The Recursive Relationship Between Personalized Music Choice and Adolescent Mental Wellness: An Empirical Study

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Summary

Music streaming services have enabled music choice to transition from a collective social listening experience to a personalized one. Our research relates the two facets of music choice when in a specific mental wellness state with the impact of the music chosen on mental wellness. Adolescents (*N* = 80) were asked the kind of music they would choose when in specific mental wellness states. They were also asked about the impact different types of music had on them. We find a recursive relationship between music choice and mental wellness state. An example is that in a sad/hurt state, we choose to listen to slow and soft music, which in turn makes us sadder. We suggest that this recursive relationship reinforced by the trend towards music personalization may exacerbate mood volatility with the possibility of pushing the listener to become excessively happy (leading to risky decisions) or excessively sad (with potential mental health challenges). We propose that developing a user-centered adaptive mobile health app that augments the listener's playlist technologically based on knowledge of their current mental state can become an important continuous mental health intervention strategy.

Keywords

Behavioral and Social Sciences; Cognitive Psychology; Music Streaming; Mental Health; Depression.

Introduction

The impact of social media apps on mental wellness is well-researched, but much less has been researched on the effects of music streaming. Music streaming on mobile phones has enabled the full spectrum of music styles to be readily available. According to IFPI, in 2022, we spent, on average, 20.1 hours per week listening to music, and the most popular method to access music was through music streaming services (24%).[1] Listeners create playlists of their favored songs, from which they choose the songs to play at a particular time based on their mental state and other variables, such as the time of day and the activity they are performing. Much literature exists on the psychological implications of listening to various kinds of music.[2-10] This study investigates a possible link between the two facets of music choice based on mental state and the impact of the music chosen on the listener's mental state. We hypothesize that there is a recursive relationship between the mental state of a listener, their preference of music given that mental state, and the impact the chosen music has on their mental wellness.

McCraty demonstrated the link between different music categories and their effects on the mental health of teenagers and adults by surveying their feelings before and after listening to four types of

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music.[2] Music has been known to improve cognitive abilities,[3] and bring out helping behavior in people.[4] Whether singing or listening to music, it impacts our mood.[5] Music has also been shown to impact us physiologically. There is evidence of decreased salivary cortisol and amylase levels, signifying stress reduction with the consumption of music.[6] Music helps in verbal memory and boosts cognitive functions.[7] Happy and sad music is also known to impact brain lateralization.[8] Musical engagements positively correlate with emotional well-being and could be used as a self-regulatory tool to manage emotions and thoughts.[9]

Music choice and appreciation, however, still needs more investigation, as they are intertwined with music structure, music-evoked autobiographical memories, and music sources, and can be a result of multiple objectives.[10, 11] Musical memory is a significant factor in music choice; and its impact on memory has been investigated.[12] When listeners chose music to trigger memories, this was negatively related to the goal of mood enhancement.[13]

The personalization of music can be characterized in three aspects –
(a) The ability to choose a song from a large set that is readily available to the listener.
(b) The ability to easily sequence the playlist of songs to be played at will.
(c) The ability to play a selected sequence to oneself without others knowing what you are hearing.

Before the availability of recording devices, music was a collective experience, heard either while participating in a group playing or singing activity or when listening to professional musicians. Indeed, music has often been thought of as a carrier of culture.[14] Vinyl records enabled a limited degree of sequencing, but it was challenging to do this easily and be the sole listener. The Sony Walkman enabled an extensive library of songs to be available to the listener, and its headphones enabled listening to transition to an individual experience. However, at-will sequencing was still difficult, even when the media moved to CDs, as it involved physical changes of a cassette or CD. While the trend towards personalization of music had begun, true personalization only started with the invention of the Apple iPod and the availability of music streaming services. For the first time, music selection could be done from an extensive library, wholly sequenced at will, and listened to individually. This level of personalization has transitioned music listening from a collective to an intensely personal experience. Today's adolescents are among the first generations to have experienced a completely personalized music-listening architecture since childhood.

The substantial shift in music consumption trends leading to personalization deserves more significant focus. While research on music choice and impact has been done independently, we did not find literature relating the two aspects together. Our study investigates if there is a recursive loop between the personalized music choice (based on prevalent mental state) and music impact (on the mental state). Two important implications motivate this research. First, while social media feed content is controlled by the technology platform, the music choice is made by the listener at will. Hence, confirming the recursive relationship can help guide future listening habits. Second, we discuss if technologically augmenting a listener's music choice with an adaptive mobile app can serve as an effective mental health intervention strategy in certain conditions.

Methods

Our research first investigates if there is a relationship between the mental state of a listener and the type of music they choose to listen to. We then examine the impact of the music the listener chooses on their mental wellness. While every mental state can be a complex set of dimensions, and every song is a complex combination of many musical characteristics, we examine these relationships one variable at a time for simplicity in our study. We then relate both these aspects of the relationship to assess if a reinforcing recursive loop exists for specific mental state and music characteristic

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combinations. Our null hypothesis is that the music chosen by a listener reinforces the same mental state they are in when they choose the music, i.e., the current mental wellness state of the listener impacts their choice of music, which in turn reinforces the same mental wellness state based on the characteristics of the music chosen, rather than moderating it. For example, if a listener is sad and chooses music, the music will reinforce the sad mental wellness state rather than make them happier. The alternate hypothesis would be that the music a listener selects moderates their current mental state rather than reinforcing it. For example, if they are sad and choose to listen to music, the music chosen makes them happier.

Variable Selection

Given the infinite variety in musical creativity, capturing every song's features in a parsimonious set of variables would be very difficult. To maintain simplicity, we select the music characteristic variables for this study from the list of features proposed by Pyun: energy, instrumentalness, liveness, loudness, mode, speechiness, tempo, and valence.[15] We select tempo, loudness, content (which we believe encompasses instrumentalness and speechiness), and tone (better understood as a general term and similar in intention to mode). While it is debatable which of these variables is more appropriate for our study, we select a smaller set applicable to listening to pre-recorded music rather than proposing a specific hierarchy of music characteristics. With that in mind, we omit liveness, as our focus is to evaluate the impact of pre-recorded music; we omit valence, as that is often a memory-related judgment made by the listener based on lyrics, and we omit energy, as we believe it can be reproduced as a combination of loudness and tempo. We use a qualitative description of the extremes of these four dimensions as the music-characteristic variables for our study. Tempo spans the spectrum between fast and slow music. Loudness spans the spectrum between loud and soft music. Content is between only vocal/lyrical and instrumental. Tone spans the spectrum between music with predominantly high notes/treble and music with mainly low notes/bass.

Like music characteristics, mental wellness can also be described in multiple ways. We select the dimensions of mental wellness from the framework proposed by The Mental Health Association of New York State, namely, physical, social, emotional, environmental, spiritual, intellectual, occupational, and financial.[16] For our study on adolescents, we select social, emotional, and occupational mental wellness as the dimensions of mental wellness. We do not select financial as that is generally the responsibility of parents or guardians rather than adolescents. We do not select environmental or intellectual, as adolescents overlap significantly with occupational, given that adolescents are students by occupation in an academic environment. We do not select spiritual, as adolescents generally have not experienced enough life to contemplate its meaning. Finally, we do not select physical, as most adolescents are less aware of their physical wellness. While proposing these dimensions for our study, we are not proposing a hierarchy or that another selection could not be equally justifiable. In our study, we use the descriptive extremes of these dimensions as variables of mental states. Emotional wellness ranges from happy/excited to sad/hurt. Occupational wellness ranges between calm/focused and stressed/irritated. Social wellness varies between socially connected and lonely.

Music Listening Habits Survey

A music listening habits survey was administered to 80 adolescent high school students participating in the 2023 Johns Hopkins Global Health Leaders Conference. Respondents were asked three questions:

a. Playlist structure - respondents were asked about the characteristics that could describe the songs in their playlist. Respondents could choose as many of the eight music characteristic variables as they thought appropriate. This was done to establish that all music characteristics being tested were available in respondent playlists. This was also validated by asking if the respondents believed they had a variety of genres in their playlists or only a limited number of genres.

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b. Music Choice - Respondents were asked what kind of music they listened to when in a particular mental state. We sought separate responses for music choice for each of the states in our study. Respondents could choose as many music characteristics as they thought applied to each mental state. Here, the independent variable was the mental state, and the dependent variable was the music characteristics the listener chose.
c. Music Impact - Respondents were then asked how they felt when they listened to music with a specific characteristic. This response on the impact on mental state was requested for each of the eight music characteristics one at a time. Respondents were allowed to choose as many mental wellness states as they thought was appropriate to answer the impact of a specific music characteristic. Here, music characteristic was the independent variable, and the dependent variable was the mental state that resulted from listening to this type of music.

All questions were asked independently of each other and allowed multiple responses or a null response. While the age demographics of the respondents were known to be adolescents, all data was collected anonymously.

Results and Discussion

Results of the characteristics of respondents' playlists are given in Table 1. The results demonstrate that participant playlists had songs from all music characteristics, and 71% of respondents responded that they had many genres in their playlists. In comparison, only 25% thought they had a limited variety of genres. This confirms the availability of various music characteristics in playlists and that respondents could choose any music. This result, therefore, confirms the ability of the respondents to select multiple music characteristics at will.

Table 1: Music listening habits survey results: all music characteristics are available in listener playlists, with various genres.

Fast Music	Loud Music	Vocal/ Lyrics Music	High Notes/ Treble	Variety of Genres
86.10%	67.10%	83.50%	43.00%	70.90%
Slow Music	**Soft Music**	**Instrumental Music**	**Low Notes/ Bass**	**Limited Genres**
73.40%	67.10%	43.00%	25.30%	25.30%

The practical significance of this result, if generalized to all listeners, is that, unlike social media, music streaming enhances music choice, which is made at will by the listener, and hence, any impact of music we choose is self-imposed rather than imposed by the technology provider. We could choose to listen to any music characteristic at any time.

Music Choice

Results of the music characteristics chosen when in each mental wellness state are given in Table 2. As the survey had questions allowing multiple responses where the respondents were independent (N=80, survey respondents) and the dependent variables were dichotomous (k=8, music characteristics), we used the non-parametric Cochran's Q test to ascertain the statistical significance of the relationship between each mental state and various music characteristics. With a success value of 1, as the p-value of each mental state relationship is less than 0.05, it confirms with statistical significance that the distribution of music choice is not random. With this result, we can confirm that

the mental state of the listener is a significant determinant of the characteristics of music we choose to listen to, given that state. This is true for all mental states in our study.

Table 2: Music listening habits survey results: Music choice. Significant results, in bold, confirm that music choice is not random.

	Happy / Excited	Sad / Hurt	Calm / Focused	Stressed / Irritated	Lonely
Fast Music	91.10%	9.00%	22.80%	42.10%	12.20%
Slow Music	12.70%	89.70%	62.00%	42.10%	83.80%
Loud Music	79.70%	11.50%	12.70%	42.10%	16.20%
Soft Music	17.70%	83.30%	69.60%	47.40%	77.00%
Vocal/ Lyrics	83.50%	67.90%	36.70%	63.20%	67.60%
Instrumental Music	16.50%	52.60%	73.40%	34.20%	37.80%
High Notes/ Treble	49.40%	15.40%	19.00%	25.00%	18.90%
Low Notes/ Bass	24.10%	48.70%	29.10%	26.30%	31.10%
Cochran's Q	226.23	228.05	125.50	33.15	186.09
p-value	**3.12 e-45**	**1.29 e-45**	**5.47 e-24**	**2.49 e-05**	**1.00 e-36**

We follow Cochran's Q test with a *post hoc* Dunn's test with a *post hoc* Bonferroni adjustment to determine the significant pairwise relationships. These results are shown in Table 3. For each mental state, the table shows the statistically significant music characteristics (in bold), where the adjusted significance after using the Bonferroni *post hoc* adjustment is less than 0.05.

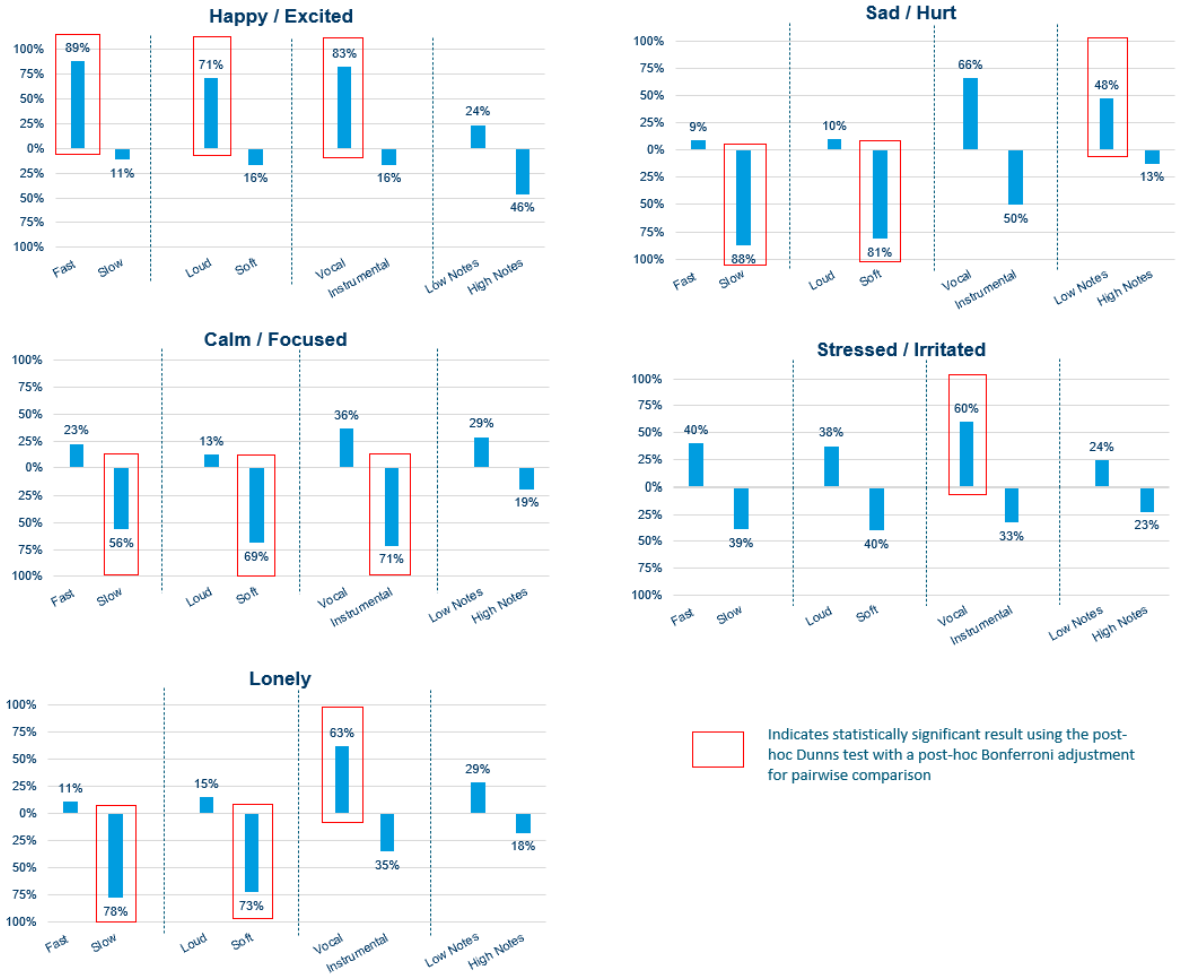
With this result, we can establish music characteristics the listener would choose when in each mental state. We find that in the happy/excited state, the statistically significant music characteristics selected by the listener were fast music, loud music, and music with vocals/lyrics. In a sad/hurt state, the statistically significant music characteristics chosen were slow music, soft music, and music with low notes. In a calm/focused state, the significant music characteristics selected were slow, soft, and instrumental. In a stressed/irritated state, the only significant characteristic was music with vocals/lyrics. Finally, listeners preferred slow, soft and music with vocals/lyrics when lonely

Tempo, loudness, and content as music-characteristic dimensions were significant in four of the five mental states in our study and hence appear to be important music-characteristic dimensions. Tone, however, was only significant in one mental state and was not significant in four others. It thus appears to be less distinctive as a music characteristic dimension.

Table 3: Results of *post-hoc* Dunn's test with Bonferroni adjustment for selected pairwise significance for music choice. Statistically significant pair results, in bold, show music characteristics chosen in each mental state.

		Happy / Excited			Sad / Hurt			Calm / Focused			Stressed / Irritated			Lonely		
Music Characteristic 1	Music Characteristic 2	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance
Fast	Slow	**71**	9	**0.0000**	7	**70**	**0.0000**	18	**45**	**0.0003**	32	31	24.3402	9	**62**	**0.0000**
Loud	Soft	**57**	13	**0.0000**	8	**65**	**0.0000**	10	**55**	**0.0000**	30	32	20.7779	12	**58**	**0.0000**
Vocal	Instrumental	**66**	13	**0.0000**	53	40	1.1427	29	**57**	**0.0002**	**48**	26	**0.0082**	50	**28**	**0.0055**
Low Notes/Treble	High Notes/Bass	19	37	0.1388	**38**	10	**0.0003**	23	15	5.4305	19	18	24.3402	23	14	3.5784
Cochran's Q				226.2359			228.0539			125.4991			33.1451			186.0941
Standard Error				0.0801			0.0794			0.0770			0.0760			0.0739

Table 3 continued: Results of *post-hoc* Dunn's test with Bonferroni adjustment for selected pairwise significance for music choice. Statistically significant pair results, in bold, show music characteristics chosen in each mental state.



Music Impact

Results of the impact of each music characteristic on mental wellness are given in Table 4. We find again that the p-value of the results of each music characteristic is below 0.05 and, hence, statistically significant. Here k=6, success=1, and *N*=80. We can, therefore, conclude that the impact of various music characteristics on mental state as the dependent variables is not random.

We again follow the Cochran's Q test with a *post hoc* Dunn's test with a *post hoc* Bonferroni adjustment to determine the statistically significant pairwise relationships. These results are shown in Table 5.

We find that listening to fast music makes the listener happy/excited and socially connected, with statistical significance. On the other hand, listening to slow music makes the listener feel sad/hurt, calm/focused, and lonely. Loud music makes the listener happy/excited, stressed/irritated, and socially connected, while soft music makes the listener feel sad/hurt and calm/focused. Music with vocals and lyrics makes the listener happy/excited, calm/focused, and socially connected, while instrumental music makes the listener calm/focused. Music with high notes/treble makes the listener happy/excited, while music with low notes makes the listener calm/focused. Our results indicate that all the music

characteristics, except the tone extremes (high notes and low notes) and instrumental music, impacted the listener along at least two mental wellness dimensions. We, therefore, establish the predominant impact on the mental wellness of each music characteristic.

Table 4: Music listening habits survey results: Music impact. Significant results, in bold, show that the impact of different music characteristics on mental state is not random.

	Fast Music	Slow Music	Loud Music	Soft Music
Happy / Excited	93.60%	15.20%	88.30%	23.40%
Sad / Hurt	2.60%	63.30%	2.60%	46.60%
Calm / Focused	12.80%	87.30%	9.10%	90.90%
Stressed / Irritated	17.90%	8.90%	35.10%	7.80%
Lonely	2.60%	39.20%	3.90%	31.20%
Socially Connected	47.40%	7.60%	45.50%	16.90%
Cochran's Q	227.64	174.77	186.33	153.94
p-value	**3.44 e-47**	**6.99 e-36**	**2.38 e-38**	**1.94 e-31**

	Vocal/ Lyrics Music	Instrumental Music	High Notes/ Treble	Low Notes/ Bass
Happy / Excited	84.40%	29.90%	68.00%	32.40%
Sad / Hurt	42.90%	23.40%	9.30%	28.40%
Calm / Focused	53.20%	88.30%	21.30%	62.20%
Stressed / Irritated	23.40%	11.70%	40.00%	21.60%
Lonely	29.90%	28.60%	8.00%	18.90%
Socially Connected	58.40%	7.80%	18.70%	18.90%
Cochran's Q	93.74	153.98	106.04	50.58
p-value	**1.10 e-18**	**1.89 e-31**	**2.81 e-21**	**1.06 e-09**

Table 5: Results of *post-hoc* Dunn's test with Bonferroni adjustment for selected pairwise significance for music impact. Statistically significant results, in bold, show the impact of various music characteristics on mental state.

		Fast Music			Slow Music		
Mental State 1	Mental State 2	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance
Happy/Excited	Sad/Hurt	**75**	2	**0.0000**	12	**50**	**0.0000**
Calm/Focused	Stressed/Irritated	10	14	7.5450	**69**	7	**0.0000**
Lonely	Socially Connected	2	**38**	**0.0000**	**30**	6	**0.0016**
Cochran's Q				227.6355			174.7735
Standard Error				0.0747			0.0773

		Loud Music			Soft Music		
Mental State 1	Mental State 2	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance
Happy/Excited	Sad/Hurt	**68**	2	**0.0000**	18	**36**	**0.0325**
Calm/Focused	Stressed/Irritated	7	**27**	**0.0112**	**70**	6	**0.0000**
Lonely	Socially Connected	3	**35**	**0.0000**	24	13	0.9146
Cochran's Q				186.3258			153.9362
Standard Error				0.0742			0.0734

		Music with Lyrics			Instrumental Music		
Mental State 1	Mental State 2	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance
Happy/Excited	Sad/Hurt	**65**	32	**0.0000**	23	18	5.7396
Calm/Focused	Stressed/Irritated	**41**	19	**0.0011**	**68**	9	**0.0000**
Lonely	Socially Connected	22	**45**	**0.0005**	22	6	0.0782
Cochran's Q				93.7391			153.9837
Standard Error				0.0692			0.0716

		High Notes/Treble			Low Notes/Bass		
Mental State 1	Mental State 2	C1	C2	Adjusted Significance	C1	C2	Adjusted Significance
Happy/Excited	Sad/Hurt	**54**	7	**0.0000**	24	21	8.7010
Calm/Focused	Stressed/Irritated	16	30	0.1871	**46**	16	**0.0000**
Lonely	Socially Connected	6	14	2.3008	14	14	15.0000
Cochran's Q				106.0403			50.5782
Standard Error				0.0700			0.0678

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Table 5 continued: Results of *post-hoc* Dunn's test with Bonferroni adjustment for selected pairwise significance for music impact. Statistically significant results, in bold, show the impact of various music characteristics on mental state.

Limitations

The conference attendees where the survey was administered were 500 high school students from all 50 US States and multiple countries worldwide. While geographically diverse, the attendees were selected from an applicant pool with admission criteria, leading to an acceptance rate of 9.5%. Both the selection of conference attendees and those who chose to respond to the survey may have created a bias in the sample population. The results of this study could be different if the surveyed population were more diverse in various dimensions than the current adolescent sample.

The survey did not attempt to ascertain if the participants' assessment of their own playlist or music choice was accurate or rational or if it reflected the characteristics that they may have used to determine their choice. It also did not validate their responses by asking them similar questions multiple times to ascertain if their responses would be consistent hence lacking test-retest validation. While the survey did not lead the respondent to any specific answer, as all possible options were allowed for each question and multiple answers were accepted, the results could vary if the question was asked differently. Finally, to manage the length of the survey to enable greater participation, the variables for which responses were requested were limited, as described above. It is possible that if different parameters of mental state or music characteristics were used in the survey, the results may differ. Further, a methodology where three different surveys were conducted: one each for music choice, music impact, and an experiment to establish causality, the triangulation of these three data sets to confirm the hypothesis of a recursive relationship would be more robust.

Our study uses the simplified approach of characterizing music one variable at a time. It is accepted that music can seldom be characterized with a single variable, and a multi-variate analysis could yield more significant results if such a study could be conceived and undertaken. However, this would require a much larger population and more complex test methodology, given the infinite variety of music characteristic combinations. Further, we limit the description of music characteristics by qualitatively labelling its extremes. In practice, all music could generally be more accurately specified if a Likert scale was used for each music characteristic dimension.

Like the description of music characteristics, the mental state of an individual is also a complex combination of various dimensions. In our study, we simplify describing the mental state using one variable at a time and with a qualitative description of its extreme state. The choice of the adjective for describing the extreme can also be debated.

Finally, we have not catered for other factors that may affect a listener's music choice, such as time of day and the activity an individual is involved in. In this survey, while the survey responses were received within three days, different participants may have filled out the responses at different times during the day and were involved in various activities that impacted their responses.

This result implies that music choice may not be effective as a mood-regulation strategy in all situations. This is consistent with previous research that adolescents who were already sad and depressed showed a worsening of their moods after listening to music.[17, 18] In contrast, in a state of happiness, music elevated their mood.[19]

Recursive Relationships Between Music Choice and Mental Wellness

Our results confirm a recursive relationship between music choice based on mental state and the subsequent impact on mental wellness for certain states and music characteristics. Figure 1 shows the specific relationships where we confirmed statistical significance in both directions of music choice and music impact. Listeners choose the music they want to listen to that matches their prevalent mental state, which then, in turn, exacerbates the same mental state rather than reverse it.

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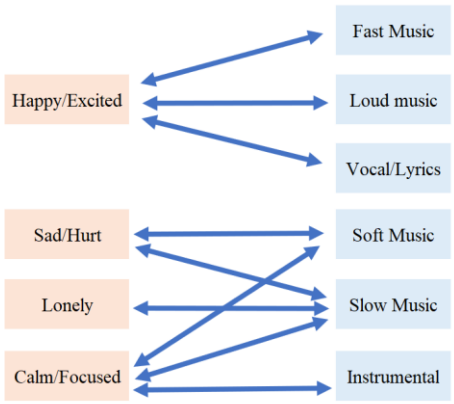

Figure 1: Significant recursive relationships between music choice and mental wellness.

In a happy/excited state, we concluded a preference for fast, loud, and vocal music, and conversely, listening to fast, loud, or vocal music resulted in feeling more happy/excited. Similarly, when feeling sad/hurt, listeners preferred slow and soft music, and conversely, listening to slow or soft music resulted in feeling sad/hurt.

Impact on Mood Variability over Time

The wellness state of individuals varies with time, with ups and downs in mood potentially at a frequency greater than daily. [20, 21] Provided the peaks and troughs of this mood cycle remain within the individual's tolerance, they remain mentally stable. However, with life changes and environmental impacts on the individual, there can be instances where external factors cause the mood cycle to breach tolerance limits, which is then detrimental to mental wellness. This is illustrated in Figure 2.

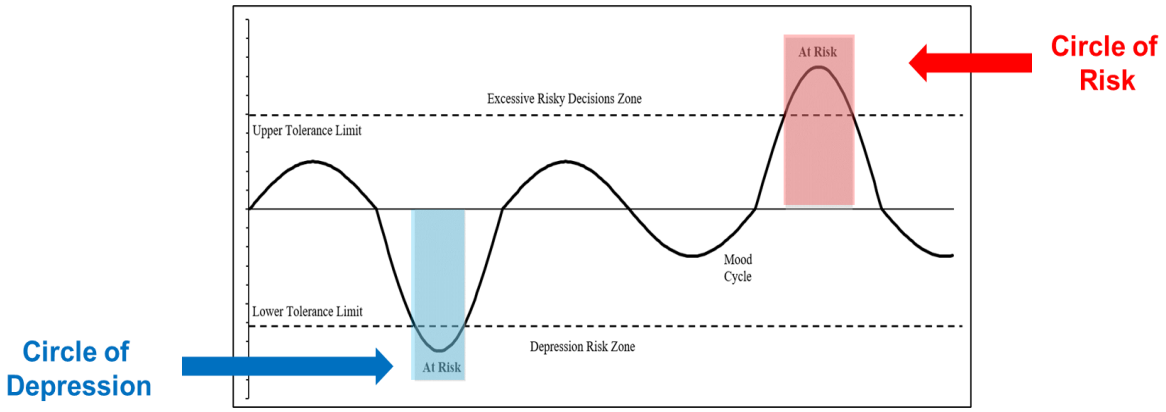

Figure 2: Illustration of the mood cycle with normal and 'at risk' states of mental wellness when the mood cycle is within or breaches tolerance limits.

An implication of the recursive relationship between music choice and mental wellness is that it can act as a factor that exacerbates the listener's mental state into the risk zone beyond the upper or lower tolerance limits in certain circumstances.

For example, when the mood cycle is low, the fact that the listener chooses to listen to slow and soft music since they are sad can, in turn, push them further toward the lower risk zone. Anecdotally, an adolescent who is sad/hurt and stressed and chooses to listen to slow and soft music may find his mental state exacerbated, making it more likely for him to fall into mental health challenges such as

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depression. These findings are consistent with previous research that young people who are already struggling with their mental health exhibit excessive use of music, which harms their mental health and fails to elevate their mood.[22] We term this the Circle of Depression, as illustrated in Figure 3 (left).

Similarly, when the listener is happy/excited, choosing to listen to fast and loud music could push them further toward the higher risk zone. Anecdotally, this can be seen. For example, if an adolescent in a happy/excited state goes to a nightclub with friends, the loud and fast music at the club may exacerbate their happy/excited state. This can potentially lead to a breach of the hypothetical upper tolerance limit and leave them at greater risk of making poor behavioral decisions such as sexual promiscuity or substance abuse. We term this the Circle of Risk, as illustrated in Figure 3 (right).

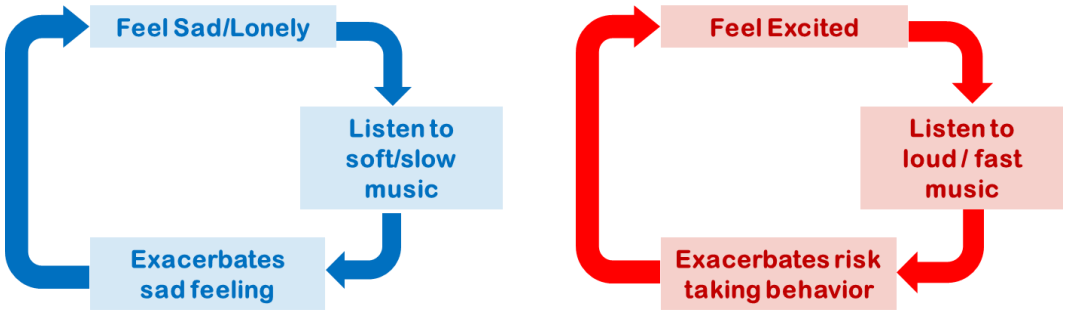

Figure 3: Illustration of the Circle of Depression (left) and the Circle of Risk (right)

Anecdotally, individuals often find comfort in listening to the music of their choice. Indeed, listeners have more intense emotions when they listen to music they choose, compared to randomly selected music, and when they listen along with a close friend or partner.[23] One explanation could be that listening to music allows us to "share" our feelings, joy, sadness, or loneliness with the imaginary companion that music provides, much like when music was a collective experience.[10] The increased popularity of music streaming could perhaps be attributed to its ability to recreate a collective listening experience for the listener, even when physically alone.

Opportunity for an Adaptive Mental Wellness Intervention Strategy

With the result that the recursive relationship between music choice and music impact can lead to a worsening mental state in certain conditions, there is potential to explore if the natural music choice by a listener can be augmented technologically to counteract the effect of potentially putting them at risk. Apple iOS17 now allows users to self-record their mental state at any time and provides physiological health data to confirm the state.[24] With self-recorded mental wellness data availability, the development of user-centered adaptive mobile mental health apps has become possible. Adaptation based on daily activity is already available.[25] Our research demonstrates that it could be possible to augment the listener-selected playlist by intermittently introducing songs from the listener's library with contrasting characteristics to moderate the impact of the music in certain circumstances. This has the potential to become an essential mental health intervention mechanism, mainly because it would always be available to the individual and use existing apparatus to deliver the therapy. Designed music can potentially promote care, relation, mental capacity, and vigor.[26] An adaptive app could moderate the impact of the listener's chosen playlist under certain conditions by bringing the mood cycle back towards the mean rather than extending away from it. If proven viable after further testing, this proposal, as illustrated in Figure 4, could have meaningful consequences.

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Figure 4: Framework for an adaptive mental health app to serve as a continuous mood regulation and mental health intervention strategy.

Extension for Future Studies

While acknowledging that neither the variety of music nor mental states can be conclusively encapsulated in a framework of a limited number of distinct variables, we propose an extension of the univariate framework used for this study to use three significant dimensions of music characteristics and mental wellness states. Further, the scale for each variable could be enhanced from the current binary ordinal responses to a Likert scale. While this would make the survey longer and more complex, it could create greater robustness in future studies.

Based on the significant recursive relationship between music characteristics, we propose the three variables for music characteristics: tempo, loudness, and content. Songs could be characterized on a scale between the two extremes of each dimension, resulting in a qualitatively rated feature of any song. While most songs would be a mix of all these characteristics rather than at the extremes, their bias could help categorize any song into discrete categories, such as fast-loud-vocal music and slow-soft-instrumental music.

Similarly, extending the mental wellness framework to three variables based on our results, we propose emotional, social, and occupational wellness. A category of happy/excited - calm/focused – connected would then depict a state of perfect mental wellness, or conversely, sad/hurt – stressed/irritated – lonely would represent the worst mental state.

Conclusions

This study investigates the relationship between the choice of music made by a listener, based on their prevalent mental state, and if the music chosen then impacts the listener to reinforce that mental state. Our study confirms a recursive relationship between music choice and music impact, which is evident for various music characteristics and mental wellness states on a univariate basis. We suggest a multi-variate framework that could be used for future research to validate these findings.

While the mass personalization of music has significantly empowered the listener in their music choice, our study demonstrates that it has also provided a readily available external stimulus that could push the mood cycle of the listener into a risky zone, potentially leading to either depression or excessively risky decisions.

With the availability of mental wellness state data of an individual, we believe there is an opportunity for an adaptive mental health mobile app, which could augment the music choice of a listener with songs from their library to moderate rather than exacerbate the impact on their mental state. Given the increasing popularity of personalized music streaming, this could be a valuable mental health intervention strategy that would be continuously available to listeners.

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Aanya Gupta is the Founder of **The H.U.M.AN.S. Initiative** (Healing mental health Using Music ANd Song), www.humansinitiative.org officially recognized by the Mental Health Association of New York State as a Community Partner. Along with the New York City Human Rights Commission, Aanya Gupta and The H.U.M.AN.S. Initiative have launched the first ever Teenage Mental Health symbol.