost and I find only demons
Strict: 21/42
Lax: 9/42

5. So Many tears 2Pac
Lord knows I tried been a witness to homicide
Seen drive by taking lives little kids die
Wonder why as I walk by
Broken-hearted as I glance at the chalk line getting high
Strict: 21/41
Lax: 15/41

6. You Never Know Immortal Technique
Got to the point when I was either with her or my crew
So I decided one day to tell her my feelings was true
I couldn't live without her so I told he rfacing my fears
But honey's only response was a face full of tears
Strict: 12/51
Lax: 6/51

7. Suicidal Thoughts The Notorious B.I.G.
All my life I been considered as the worst
Lyin' to my mother even stealin' out her purse
Crime after crime from drugs to extortion
I know my mother wished she got a fucking abortion
Strict: 16/43
Lax: 12/43

8. Dance With the Devil Immortal Technique
Dance forever with the devil on a cold cell block
'But that's what happen when you rape murder and sell rock
Devil used to be gods and angels fell from the top
There's no diversity because we're burning in the melting pot
Strict: 20/48
Lax: 10/48

Anger Rap

1. Kill Shot Eminem
Kill shot I will not fail I'm with the Doc still
But this idiot's boss pops pills and tells him he's got skills
But Kells tell the day you put out a hit's the day Diddy admits
That he put the hit out that got Pac kill

Strict: 29/46
Lax: 29/46

2. The Blacker the Berry Kendrick Lamar
I'm the biggest hypocrite in two thousand fifteen
Once I finish this witness will convey just what I mean
Been feeling this way since I was sixteen came to my senses
You never liked us anyway fuck your friendship I meant it
Strict: 18/52
Lax: 17/52

3. Fuck Tha Police NWA
Fuck the police commin' straight from the underground
A young nigger got it bad 'cause I am brown
And not the other color some police think
They have the authority to kill a minority
Strict: 14/44
Lax: 14/44

4. Kim Eminem
You really fucked me Kim you really did a number onme
Never knew me cheating on you would come back to haunt me
But we was kids then Kim I was only eighteen
That was years ago I thought we wiped the slate clean
Strict: 19/48
Lax: 12/48

5. When Will They Shoot Ice Cube
Doin us wrong from the first day
And don't understand why a nigga got an AK
Callin me an African American
Like everything is fair again shit
Strict: 12/39
Lax: 8/39

6. I Don't Like Chief Keef
Broski got thirty he ain't trynna fight
Got your bitch I was in it all night
Fredo in the cut that's scary sight
You not with the six you can die tonight
Strict: 15/40
Lax: 6/40

7. Go to sleep Eminem/DMX/Obie Trice
Sufficient enough 'cause we are just gonna be
Enemies as long as we breathe I don't ever see
Either of us comin' to terms where we can agree
There ain't gonna be no reason speak'in with me
Strict: 20/45
Lax: 20/45

8. Czar Busta Rhymes/M.O.P.
Take this loss all day sauce
Take chains off uh everything off uh
Take it all in her mouth and make the stray cough
Cocaine boss all day loss
Strict: 21/34
Lax: 19/34

Pride rap

1.California Love Dre/2Pac
Out on bail fresh out of jail California dreamin'
Soon as I step on the scene I'm hearing hoochies screamin'
Fiendin' for money and alcohol the life of a Westside player
Where cowards die and the strong ball
Strict: 22/47
Lax: 10/47

2. Majesty Nicki Minaj/Eminem
I got the trophies and the catalogue
Just did a deal Mercedes-Benz check the catalogue
I'm buying buildings we don't buy the blogs Kyuh
The Nicki challenge when I fly to Prague
Strict: 21/42
Lax: 14/42

3. Ballin Logic
I came from nothin' to somethin' like it's nothin'
Yeah you know I doneitnah there's no discussion
Bitch I'm ballin' ballin'
I made a promise to mymama
I ma' turn these zeros into tens and commas
Strict: 25/51
Lax: 8/51

4. Niggas in Paris Jay-z/Ye
Ball so hard let's get faded
Le Meurice for like six days
Gold bottles scold models
Spilling 'Ace on my sick J(ay)'s
Ball so hard bitch behave
Strict: 17/36
Lax: 13/36

5. In Da Club 50 Cent
When I pull up out front of you see the Benz on Dubs
When I roll twenty deep it's twenty knives in the club
Niggas heard I fuck with Dre now they wanna show me love
When you sell Eminem and hoes they wanna fuck
Strict: 20/46
Lax: 18/46

6. Venom Eminem
I said knock knock let the devil in
Shotgun p-p-pellets in the felt pen
Cocked fuck around and catch a hot one
It it's evident I'm not done
V-venomous the thoughts spun
Like a web and you just caught in 'em
Strict: 26/55
Lax: 22/55

7. Business Eminem
Flow's too wet nobody close to it
Nobody says it but still everybody knows the shit
The most hated on out of all those who say they get hated on
In eighty songs and exaggerate it all so much
Strict: 24/45
Lax: 22/45

8. Still ballin' Logic/Wiz Khalifa
You salty uh I said you salty 'cause you sluggish
I made it 'causeI'm me ain't switch the image like I'm thuggish
I'm ballin' like the Nuggets they hatin' I'm like F**k it
Every shot I take I make like Kobe I'm like buckets
Strict: 28/48
Lax: 10/48

2 Songs for Tests:
Gucci Gang Lil Pump
My lean costs more than yourrent
Your mama still live in a tent
Stills langin' dope in the 'ject
Me and my grandma take meds
Strict: 14/32
Lax: 6/32

Brain Damage Eminem
These are the results of a thousand electric volts
A neck with bolt, Nurse we're losing him check the pulse
A kid who refuse to respect adults
Wore spectacles with taped frames and a freckled nose
Strict: 23/46
Lax: 14/46