

Using Generative Artificial Intelligence to Identify Themes of Basic Psychological Needs in Popular Song Lyrics

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Abstract

Music listening is a universal human behaviour, increasingly recognised for its association with well-being. The mechanisms underlying how music listening influences well-being remain unclear, especially in terms of broader motivational processes. Utilising a self-determination theory (SDT) framework, we examined the extent to which popular song lyrics represented themes of basic psychological needs (BPN). Our corpus comprised the top 10 songs of the Australian Recording Industry Association's top 100 singles chart for the period 1988–2023, resulting in 360 unique songs. Lyrics were analysed through deductive content analysis using a researcher-created application, *MuseAI*, which employs large language model platforms using custom media input. Our findings indicated the representation of all three BPNs across the pop song lyric corpus. Relatedness themes occurred at the highest frequency, followed by autonomy and competence, respectively. Need satisfaction occurred more frequently than need frustration. As these songs were those most listened to by audiences across more than three decades, our findings suggest that song lyrics frequently represent themes of BPN, which may help explain the motivational appeal of music listening. This exploratory research provides initial theoretical support for further investigation of music listening engagement utilising an SDT framework.

Keywords

music listening, well-being, self-determination theory, basic psychological needs, generative AI, large language model, song lyrics

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Introduction

Music listening has been dated to the most ancient of human societies and remains one of the most engaged with leisure activities in contemporary society (T. Schäfer et al., 2013).

Links between music listening and well-being have been well demonstrated across cultures (Boer & Fischer, 2012; Dingle et al., 2021) and age groups (Laukka, 2007; Papinczak et al., 2015; Saarikallio & Erkkilä, 2007). Music listening can lead to well-being outcomes such as an improved sense of agency (Saarikallio et al., 2020), self-esteem (Elvers et al., 2018), perceived life satisfaction (Krause et al., 2021), and connectedness with others (Granot et al., 2021; Krause et al., 2021). One of the most consistent findings to date is that music listening can promote mood regulation (e.g., Lonsdale & North, 2011). This positive experience is evident across adolescence and young adulthood and within older adult samples, where music listening is used to sustain and promote positive moods (e.g., pleasure and relaxation) and reduce negative moods (e.g., stress and anxiety), as well as to shift mood in positive directions (Laukka, 2007; Lonsdale & North, 2011; Saarikallio & Erkkilä, 2007).

Music lyrics are a highly prevalent feature of music listening that listeners actively attend to and use to construct meaning (Krause et al., 2015). Several studies have established that lyrics are a salient feature in people's minds during music listening and are a feature of music that people frequently focus on (Demetriou et al., 2018; Saarikallio & Erkkilä, 2007). A growing body of research has focused on the importance of song lyrics as indicators of emotional, societal, and cultural trends (Brand et al., 2019; DeWall et al., 2011; North et al., 2021). A computerised content analysis of 1,414 U.K. Top 5 singles examined the linguistic features within song lyrics over time, identifying several trends that act as important cultural indicators and reflect broader social and psychological trends (North et al., 2021). DeWall et al. (2011) also observed increases in lyrics that reflected self-focused and negative emotional language in a U.S. Top 10 song corpus spanning 27 years. These studies provide important societal-level examination of shifts in lyrics over time; however, contextual nuance such as metaphor, symbolism, narrative perspective, and other literary devices may have been lost.

Contextual nuance within lyrics may be important for understanding motivation for music listening as well as how music listeners connect with and interpret song lyrics. Research has begun to utilise Large Language Models (LLMs) to go beyond word frequency to classify psychological themes in song lyrics (e.g., self-esteem, self-control, seeking to belong, and seeking recognition; Smith et al., 2024). Smith and colleagues evaluated whether LLMs alongside human coders could identify psychological meaning in a corpus of 260 song lyrics, with results indicating that the LLM was able to draw on contextual meaning rather than keyword detection alone. These findings have important implications for future research, suggesting that LLMs may support large-scale analysis of lyrical meaning, potentially enabling deeper exploration of how lyrical content relates to psychological processes, such as those that motivate music listening behaviour.

A Theory of How: Self-Determination Theory and Basic Psychological Needs

The mechanisms underlying *how* music listening leads to improved well-being remain theoretically underdeveloped. Various models have been proposed that typically focus on how music listening might lead to specific outcomes, such as improved self-esteem or mood regulation. For example, the Uses and Gratifications (Katz et al., 1973) model has been applied to music listening (see Lonsdale & North, 2011), which considers how people actively use music listening to satisfy needs. While these studies have been informative in identifying well-being as a motivator for music listening, the Uses and Gratifications model has ultimately been limited in its ability to explain how media use *leads* to improved well-being.

Self-determination theory (SDT; Ryan & Deci, 2017) posits that well-being is driven by the satisfaction of three basic psychological needs (BPNs). These are the need for *autonomy*, defined as volition over one's choices; *competence* through mastery over tasks; and *relatedness* through feeling connected to others. A substantive literature of more than 50 years of quantitative, qualitative and meta-analytic research supports the notion that these three BPNs underpin well-being outcomes (Vansteenkiste et al., 2020). As an empirically supported theory of human motivation and well-being, SDT offers a potentially insightful model for explaining a wide range of well-being outcomes linked to music listening. For instance, an improved sense of agency (Saarikallio et al., 2020) may reflect a component of autonomy satisfaction. Similarly, improved sense of belonging (Granot et al., 2021; Krause et al., 2021) and self-efficacy (Gupta & Singh, 2020) may reflect needs for relatedness and competence satisfaction, respectively.

SDT is particularly suited to investigating well-being in media forms used for leisure, as motivation for media use is said to stem from its ability to satisfy our BPN (Rigby & Ryan, 2017). For example, Ryan and colleagues (2006) found that motivation for video gaming was largely predicted by a game's ability to satisfy a player's BPN. Other research has also found that specific contextual gaming features, such as multiplayer options and improved control interfaces, lead to increased relatedness and competence satisfaction, respectively (Tamborini et al., 2010). Need satisfaction through these active forms of media engagement has been shown to increase short-term well-being in the form of positive affect and vitality (Ryan et al., 2006).

Engagement with other forms of media has similarly been linked to improved well-being through the satisfaction of BPN. Rigby and Ryan (2017) found that when watching television, empathising and identifying with on-screen characters allowed viewers to vicariously satisfy their own BPN by immersing themselves in the fictional experiences and perceived emotions. Given that music listening is similarly passive, it may be that music listening operates under a similar mechanism. In other words, it may be that music listening offers the capacity to vicariously influence BPN through identification with song lyrics.

Past research on music lyric content has indicated themes that are suggestive of BPN. Content analyses of pop song lyrics in the United States and Germany showed dominant themes of love and relationships (Christenson et al., 2019; Ruth, 2019), which parallel the needs for relatedness. Similarly, themes of freedom, identity, and wealth/status found in pop song lyrics (Christenson et al., 2019; Kohno et al., 2019) may broadly mirror the needs for competence and autonomy. Despite these parallels, to our knowledge, this is the first study to explicitly investigate the presence of BPN in music lyrics. Such research is required to further our understanding of *how* the contents of lyrics might play a role in linking motivations for music listening to well-being. Accordingly, we aimed to address this gap in the literature by examining the extent to which popular song lyrics represent themes of BPN: autonomy, relatedness, and competence.

The questions guiding our research were (1) do popular song lyrics represent themes of satisfied or frustrated BPNs, (2) if so, what are the relative frequencies of BPN themes across popular song lyrics, and (3) if present, do BPN themes change over time?

The present study also sought to make a methodological contribution through the application of a novel analytic tool, *MuseAI*. *MuseAI* is a purpose-built application that utilises a graphical user interface (GUI) to allow integration with a range of LLMs (i.e., ChatGPT) to support theory-driven deductive content analysis. *MuseAI* allows for the structuring and testing of customised prompts, easy parsing of large data, standardising coding decisions, and recording model outputs, thereby enabling the systematic analysis of large lyrical corpora.

Method

Song Lyric Corpus

Popular (pop) music was chosen for the corpus, as it represents music that, by definition, is engaged with by a large number of listeners (Moore, 2003). In line with previous research, pop music was defined according to the highest record sales and streaming activities, rather than a specific musical style (Buda, 2012). The pop “genre” is not monolithic and consists of various musical styles such as rap, rock, soul, and R&B (Thornton, 1996).

Specific songs were operationalised using data from the Australian Recording Industry Association’s (ARIA) “Top 100 Singles” Charts, as these charts are calculated on the highest music sales and streaming activities within Australia each year (ARIA, n.d.). The ARIA was selected due to its extensive chart records and consensus in recent decades as the official Australian pop music chart (Hughes et al., 2013). These charts are funded by major recording companies, allowing for resources that provide a higher level of chart research (Lowe, 2008). In addition, ARIA undertakes a rigorous weighting process in its chart calculations to ensure that retail sales and streaming activities are accurately represented (ARIA, n.d.).

Data Collection

The data collection process began with the identification of the top 10 songs from ARIA’s “Top 100 Singles” charts from 1988 to 2023 (inclusive). This information was accessed online through ARIA’s official website. Data for song titles, artist names, and chart years were collated into spreadsheets, beginning from the Number 1 to Number 10 positions on each chart. We identified seven songs that appeared across multiple chart years. In these instances, the next most popular song from the more recent chart was included. This approach was used to reduce redundancies in our analyses and increase the diversity of lyrics being analysed. The data collection process stopped when information for 360 unique songs was obtained. A 36-year period was chosen to allow for a more holistic analysis of pop music, as lyrical themes in pop music have been found to vary across time (Christenson et al., 2019). A representative of ARIA also confirmed that the earliest and latest chart records available were 1988 and 2023, respectively.

A total of 344 song lyrics were obtained online from a public website that provides a database of popular music lyrics (AZLyrics.com, n.d.). This database was utilised, as it has an extensive collection and has frequently been used in previous research (North et al., 2021). Despite the extensive collection, secondary databases were required for 16 songs that could not be located on the primary database. A total of eight songs were identified as having lyrics in primarily a foreign language, seven in Spanish, and one in Korean. Following discussion by our research team, consensus was that these songs should be removed from the dataset to maintain the integrity with respect to the reliability of the analysis. In these eight instances, the next most popular song from the same chart year was utilised in its place. A database of all lyrics in plain text was created as the primary input for content analysis. The full list of songs included in the analysis and the associated BPN coding is provided in the supplementary materials (Supplementary File S1).

Research Approach

A deductive theory-driven content analysis was used to determine whether BPN were present in the 360 song lyrics. A deductive approach was deemed most appropriate for this study, as it allowed for theory testing of SDT in relation to music listening. Specifically, autonomy, competence, and relatedness definitions informed the categories under investigation. Descriptive

trends were identified based on deductive content analysis. Chi-square tests were then conducted to determine whether there were differences in the frequencies of satisfied and frustrated need states, as well as whether certain BPN occurred more frequently across the corpus than others.

Data Analysis Tools

Research shows that when prompted accurately, LLMs are an effective tool for conducting deductive content analyses (Siiman et al., 2023), as they can systematically code large amounts of datasets and be trained to accurately understand clusters, themes, and context (Nguyen-Trung, 2024). For this reason, and given the large corpus of lyrics analysed, we used an LLM to efficiently evaluate the content for thematic patterns. We worked with an experienced software engineer to develop a web-based application (*MuseAI*) with a GUI. MuseAI allowed rapid generation, saving and dynamic testing of prompts to drive thematic analysis for the entire lyric corpus. MuseAI also facilitated sample thematic analysis across a variety of LLMs to test for reliability. Prompt text was concatenated with song lyrics and sent to LLMs via public service API. Responses were then presented via the GUI output screen and saved to local spreadsheets. MuseAI was developed to ensure a rigorous and reproducible process that could not be achieved through a standard LLM interface. The application allowed for batch processing of hundreds of songs simultaneously while applying a consistent and locked prompt across all lyrics. In addition, automatic logging of prompts and outputs supported transparency and reproducibility in thematic coding procedures. Although MuseAI is not currently publicly available, development is ongoing, and the research team intends to release it as a research tool in future studies.

As recommended in previous thematic research (Nguyen-Trung, 2024), we tested several LLMs, including ChatGPT 3.5 Turbo, ChatGPT-4, and Gemini 1.5 Pro, for consistency of testing and analysis. ChatGPT 3.5 Turbo provided the most reliable and consistent analysis (OpenAI, n.d.). As an LLM, ChatGPT generates humanlike text responses to queries or “prompts” (OpenAI, n.d.) and has been demonstrated to outperform humans on complex language-related tasks (Brown et al., 2020).

LLM Prompt Engineering

Research shows that a clear and detailed input prompt is pivotal to the production of reliable, high-quality output from LLMs (Zhang et al., 2024). Accordingly, we employed an iterative prompt engineering process that involved comparing the consistencies of output produced by different prompts across LLMs and found ChatGPT to be the most consistent and effective LLM. Techniques suggested for enhancing the quality of LLM prompts were also implemented (Zhang et al., 2024). For example, role prompting was used to assign the LLM the position of “qualitative researcher” and to provide greater context for its analyses. We also specified a structure for the required output and used polite wording to improve the LLM’s learning environment. Finally, we requested that the LLM provide a rationale for its responses to increase transparency of analyses. The prompt engineering process stopped when the input prompt yielded consistent responses for the same songs across multiple trials, provided output in the specified format, and gave comprehensive and logical rationales for its responses.

The final prompt began with a definition of the six BPN states. The option for “no theme” was also specified, and the LLM demonstrated the ability to yield this option during multiple tests in the prompt engineering phase. The LLM was then asked to identify whether the following song lyrics indicated the presence of any need states.

Table 1. Prompt Definitions.

Need theme	Definition
Autonomy satisfaction (AS)	is defined as the ability to act and express oneself in a free and volitional manner in accordance with one's values and self-conceptualisation.
Autonomy frustration (AF)	is defined as the feeling that one must behave or express oneself in accordance with external or self-imposed pressures and obligations.
Competence satisfaction (CS)	is defined as exploring one's environment to develop skills; feeling effective, confident, and capable of achieving one's goals; and feeling a sense of mastery in physical and social contexts.
Competence frustration (CF)	is defined as doubting one's abilities or experiencing a sense of failure or helplessness.
Relatedness satisfaction (RS)	is defined as experiencing social connection and intimacy with others and feeling a sense of belonging in relationships with others.
Relatedness frustration (RF)	is defined as the absence of a genuine connection with important individuals in one's life and experiencing a sense of exclusion and loneliness.
No theme (NT)	represents an absence of any of the AS, AF, CS, CF, RS, and RF themes.

Note. These definitions underwent quality review by a member of the research team with expertise in SDT and well-being to ensure that the need states were accurately and sufficiently represented.

LLM Prompt Definitions

Basic Psychological Needs. To test for the presence of BPN in song lyrics, the prompt included definitions of BPN derived from the widely used Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS; Chen et al., 2015). The BPNSFS consists of 24 items categorised into six subscales describing autonomy, competence, and relatedness, with items for both satisfaction and frustration. Due to the prolific use of the BPNSFS and its primary utility as a self-report measure, we summarised the BPN definitions to increase the clarity of the input prompt. In alignment with the BPNSFS, the definitions presented in Table 1 were provided to ChatGPT.

Interrater Reliability

To assess the level of agreement between ChatGPT and humans in the analysis of song lyrics, interrater reliability was conducted on a selection of 11 randomly selected songs from the corpus. Four of the authors individually coded 11 Number 1 songs from the ARIA charts from 2012 to 2022 (inclusive). The human coders were given a protocol sheet containing instructions and the same definitions of the need states derived from the BPNSF to aid with their analyses of the lyrics. Cohen's kappa was used as a measure for examining interrater reliability, as it is more sensitive than percentage agreement, as it considers potential chance categorisation of nominal findings between raters (McHugh, 2012). Agreement between human raters and the LLM for the 11 analysed songs indicated near-perfect agreement ($\kappa = .87$; Landis & Koch, 1977).

Results

All 360 song lyrics were coded as having a dominant theme of autonomy, competence, or relatedness. No song was coded as having "no theme." The frequencies of BPN states across the corpus were assessed based on their relative presence across the corpus. As can be seen in Table 2, songs with need satisfaction themes (65.8%) were almost twice as prevalent as need frustration (34.2%).

Table 2. Frequencies of BPN Themes (Autonomy, Competence, and Relatedness) and Need States (Satisfaction and Frustration) in Pop Song Lyrics.

BPN theme	Frequency	% of Corpus
Autonomy	56	15.6
Satisfaction	32	8.9
Frustration	24	6.7
Competence	41	11.4
Satisfaction	33	9.2
Frustration	8	2.2
Relatedness	263	73.1
Satisfaction	172	47.8
Frustration	91	25.3
Satisfaction	237	65.8
Frustration	123	34.2

Note. Frequencies represent the number of times each BPN was coded as the dominant theme for a song.

Relatedness themes were coded for most frequently (73.1%) across the corpus. Relatedness satisfaction (47.8%) had the highest prevalence of all need states, followed by relatedness frustration (25.3%). Autonomy was the second most frequent theme (15.6%), with a higher prevalence of autonomy satisfaction (8.9%) than autonomy frustration (6.7%). Competence was coded for least frequently (11.4%) across the corpus, with competence satisfaction (9.2%) coded for more frequently than competence frustration (2.2%).

Illustrative LLM Coding by Need State

Table 3 includes direct excerpts of the LLM coding output, showing how the model reasoned through the classification of lyrics into satisfied or frustrated need states.

Relatedness Satisfaction

Lyrics referencing intimate connections in a romantic context were coded as Relatedness satisfaction. For example, in Leona Lewis' (2008) song "Bleeding Love," the LLM reasoned that the lyrics "found something true . . . there is nothing greater than . . . your embrace" depict a deep emotional and physical connection between the singer and their significant other. Songs that referenced connections to family and friends were also coded as Relatedness satisfaction. For example, in Ed Sheeran's (2017) song "Castle on the Hill," the LLM quoted the lyrics "I can't wait to go home . . . these people raised me" as an example of the singer's deep sense of belonging felt with those in his hometown.

A small number of songs referencing connections to place, the self, and religion were also coded by ChatGPT as Relatedness satisfaction. For example, in the Red Hot Chilli Peppers' (1992) song "Under the Bridge," ChatGPT explained that the lyrics reflect a deep connection and love that the singers have for their city. This is demonstrated through the lyrics "at least I have her love, The city, she loves me . . . Lonely as I am together we cry." Lastly, connections to religion were demonstrated in Mary Mary's (2000) song "Shackles (Praise You)." According to ChatGPT, the lyrics "You [God] broke the chains now I can lift my hands" indicate the singers' closeness and sense of gratitude felt towards God for liberating them from difficult circumstances.

Table 3. Illustrative Thematic Coding of Lyrics by MuseAI.

Song title (artist)	Summary of the overall message	Dominant theme	Illustrative lyrics
Flowers (Miley Cyrus)	The overall message of the song is about self-love and empowerment. The lyrics convey a sense of independence and resilience after a relationship has ended. The singer acknowledges the pain of leaving someone they cared about but ultimately realises that they can love themselves better than anyone else can.	AS	– "I can buy myself flowers," – "Talk to myself for hours," – "I can hold my own hand"
Anti-Hero (Taylor Swift)	The overall message of the song seems to be about self-awareness and self-reflection, particularly in relation to one's own flaws and shortcomings. The lyrics touch on themes of depression, self-destructive behaviour, and a sense of alienation from others.	AF	– "I should not be left to my own devices" – "I end up in crisis" – "It's me, hi, I'm the problem, it's me"
Sexy and I Know It (LMFAO)	The overall message of the song is about self-confidence and feeling good about oneself. The lyrics emphasise the singer's physical appearance and how they are proud of their body.	CS	– "I got passion in my pants and I ain't afraid to show it" – "I'm sexy and I know it"
It's Like That (Run DMC Vs. Jason Nevins)	The overall message of the song seems to focus on the harsh realities of life, including economic struggles, social injustices, and the importance of education and self-improvement. The lyrics highlight the challenges people face in trying to make ends meet, the impact of money on one's life, the presence of wars and violence, and the need for unity and understanding.	CF	– "Bills rise higher every day, We receive much lower pay, I'd rather stay young, go out and play" – "You should have gone to school, you could've learned a trade, But you laid in the bed where the bums have laid"
All of Me (John Legend)	The overall message of the song seems to be about unconditional love and acceptance. The lyrics express a deep connection between two individuals, highlighting their imperfections and vulnerabilities, yet still choosing to love each other wholeheartedly.	RS	– "You're my downfall, you're my muse" – "Through every mood"
Never Be Like You (Flume Feat. Kai)	The overall message of the song seems to be about regret, longing, and the pain of losing someone special. The lyrics express a sense of missing someone deeply and feeling the weight of past mistakes.	RF	– "He'll never be like you"

Relatedness Frustration

Songs coded by the LLM as reflecting relatedness frustration included lyrical references to romantic heartbreak. For example, in Flume's (2016) song "Never Be Like You," ChatGPT reasoned that the lyrics "he'll never be you" emphasise the singer's yearning and regret for a connection now lost. Lyrics referencing isolation from friends and family were also coded as relatedness frustration. For example, in Kelly Rowland's (2003) song "Stole," the LLM reasoned that the overall song message centres around the impact of loneliness and isolation. The LLM indicated that this was reflected through the lyrics "he wasn't welcome . . . Some guys were puttin' him down, bull-yin' him round." References to isolation from family were also evident in the song "Cats in the Cradle" by Ugly Kid Joe (1993). According to ChatGPT, the lyrics "When you comin' home? . . . Son, I don't know" reflect a father's remorse for being absent from his son's life.

Autonomy Satisfaction

Lyrics that referenced independence and self-reliance were coded by the LLM as autonomy satisfaction. For example, in Miley Cyrus' (2023) song "Flowers," the LLM quoted the lyrics "I can buy myself flowers, write my name in the sand" as an example of the singer's ability to provide for herself without a romantic partner. Autonomy satisfaction was also reflected in songs referencing freedom from societal pressures. For example, in Katy Perry's (2008) song "I Kissed a Girl," the LLM reported that autonomy satisfaction was evidenced through the singer's willingness to experiment with her identity, despite this not being "what girls do."

Autonomy Frustration

Songs that referenced a loss of control were coded by the LLM as autonomy frustration. For example, in Taylor Swift's (2023) song "Anti-Hero," the LLM explained that autonomy frustration was reflected in the singer's reluctance to trust herself in fear of falling into self-destructive patterns. This was indicated through the lyrics "I should not be left to my own devices . . . I end up in crisis."

Autonomy frustration songs also made references to desires for freedom, such as in Hozier's (2015) song "Take me to Church." According to the LLM, the lyrics "my church offers no absolutes" suggest a sense of disillusionment and a desire for greater freedoms from traditional practices.

Competence Satisfaction

Songs coded as competence satisfaction included references to self-confidence, such as in LMFAO's (2011) song "Sexy and I Know it." According to ChatGPT, the lyrics "when I walk on by, girls be looking like 'damn, he fly'" convey competence satisfaction through the singer's self-confidence in physical appearance and ability to attract female attention. Competence satisfaction was also demonstrated in songs referencing material wealth, such as in Post Malone's (2018) song "Psycho." According to the LLM, the lyrics "got diamonds by the boatload" highlight the singer's sense of accomplishment and pride in his ability to acquire luxury items.

Competence Frustration

Songs that referenced feelings of helplessness were coded as competence frustration, such as in Run DMC Vs. Jason Nevins' (1998) song "It's Like That." According to the LLM, the lyrics "bills rise higher every day . . . You should have gone to school" illustrate the singer's sense of inadequacy and frustration in dealing with their difficult financial circumstances.

Table 4. Basic Psychological Need (BPN) Themes Across Time (1988–2023).

Year	Autonomy	Competence	Relatedness
2020–2023	8	5	27
2010–2019	21	11	68
2000–2009	17	11	72
1990–1999	10	14	76
1988–1989	0	0	15
Frequency	56	41	263

Note. Data for 2020–2023 are presented for descriptive purposes only and were excluded from chi-square analysis due to representing an incomplete decade.

Differences in Frequencies Between BPN

A chi-square goodness-of-fit test was conducted to determine whether the frequencies of autonomy, competence, and relatedness significantly varied from equal distribution. The results indicated a difference between the three groups, $\chi^2(2, N=360)=256.55, p<.001$. Post hoc tests were conducted to examine where these significant differences were located. This involved comparing three group pairs (e.g., autonomy vs. competence) individually using chi-square tests. Given multiple comparisons, Bonferroni’s correction was used, resulting in an adjusted significance threshold of .017. Differences were found when comparing relatedness to competence and when comparing relatedness to autonomy (all $ps<.017$). No differences were found between autonomy and competence. A chi-square test also found that satisfaction themes occurred more than frustration themes across the corpus, $\chi^2(1, N=360)=36.10, p<.0001$.

Changes in BPN Across Time

Summary data for changes in BPN themes across time are presented in Table 4. Data for 2020–2023 were excluded from inferential analysis, as this period represents an incomplete decade and is reported for descriptive purposes only. A chi-square analysis indicated no significant differences between the themes across time, $\chi^2(6, N=315)=10.76, p=.096$. Although nonsignificant, autonomy themes demonstrate a gradual increase over the time periods examined.

Discussion

This study used a novel researcher-designed, LLM-driven application to examine the extent to which popular song lyrics contain representations of BPN themes. The questions guiding our research were as follows: (1) Do popular song lyrics represent themes of satisfied or frustrated BPN? (2) If so, what are the relative frequencies of BPN themes across popular song lyrics? (3) If present, do BPN themes change over time?

We found that all three BPN were represented across the corpus, with satisfaction themes occurring significantly more frequently in pop song lyrics than need frustration. Although preliminary, these findings align with those of Rigby and Ryan (2017), who asserted that need satisfaction is a key motivator for entertainment media use. This is potentially because engagement with need satisfaction themes allows for vicarious satisfaction of a consumer’s own BPN (Rigby & Ryan, 2017). However, this does not explain why need frustration themes were also present in the lyrics, albeit less frequently. As noted by Oliver (2008), some media forms present sentiments that are antithetical to positive experiences, yet audiences are still motivated to engage with these media. It

is possible that people find these narratives “inspirational” as they empathise with the negative sentiments and experiences depicted. People may use music listening to feel understood and accepted when experiencing troubles and sadness, a suggestion that is supported by Levy and colleagues (2024) as well as through the “solace” component of the Mood Regulation by Music model (Saarikallio & Erkkilä, 2007).

Taken together, findings regarding the presence of BPN themes in all of the songs analysed suggest that immersion in lyrics with need satisfaction themes may be motivated by vicarious need satisfaction, as the transfer of these need states may be more direct. The experience of listening and empathy through identification with need frustration lyrics when listeners desire solace and understanding in their personal challenges may also be a factor motivating popular music listening.

Indeed, past research has supported the notion that vicarious need satisfaction can occur through entertainment media, which leads to short-term increases in well-being, such as improved mood and vitality (Ryan et al., 2006). Accordingly, need satisfaction when attending to music lyrics may underlie at least part of the link between music listening and improved well-being. Further research examining listeners’ subjective perceptions of need satisfaction through music listening is required to tease apart and clarify these links. Further research should examine the impact of processing when lyrics of varying BPN themes are attended to, whether or not the listener is consciously aware of the lyrics.

The high prevalence of relatedness aligns with earlier findings of romantic love and friendship being dominant topics reflected in Western pop lyrics (Christenson et al., 2019; Ruth, 2019). Relatedness was characterised through lyrics depicting human-to-human connections as well as more abstract concepts such as connections to place and religion. The dominance of relatedness supports the notion that humans express the desire for interpersonal connection at a greater rate than other needs (Baumeister & Leary, 1995). Indeed, evolutionary perspectives have long posited that humans are inherently social creatures who have used music to reinforce social bonds, communicate emotions to others and coordinate group activities (Panksepp & Bernatzky, 2002). Accordingly, traditional uses of music for social connection may be culturally ingrained, leading to an intentional or subconscious use of music to vicariously fulfil relatedness needs.

Relatedness songs may also provide listeners with a proxy for interpersonal communication. Aligning with K. Schäfer and Eerola’s (2020) idea of “social surrogacy,” numerous studies highlight the ability of music listening to act as a temporary substitute for direct social interaction. For instance, Krause and colleagues (2021) found that the conversational-style narratives of popular song lyrics could reduce listener loneliness by mimicking the presence of singers. Granot and colleagues (2021) similarly found that listeners could experience music as a virtual person due to its ability to arouse and express movements and emotions.

The second most prevalent theme across the corpus was autonomy and included lyrical references to independence, self-reliance and loss of personal control. When examined across years, our results demonstrated a nonsignificant yet interesting steady increase in the number of autonomy-themed songs, which may be explained by the changing public discourse in Western cultures. This finding reflects the trend that as societies evolve and taboo topics become increasingly destigmatised, artists find that they have increasing scope to express their identity and personal values through song lyrics. For example, the lyrics in Katy Perry’s (2008) “I Kissed a Girl” focus on a protagonist’s experience of volitionally kissing someone of the same sex. As noted by Wadley (2014), nonheterosexual identities have become more prevalent in Western media as the legalisation of same-sex marriages has become more widespread. Expressions of autonomy in the corpus also coincide with a rise in feminist ideology in Western societies (Rottenberg, 2013), such as in Miley Cyrus’ (2023) “Flowers,” which centres around female independence and empowerment. Accordingly, autonomy may be a relevant theme to well-being because an individual’s freedoms

and choices are constantly being affected by the cultural changes around them, reinforcing the production and relevance of autonomy themes in pop songs.

The least prevalent theme across the corpus was competence, which included lyrical references to self-confidence and helplessness. The lack of competence-themed songs may be explained by overlap with other needs that were more central to a song. Indeed, SDT suggests that needs are highly interconnected (Ryan & Deci, 2017). A very small number of construct overlaps were evident during the hand-coding process of song lyrics, with issues of consensus between our human coders being primarily focused on competence. As SDT theory would predict, BPN measures have often found competence to be correlated with autonomy and relatedness (Van den Broeck et al., 2016). While care was taken in how BPNs were defined within the prompt, this highlights the possibility that competence themes may have been overshadowed and thus coded as autonomy or relatedness. Another explanation is that people may prefer to seek competence satisfaction through engagement in less passive activities. For example, numerous studies highlight the utility of physical sport for increased competence perceptions (Fransen et al., 2018; Zanatta et al., 2018). Accordingly, music listening may not be a preferred or optimal means for satisfying competence needs, therefore leading to less demand and popularity of this theme in pop music lyrics.

Another possible explanation for this finding may relate to genre effects in the corpus. As noted by Kwon et al. (2021), top-charting music tends to be dominated by pop, contemporary, R&B, and hip-hop music. Previous research in hip-hop and R&B demonstrates negative and emotionally intense themes in song lyrics, whereas pop is often characterised by relational themes (Brand et al., 2019; Kwon et al., 2021). Therefore, the lower representation of competence themes may not reflect an absence of competence in music more broadly but potentially the genre-based conventions of commercially charting music, which prioritise relational and emotional themes over mastery and achievement.

The representation of all three BPN in pop lyrics aligns with past assertions that BPN themes form the core ingredients of entertainment media (Rigby & Ryan, 2017). Specifically, our findings suggest that music listening may primarily be motivated by our needs for relatedness – to feel connected to others. Themes of autonomy also appear to be a moderate motivator for music listening, as the increasing prevalence of these lyrics may reflect changing societal issues important to listeners' personal lives. In contrast, competence appears to be the least critical motivator for music listening, suggesting that satisfaction of this need may be preferable or more effective through engagement in other, more active leisure behaviours. Together, these findings highlight the applicability of SDT to music listening and lay the groundwork for important research into understanding the mechanisms that link motivation for music listening to well-being.

Beyond the contributions of this research to the music listening literature, this study also contributes methodologically to demonstrating the applicability of LLMs for lyrical analysis at scale. Similar to Smith et al. (2024), the current research allowed for the exploration of contextual meaning and the representation of psychological needs in song lyrics at a scale impractical for humans. This is an important extension of previous research that has used word frequency and lexicon-based methodologies, offering a novel pathway for the examination of lyrical meaning and psychological constructs in large corpora of popular music.

Limitations and Future Directions

Given that the dataset consisted solely of English-language songs from an Australian popular music chart, caution should be exercised when generalising findings cross-culturally, as BPN themes may be expressed differently in non-English or multilingual cultures. Furthermore, as the

corpus was drawn from a popular music chart which was dominated by pop and other associated genres, other musical genres may indicate the representation of different need themes.

Given the novelty of generative AI in the academic research space, there were some limitations with its use. During the prompt engineering phase, although the chosen LLM was overall very consistent, it was noted that the other LLMs could be inconsistent in their identification of a dominant song theme. For some LLMs, this was true even when using the same input prompt to analyse the same set of song lyrics. Iterative prompt engineering ultimately yielded consistent responses across multiple trials with a select sample of songs. Indeed, we would stress that temperature, the adjustable aspect of an LLM that controls predictability versus creativity of the output, is an important consideration for researchers using some LLMs.

A methodological limitation was the potential for bias in the LLM's output. When explicitly asked to state whether it was prone to biases, the LLM was affirmative but mentioned the use of techniques to mitigate these impacts. Specifically, the LLM mentioned possible susceptibilities to gender, racial, and cultural biases, which may have influenced its interpretation of the dominant song theme. A review of output revealed only one clear instance in which gender bias may have occurred. Specifically, LMFAO's (2011) song "Sexy and I Know It" was coded as competence satisfaction, whereas Meghan Trainor's (2014) song "All About That Bass" was coded as relatedness satisfaction, despite both songs having specific references to confidence in attracting a partner (LMFAO: "When I walk on by, girls be looking like, 'Damn, he fly'"; Meghan Trainor: "Cause I got that boom boom that all the boys chase"). A potential explanation for these discrepancies is that the source of the singers' confidence differed. In "All About That Bass," the LLM argued that the singer's confidence came from her mother's reassurance that her body was perfect, whereas in "Sexy And I Know It," the singers gain their confidence from their ability to attract female attention. Researchers using LLMs for thematic analysis should be aware of the inconsistencies that can be produced both across and within generative AI platforms. Furthermore, specific attention and care must be exercised when engineering prompts to minimise variability and promote more reliable results.

To clarify the impacts of music listening on well-being, future research should examine how engagement with music lyrics influences the satisfaction or frustration of a listener's BPN in a controlled music listening task. As our study only examined the top 10 songs from each top 100 singles chart, it is unclear whether the frequency of BPN themes is similar across lower-ranked songs on the pop music charts and whether BPN themes can be tied in a meaningful way to music genre. Future research should examine songs from a variety of genres and cultural contexts to determine whether relatedness is similarly the most frequent BPN theme or whether autonomy and competence are more prevalent in this section of the charts. In other words, are relatedness-themed lyrics a consistent component of music that links music listening to well-being or does this vary by genre and cultural context?

The cross-cultural applicability of these findings should also be examined, as this study only focused on an Australian corpus with lyrics reflecting primarily Western values and ideals such as individualism. Future research should examine whether lyrics in languages other than English and non-Western contexts similarly reflect BPN themes, as past studies show some universalities in the uses of music listening, such as self-regulation and social bonding (Boer & Fischer, 2012).

Implications and Conclusion

As the use of generative AI in scientific research is still nascent, the *MuseAI* app provides researchers with a user-friendly tool for navigating the use of generative AI in other large-scale text and content analyses. The comprehensiveness of *MuseAI* allows researchers to dynamically engineer

input prompts and retrieve output data within the same application, streamlining the research process. With the enhanced coding efficacy of generative AI in qualitative research (Zhang et al., 2024), there is now a greater opportunity for advancement in research fields where the use of human coders was once too costly or time-consuming.

This research contributes to a growing literature that is seeking to understand the mechanisms that link music listening and well-being. As this understanding grows, mental health practitioners and organisations can draw on findings to develop novel interventions for promoting mental health and well-being. For example, applications might include emotion regulation apps targeted at adolescents that curate helpful and adaptive music listening for individuals in this emotionally turbulent stage of life (Miranda & Gaudreau, 2011; Saarikallio & Erkkilä, 2007). These apps could request adolescents to self-report their need states and make song recommendations targeted at improving or maintaining well-being. For example, if an adolescent reports feeling lonely or insecure, the app could recommend songs approved by listeners with relatedness satisfaction or competence satisfaction lyrics to encourage shifts towards greater feelings of connectedness and confidence. Targeted clinical interventions might harness music and its themes to promote empathic responding and, designed collaboratively, could promote autonomy implicitly.

This study utilised an SDT framework and a novel generative AI tool to examine whether popular music lyrics might contain representations of the BPN satisfaction and frustration. We found a greater prevalence of need satisfaction as opposed to need frustration themes, and although all three BPNs were present in the lyrics, relatedness satisfaction was clearly dominant. As an exploratory study, our findings suggest that expressions of relatedness, autonomy, and competence appear in song lyrics, which may reflect symbolic and culturally shared representations of our BPN. Further research is encouraged to examine how people may subjectively experience need satisfaction through music lyrics, as clarification of these links will promote a better understanding of how music listening can be used to effectively and intentionally design interventions and experiences that harness music to improve mental health and well-being.

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