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Energetic Music is Used for Anger Downregulation: A Cross-Cultural Differentiation of Intensity from Rhythmic Arousal

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Abstract

Music is often used to 'soothe the soul', and one important function of music listening has been for emotion regulation. In comparing consumption trends across cultures, past research has shown that individuals in Western countries, with typically higher prevalence of high arousal negative emotions, tend to listen to similarly high arousal rhythmic (Danceable) music to cathartically discharge those emotions. However, other studies have shown that Spotify's energy feature, a measure of the intensity-based arousal of a song, indicates the opposite effect: energy was higher in songs in East Asian Top-50 charts than Western ones. Combining evidence from reanalyses of secondary data (Pilot Analyses 1 and 2), sentiment analyses of lyrics from US and Singapore (Study 1; N = 87 songs) and an emotion induction experiment in Japan and the US (Study 2; N = 353 participants), we show that collectivistic, East Asian cultures generally prefer songs with higher energy levels, and Energetic songs are robustly associated with anger downregulation, over sadness and anxiety downregulation. We speculate that energy, as an intensity-based musical arousal feature, may represent internalizing (control) regulation that one uses to 'drown out' anger, which would be more prevalent in East Asian cultures due to sociocultural norms of emotion (non)expression. Conversely, this would be different from the externalizing regulation associated with rhythm-based musical arousal (i.e., danceability).

Energetic Music is Used for Anger Downregulation: A Cross-Cultural Differentiation of Intensity from Rhythmic Arousal

Introduction

Cultures differ in the music they consume. A recent large-scale analysis of music listening patterns and preferences from 1 million Spotify users found divergent trends of music listening in regions around the world (M. Park, Thom, Mennicken, Cramer, & Macy, 2019). For example, music listened to in East Asian countries tended to be lower on arousal than music from Latin America or the West. Considering that human perception of music is largely universal (see Savage, Brown, Sakai, & Currie, 2015), these cultural differences in patterns of music consumption may be more a reflection of cultural differences in music preference, and less of a biological or physiological difference in auditory sensation and perception towards music.

Accordingly, since perception is largely universal, why do certain cultures prefer some types of music over others? Park et al. (2019)'s findings on arousal hint at one important aspect in answering this question. One of the primary, functional reasons that people listen to music is for affect regulation (Cook, Roy, & Welker, 2019; Groarke & Hogan, 2018), particularly the downregulation of negative emotions (Sharman & Dingle, 2015). However, affective norms are highly sensitive to cultural influences (Mesquita & Frijda, 1992; Tsai, 2007; Uchida & Kitayama, 2009), and both the intensity and frequency of experienced emotions, as well as the individual's desired emotional goals, vary systematically between cultures. For example, in some cultures, primarily East Asian, collectivistic societies, high-arousal negative (HAN) emotions are discouraged and consequently experienced to a smaller extent (Kitayama et al., 2015), as they may lead to strife and a deterioration of relational harmony (Akutsu, Yamaguchi, Kim, & Oshio, 2016). Conversely, Western, individualistic cultures may tolerate stronger displays of negative emotions (e.g., Forbes, Zhang, Doroszewicz, & Haas, n.d.; Salchegger, 2013), such that HAN emotions may be widely experienced. This dimension of cultural difference in HAN emotion prevalence and affordance is then mirrored in the music they consume.

In a series of studies, Liew et al. (2021a), found that the cultural consumption of Danceable ('rhythmic' high-arousal) music approximated the amount of HAN emotions they

experienced. In analysing 1 million songs produced by Japanese or Western (American) artists, the authors found that Western songs were generally higher in 'danceability' than Japanese songs. Following which, an East-West examination of Top-50 songs found that Western cultures consistently preferred songs with higher 'danceability' than East Asian songs. Similarly, in a study of 60 Spotify-using cultures, the authors found that the greater the prevalence of HAN emotions within a country, the stronger the 'danceability' of songs on its Top-50 charts, and the association was stable even after controlling for GDP, cultural background (colonial history), and cultural dimensions (e.g., individualism-collectivism and tightness-looseness). This is consistent with research on discharge regulation in music listening (Saarikallio, 2012), where listening to high-arousal music provides cathartic relief for their pre-existing HAN emotions (Sharman & Dingle, 2015). Moreover, these results appeared reflective of only negative emotion prevalence, and did not generalize to high-arousal positive (HAP) emotion prevalence.

Arousal in Music and Negative Emotions Across Cultures

In considering what constitutes high-arousal music, researchers often turn towards the 'rhythmic' and 'intensity' aspects of music. This can then be reorganized by musical features. Musical, or acoustic features, are predominantly low-level properties of audio signals extracted from digital sources of music and sound, and often model some aspect of human auditory perception (McKinney & Breebaart, 2003; see also loudness, roughness and sharpness, Fastl & Zwicker, 2006). Here, music streaming services like Spotify use these features to catalogue songs available on their platform, and are often used for purposes like music recommendation within these platforms (e.g., Zangerle, Pichl, & Schedl, 2020). Fortunately, these databases are available online for researchers to access, and from this list of features, some of them appear to indicate the abovementioned aspects of musical arousal: The danceability feature, for example, may represent the rhythmic aspects of musical arousal (Liew et al., 2021a), and energy, a composite feature that reflects the loudness or intensity and activity of a song, may represent the 'intensity' aspects of musical arousal (see Vidas, McGovern, & Nitschinsk, 2021)[1]. A song high on danceability may be perceived as having a strong and salient 'beat',

[1] Despite our assumption that energy can be used as a proxy for intensity-arousal, we caution that the specific algorithms used for determining energy on the Spotify platform are not publicly available and

and energy may be perceived as being loud and full-of-activity (noisy; see below for examples).

As introduced earlier, high-arousal music is often used to downregulate HAN emotions (through cathartic listening), and societies with higher prevalence of HAN emotions (as individualistic, or culturally loose societies) may have stronger preferences for high arousal music due to stronger and more pervasive HAN emotions in daily life. This was observed for rhythmic markers of musical arousal, namely danceability, but preliminary observations suggest that intensity markers of musical arousal, such as energy, may deviate from this trend. Liew et al. (2021b) found that music consumed and produced in Japan, with lower affordances for HAN emotions, were much higher in energy than the US, with higher affordances for HAN emotions. Similarly, Vidas et al. (2021) found no significant differences in energy between Top-50 music from Pan-Asian and Anglo-Western countries. In short, energy appears to deviate from the earlier notion that countries with higher cultural affordances for HAN emotions have greater consumption of high-arousal music. Based on our initial line of reasoning, the present research aims to elucidate the pattern of effects for energy to examine if they are indeed consistent (or inconsistent) with these theories. Thus, our main research questions are twofold: 1) does energy still reflect HAN emotion downregulation, as suggested by the literature on discharge regulation and cathartic listening, and 2) do countries with higher tolerance for negative emotions (such as individualistic countries) have increased consumption of Energetic, high (intensity) arousal music, or is it the other way round?

This distinction between energy and danceability may be conceptually important. While many songs are high in both intensity (energy) and rhythmic (danceability) arousal (e.g., Pa Jamaica by El Alfa: danceability = 0.859, percentile rank = 0.93; energy = 0.985, percentile rank = 1.0), these may sometimes differ; a song can be high in intensity arousal but not rhythmic arousal (e.g., Ao To Natsu by Mrs. Green Apple: danceability = 0.310, percentile rank = 0.02; energy = 0.887, percentile rank = 0.96), or high in rhythmic arousal but not intensity arousal (e.g., Yes Indeed by Lil Baby: danceability = 0.964, percentile rank = 1.0; energy = 0.346, percentile rank = 0.07). Accordingly, previous research has already alluded to a differentiation between intensity and rhythmic arousal (Stupacher, Hove, & Janata, 2016). Specifically, we think that as dance is associated with the external expression of emotion (Bernardi, Bellemare-Pepin, & Peretz, 2017), danceability may reflect tendencies towards

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we are not able to definitively conclude this relationship.

expressive mechanisms for emotion regulation. On the other hand, colloquial mentions of the use of music to 'drown out your feelings'[2], which hints at internalizing forms of HAN downregulation aside from dance and danceability. Moreover, in considering a cultural perspective, we also note that the divergence in affective and cultural effects that are associated with these separate states of musical arousal is relatively unexplored. We posit that this may be situated within cultural-based explanations (e.g., individualism-collectivism), and by demonstrating the clear and consistently differentiated patterns between cultures in music-based emotion regulation, we hope to contribute towards the literature on culture and emotion regulation.

We first conducted two pilot analyses of secondary data from Liew et al. (2021a)'s data on Spotify Top-50 charts around the world. This allowed us to compare the effect of energy with effects initially observed and reported using the danceability feature. In particular, we mirror Studies 2 and 4, that compared energy from songs in the Top-50 charts between 4 East Asian, and 4 Anglo-Western cultures (Pilot Analysis 1), and examined energy as an outcome variable in a mixed effects modelling of Negative Emotion prevalence and individualism-collectivism from 60 countries (Pilot Analysis 2). Following which, we examined musical arousal and energy through a different modality, lyrics (Study 1), between the East and West. Like other cultural products, lyrics contain rich information on the wider cultural attitudes and values that shape its composition. This has been attractive to social psychologists, as it encapsulates these sociocultural contexts at a fixed point in time and space, allowing for rich studies on the evolution of society and values over time (e.g., Brand, Acerbi, & Mesoudi, 2019; Dewall, Pond, Campbell, & Twenge, 2011), or the comparison of societal values and tendencies across geographical locations (e.g., De Almeida & Uchida, 2018). Our analysis of lyrics here would help to contextualise the findings on culture and energy, by relating it to other forms of intentional emotion content from within the music. Finally, we experimentally induced various negative emotions (Anger, Sadness, and Anxiety) in participants from Japan and the US, and measured the musical arousal (danceability and energy scores) of songs they would use for downregulation of these emotions (Study 2). This would help us to elucidate the effect of negative emotional context and culture on the listening and consumption of Energetic songs.

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[2] https://www.reddit.com/r/infp/comments/lr6ak2/does_anyone_else_drown_your_feelings_out_with/

Pilot Analyses of Secondary Data

Analysis 1

We conducted two secondary analyses of data from 2 studies by Liew et al., (2021) using Spotify's energy (instead of danceability). Analysis 1 examined cultural differences in energy from Top-50 charts in late-2018 (R1) and mid-2019 (R2), between East Asia (Japan, Taiwan, Hong Kong, and Singapore), and the English-speaking West (USA, UK, Australia, Canada), for a total of N = 800 songs. The East Asian cultures were determined due to the availability of Spotify as a service at the time of data collection. To match these four East Asian countries, we selected the four largest English-speaking countries by size of population (thereby excluding New Zealand and Ireland). A Two-Sided Test of Equivalence (TOST) with alpha = .05, and equivalence bounds (smallest effect size of interest) of Cohen's d = .05, showed that scores for energy were not significantly different, t(797) = -0.53, p = .599, and statistically equivalent between R1 and R2 (fully contained equivalence bounds: Upper t(797) = -7.60, p < .001; Lower t(797) = 6.54, p < .001). As such, R1 and R2 were merged for the analysis.

Results. A one-way Analysis of Variance (ANOVA) was conducted with culture (East or West) as the independent variable, and energy as the dependent variable. A significant effect of Culture was observed, F(1,797) = 16.0, p < .001, η^2_p = 0.02, Cohen's d = 0.28, showing that energy was significantly higher in East Asian charts than Western charts.

Analysis 2

For Analysis 2, we utilized a 60-country comparison of official Spotify Top-50 charts per country, to examine the broader pattern of cultural differences in Spotify's energy. As an indicator of arousal in music like danceability, we expected energy to similarly reflect sociocultural affordances for negative emotions: Cultures with higher prevalence of HAN emotions should also utilize high-arousal Energetic music to downregulate those emotions. At the same time, given that energy appeared consistently higher in collectivistic East Asia than the comparatively individualistic West, we expected collectivism to predict energy in songs from Top-50 charts. Collectivism was measured using a bi-directional country-level score on individualism-collectivism (Hofstede, 2001), where the higher the value, the more individualistic a country's cultural orientation (the lower the score, the more collectivistic). To

control for the effect of (country-level) socioeconomic statuses (SES) affecting music preference (e.g., lower SES societies have narrower music preferences due to limited access, Chan & Goldthorpe, 2006), GDP per capita was included in all models as a control variable. We obtained a measure for negative emotions used from the World Happiness Report 2019 (Helliwell, Layard, & Sachs, 2019), that is a cultural-level prevalence measure of the proportion of participants who experienced anger, sadness, or worry, in the day prior to participating in the survey (see Figure 1). To examine if the effect of negative emotion and collectivism on energy were above and beyond the emotional characteristics of the songs, we also included Spotify's danceability, Valence, and Loudness as control variables in a separate model.

Results. A linear mixed effects model was fitted, marginal $R^2 = 0.07$, conditional $R^2 = 0.16$, with random intercepts for Country, energy as the outcome variable, and log-transformed GDP per capita, negative emotion (prevalence), and individualism-collectivism as fixed effects. After controlling for GDP per capita, negative emotion (b = 0.35, SE = 0.12, 95%CI[0.12, 0.59], t(55.8) = 2.93, $p = .005$) and individualism-collectivism (b = -0.0009, SE = 0.004, 95%CI[-0.001,-0.0001], t(55.7) = -2.25, $p = .028$) significantly predicted energy. A second model was fitted (marginal $R^2 = 0.58$, conditional $R^2 = 0.61$) that additionally included danceability, Valence, and Loudness as control variables (for these variables, random slopes by country were omitted from the model due to issues with model convergence), cultural prevalence of negative emotion remained significant in predicting energy (b = 0.13, SE = 0.05, 95%CI[0.02, 0.23], t(53.7) = 2.33, $p = .023$. Individualism-collectivism did not significantly predict energy (b = 0.00002, SE = 0.0002, 95%CI[-0.0003,0.0004], t(55.4) = 0.10, $p = .918$). Loudness (b = 0.13, SE = 0.002, 95%CI[0.12,0.13], t(3067.8) = 56.9, $p < .001$) and Valence (b = 0.07, SE = 0.009, 95%CI[0.06,0.09], t(3097.5) = 8.46, $p < .001$) positively and significantly predicted energy, but danceability negatively and significantly predicted energy (b = -0.08, SE = 0.05, 95%CI[0.02,0.23], t(69.6) = -4.94, $p < .001$). We also examined zero-order correlations between danceability, energy, Loudness, and Valence in Table 1. A strong correlation was observed between loudness and energy (Spearman's $\rho = 0.73$), but only weak to moderate correlations were observed for the other variables (all Spearman's $\rho s < 0.34$).

Discussion

The pilot analyses provide more evidence to support the notion that East Asian songs are higher on energy than Western songs. At the same time, these appear to be arguably influenced by collectivistic tendencies: Collectivistic cultures generally consumed songs with higher energy content, but unlike the relationship between negative emotion prevalence and energy, this relationship was not significant when other forms of music arousal were included in the model. At present, these findings appear difficult to reconcile. Songs that are high in arousal enable listeners to cathartically release their pent-up emotions (discharge regulation), so cultures with a higher prevalence of negative emotions may thus have a greater demand for high-arousal music to facilitate this release. This should then be reflected in the arousal markers (i.e., intensity: energy, rhythm: danceability) from that culture's charts. For danceability, a rhythmic marker, this effect was notably consistent, in that countries with stronger prevalence of negative emotions, and loose (as opposed to tight) social norms had higher danceability in their Top-50 charts (Liew et al., 2021). Yet, in this analysis, energy, while consistently predicted by negative emotion prevalence, was significantly associated with collectivistic cultures, which typically discourage the experience and expression of high-arousal negative emotions (Kitayama et al., 2015). On one hand, this reduction in expressive emotion norms should have negated the demand for high-arousal, Energetic music. Yet, we observed the opposite phenomenon, where collectivistic cultures had unexpectedly stronger preferences for high-intensity (Energetic) music. This effect was consistent across Analyses 1 and 2.

In order to reconcile these results, we used alternative methods to track the associations with musical arousal in Studies 1 and 2. Past research has shown that the amount of emotion-related words and individualism/collectivism-related words in a song's lyrics mirror its recognized emotion content (Susino & Schubert, 2019), and the corresponding cultural orientation of the country it is popular in (Morling & Lamoreaux, 2008). For Study 1, we examined relevant aspects in lyrics of popular songs, with the reasoning that cultural preferences for energy, as a measure of intensity arousal in music, would also manifest themselves in the lyrics of the examined songs. In Study 2, we induced a negative emotion in participants, and directly asked them what music they would listen to to downregulate those emotions. By measuring the corresponding energy levels of these music, we can test the effect of cultural orientation and negative emotions in an experimental setting. These would provide

more evidence for the differentiation in arousal and collectivism that pertains to energy, and shed light on possible mechanisms.

Study 1

In this study, we examined the usage of relevant emotional and individualistic-collectivistic words within the lyrics of Top-50 songs, relying on sentiment analysis using the LIWC (Pennebaker, Mehl, & Niederhoffer, 2003) lexicon. Lexicon-based sentiment analyses match words within a document (lyric) to pre-determined lexical categories. For LIWC, these mainly comprise categories of psychological motivations (such as drives, affect, etc.), and by counting the relative amount of words matched to these categories, we can estimate the relevance of a category for that document, for use in further statistical analyses. This quantifies the difference in lyrical styles for the music preferred by each culture, and contextualises them in the energy of the music. This then functions as robustness checks to evaluate musical arousal across cultures, and to quantify the relationships to specific collectivism-related tendencies and negative emotions embedded within the songs.

To remove the confound of linguistic differences in emotion-word usage, we restricted our cross-cultural comparisons to Singapore and the US, where English is widely spoken as a first language. Building on the results of the Pilot Analyses, we hypothesised that 1) lyrics from songs in US Top-50 charts would contain more usage of negative emotions, particularly HAN emotions like anger, given that the US (0.29) had considerably higher negative emotion prevalence than Singapore (0.11), and 2) regardless of culture, Spotify's energy would be associated with these negative-emotion words. We also examined the use of individualistic/collectivistic-related words between cultures. As the LIWC lexicon is frequently used to examine different kinds motivational drives in text (beyond just emotion), we expected to see 3) stronger usage of 'we' pronouns, and words associated with interpersonal relationships (e.g., social, friend), in Singapore, but stronger usage of 'I' pronouns, and lesser usage of words associated with interpersonal relationships in the US. This follows past literature on LIWC and language use in individualistic/independent versus collectivistic/interdependent cultures (DeAndrea, Shaw, & Levine, 2010; Jaremka, Gabriel, & Carvallo, 2011; Na & Choi, 2009), surrounding the use of language that is congruent with individualistic (US) and collectivistic (Singapore) cultural orientation. Finally, given the

previous analyses shown that energy was stronger in music from collectivistic countries, we also expected that 4) energy would be positively associated with collectivism-related words ('we' pronouns, family, social, friend LIWC categories) and negatively associated with individualism-related words ('I' pronouns).

Data and Methods

For this study, we subsetted Top-50 charts data from Analysis 1, by focusing only on data from the US and Singapore. After manually checking the language of the songs, we removed all non-English songs from the dataset (Singaporean charts contained a number of Chinese and Korean songs, and US charts contained a number of Spanish and Korean songs). In total, we obtained N = 87 songs (Singapore N = 38, US N = 49) in R1 and N = 78 songs (Singapore N = 34, US N = 44) in R2, for a total of N = 165 songs. A TOST with alpha = .05, and equivalence bounds (smallest effect size of interest) of Cohen's d = .05, showed that these scores for energy were not significantly different, t(163) = -0.58, $p = .562$, and statistically equivalent between R1 and R2 (fully contained equivalence bounds: Upper t(163) = -3.79, $p < .001$; Lower t(163) = 2.63, $p = .005$). Thus, as in Analysis 1, R1 and R2 were merged for the analysis. For each song, scores for Spotify's energy feature were also obtained from the API.

We then obtained lyrics through the Genius API, using the geniusr wrapper (Henderson, 2020). These were then fed into the LIWC software (Pennebaker et al., 2003), for the lexicon categories of 'negemo' (negative emotion), and 'anx' (anxiety), 'anger', and 'sad', for negative emotion-related words. Note that the list of terms in 'negemo' is longer and more representative of general negative emotions that the combination of above-mentioned specific negative emotion terms from the dictionary. At the same time, we used the 'social', 'friend', 'family', and 'we' pronouns for collectivism-related words, and 'I' pronouns for individualism-related words.

Results

Culture and Negative Emotions. A Kruskal-Wallis test for culture and anger was significant, $\chi^2 = 17.7, df = 1, p < .001, \epsilon^2 = 0.11$, suggesting that the US was significantly higher than Singapore (W = 5.94, $p < .001$; see fig 2). No significant effects were observed for

negemo, $\chi^2 = 2.75, df = 1, p = .097$, anx, $\chi^2 = 0.01, df = 1, p = .909$, and sad $\chi^2 = 2.25, df = 1, p = .134$.

energy and Negative Emotion. A forward-stepwise linear regression model was conducted with energy as the outcome variable, and anger (base model), negemo, anx, and sad were progressively added to the model. Model comparisons revealed that none of the subsequent iterations were significantly improved over the base model (all *p*s > .06), so we only examined the base model, $R^2 = 0.04$, F(1,163) = 5.97, $p = .016$ (model comparison results are available in the OSF repository). Anger significantly and positively predicted energy (b = 0.02, SE = 0.007, t(163) = 2.44, $p = .016$). However, we noted this effect could be confounded by baseline cultural difference in energy and anger between the US and Singapore, so we repeated the analysis with country included as a control variable. Model comparisons then revealed that the country, anger and negemo model, $R^2 = 0.14$, F(3,161) = 8.73, $p < .001$, was significantly improved over base country and anger model, $\Delta R^2 = 0.03$, F(1,161) = 6.34, $p = .013$, and no other significant improvements were observed (all *p*s > 0.450). In interpreting the model, energy was positively predicted by anger (b = 0.04, SE = 0.010, t(161) = 4.25, $p < .001$), and negatively by negemo (b = -0.02, SE = .006, t(161) = -2.52, $p = .013$). Consistent with the earlier analyses, country was also a significant predictor (b = -0.09, SE = 0.02, t(161) = -3.97, $p < .001$), where Singaporean charts had songs with higher energy than US charts. In short, after controlling for the effect of culture, anger in lyrics remained positively associated with energy. Yet, when controlled for the effect of anger, frequency of negative emotion words in lyrics were negatively associated with energy. We interpret this to mean that HAN emotions, like anger, may have a differentiated pattern of effects from general negatively-valenced emotions: HAN emotions may be heightened in high-energy songs, but if only considering valence without regard for arousal, negative emotion words may be slightly more in low-energy (low-arousal) songs.

Individualistic/Collectivistic Tendencies in Lyrics. A Kruskal-Wallis test revealed a significant effect of social-related words, $\chi^2 = 17.6, df = 1, p < .001, \epsilon^2 = 0.11$, and the 'we' pronoun, $\chi^2 = 5.75, df = 1, p = .016, \epsilon^2 = 0.04$. suggesting that Singapore was significantly higher than the US for social-related words and the 'we' pronoun. For a visualisation of between-country differences, refer to Figure 2. No significant effects were observed for family, $\chi^2 = 0.20, df = 1, p = .65$, friend, $\chi^2 = 0.35, df = 1, p = .55$, and the 'I'

pronoun, $\chi^2 = 0.93, df = 1, p = .34$. To some extent, Top-50 lyrics in Singapore were more collectivism-oriented ('we' pronouns, social, and lesser 'I' pronouns) than Top-50 lyrics in the US.

energy and Individualism/Collectivism-Related Words. A forward-stepwise linear regression model was conducted with energy as the outcome variable, and social (base model), family, and friend-related words, followed by the 'we', and 'I' pronouns were progressively added to the model. Model comparisons revealed that only the 4th model (inclusion of the 'we' pronoun) showed a significant improvement over the previous iteration, $\Delta R^2 = 0.02$, F(1,160) = 3.97, $p = .048$. All other model comparisons showed no significant improvements (all ps $> .19$). In interpreting the model, $R^2 = 0.04$, F(4,160) = 1.75, $p = .142$, only the 'we' pronoun frequency significantly predicted energy (b = 0.01, SE = 0.007, t(160) = 1.99, $p = .048$), and no significant effects were observed for social (b = -0.0004, SE = 0.002, t(160) = -0.20, $p = .84$), family (b = 0.02, SE = 0.01, t(160) = 1.48, $p = .28$), and friend (b = -0.01, SE = 0.010, t(160) = -1.09, $p = .28$). However, when Country was included in the model ($R^2 = 0.07$), Country significantly predicted energy (b = -0.06, SE = 0.03, t(159) = 02.18, $p = .031$), but the 'we' pronoun usage did not significantly predict energy (b = 0.01, SE = 0.007, t(159) = 1.51, $p = .13$). This suggests that usage of the 'we' pronoun in lyrics was weakly and positively associated with Spotify's energy, but this could be largely due to energy being higher in Singaporean Top-50 lyrics than the US.

Discussion

Our hypotheses were somewhat supported. While the available emotion categories were limited, we noted that anger, a HAN emotion, significantly differed between the US and Singapore, and was also associated with the energy scores of Top-50 songs across both countries, but in contrasting ways. On one hand, energy was significantly higher in Singapore than in the US, and associated with anger. On the other hand, angry lyrics were more prevalent in the US than Singapore. Given that negative emotion prevalence at a country-level appears linked to both the intensity and rhythmic arousal of its charts (Analysis 2), one possibility could be that the wider prevalence of anger lyrics could be a similar reflection of HAN downregulation in both danceability and energy, as danceability was higher in Western than East Asian songs. Moreover, high-danceability genres, like hip-hop, also appeared to be

more prevalent in American charts than in Singaporean charts, and these American songs tend to have stronger and arguably more angry lyrics (Napier & Shamir, 2018). Conversely, in focusing only on energy, we noticed that energy was consistently higher in Singapore, and associated with anger and to a certain extent, collectivistic word use. Furthermore, with the inclusion of culture as a control variable, the effect of 'we' pronoun usage on energy became not significant, suggesting that the variance here can be explained largely by cultural differences in music preference. Accordingly, both the music and lyrics seem to suggest a convergence of HAN emotional expressions with regard to energy and East-Asian cultures. Taken together, we offer a speculative interpretation: differentiating rhythmic and intensity arousal appears to offer a coherent explanation of this seemingly contradictory result. In the US, anger may be contextualized by rhythmic arousal in music, so cathartic regulation for downregulating anger may occur through danceability and expression. In Singapore (and East Asia), energy may instead be a more characteristic feature of music used for cathartic anger regulation.

Additionally, we note that despite the inclusion of only English songs in both charts, we found a significant difference between US and Singaporean charts. This shows the strong effect of cultural music preference arising from demand (and not supply - due of the lack of widely popular locally-produced English songs in Singaporean culture). Most of the songs in the Singaporean charts in this study were produced by Western artists, so the persistently higher energy scores reflect a stronger cultural demand for these kinds of music rather than a supply-side limitation of the availability of local music.

However, the pilot study and Study 1 used cultural products as evidence for proposing the role of Energetic music for negative emotion downregulation and its differentiation by culture. While this does show some aspect of real-world validity, we are unable to examine specific, individual-level effects, and estimations of psychological concepts used may be vague and imprecise. For example, the proportion of angry words in the lyrics may highlight the emotional content of the song, but cannot reveal the emotional processes of the listener. As such, we conducted Study 2 to address this issue.

Study 2

Study 2 was conducted as an online, US-Japan comparison study. Participants were first induced to feel a negative emotion, and then asked to recommend a song they would listen to

to downregulate that emotion. We then obtained the energy features for these songs from the Spotify API, and compared them for differences across cultures and induced negative emotions.

Prior to this study, we observed a consistent effect throughout the Pilot Analyses and Study 1: Spotify's energy appeared to be stronger in collectivistic, East Asian countries than in Western, Anglo-American countries, and was also closely linked to anger. According to Liew et al., (2021a), one possibility could be that high arousal, Energetic music, may facilitate HAN (anger) downregulation by cathartically discharging that emotion. If so, we hypothesize that 1) participants induced to feel anger would listen to more Energetic music to downregulate it. Secondly, considering the consistent results on collectivism and energy thus far, we also hypothesized that 2) participants in Japan would also listen to more energetic music than participants in the US.

Methods

Participants. After excluding participants with invalid responses (2 Japanese participants failed to complete the survey) or who failed the attention check (1 US participant), a total of N = 353 participants (Japan: N = 171, Mean age = 40.2, SD = 9.3, Female = 76, Male = 90, Others/Rather not say = 5; US = 182, Mean age = 32.0, SD = 10.3, Female = 81, Male = 95, Others/Rather not say = 6) were recruited for the study from the Prolific.co (US) or Lancers.jp (Japan) crowdsourcing platforms. Participants were reimbursed with either GBP 1.01 (US) or JPY 70 (Japan) for their involvement in the study. All Japanese participants reported Japanese as their first language, and 173 US participants reported English as their first language. The other languages were Chinese (2), Spanish (4), Russian (1), Vietnamese (1) and others (1). This study received approval from the Institutional Review Board (Kokoro No Sentan Research Unit) of Kyoto University.

Procedure. Participants were first assigned to one of three negative emotion contexts; participants were induced to feel sad (US: N = 64, Japan: N = 64), angry (US: N = 61, Japan: N = 48), or anxiety (US: N = 57, Japan: N = 59) through a recall/writing task (Mills & D'Mello, 2014; Siedlecka & Denson, 2019): they were asked to recall a specific memory related to these emotions, and to write it down in the survey. Participants then reported their intensity of felt emotions, i.e., "To what extent do you feel happy, awe, moved,

gratitude, excited, calm, sad, anxious, angry, (general) positive, or (general) negative", on a 7-point Likert scale, of which we focused on sad, anxious, angry, and general negative valence as manipulation checks. Following which, as an added attention check, participants were asked what negative emotions they were asked to recall. Participants were then asked to list "what kind of music (they) would listen to in order to feel less sad/angry/anxious", and provided the artist name and song title. Participants then completed demographic questions. US participants also completed another study for a different research project. All questions were administered through the Survey Monkey (https://surveymonkey.com) platform. For analysis of the recommended songs, we first utilised the Spotify search algorithm to retrieve the closest song (track) match to the participant-provided song titles and artist names. These were then confirmed manually, and amended where necessary, and music features (including energy) were extracted from the Spotify API. A minority of participants provided artist names without song titles, so we extracted features for all songs by that artist on the Spotify platform, and averaged their scores for a single score per feature. In sum, we obtained participant preferences for specific songs for downregulation of each of the negative emotion contexts, with the emotion induction task contributing towards the ecological validity of the experiment.

Results

Manipulation Checks. We first examined the emotion ratings for sadness, anxiety and anger after the emotion induction recall/writing task. Separate 2x3 ANOVAs with country (US or Japan) and negative emotion (sad, anxiety, and anger) conditions were conducted with participant-rated sadness, anxiety, and anger. For rated sadness, the model was significant, $F(5,347) = 10.4$, $p < .001$. Significant main effects were observed for country, $F(1,347) = 18.4$, $p < .001$, $\eta^2_p = 0.05$, and induced negative emotion, $F(2,347) = 15.7$, $p < .001$, $\eta^2_p = 0.08$. However, no significant interaction was observed between country and induced negative emotion, $F(2,347) = 0.13$, $p = .881$. Post-hoc Holm-Bonferroni corrected pairwise comparisons revealed that rated sadness was generally higher in Japan than the US ($t(347) = 4.29$, $p < .001$, Cohen's d = 0.46). Rated sadness was also higher in the induced sadness condition than in the induced anger ($t(347) = -5.07$, $p < .001$, Cohen's d = 0.66), and induced anxiety conditions ($t(347) = -4.46$, $p < .001$, Cohen's d = 0.57).

For rated anxiety, the model was significant, $F(5,347) = 6.47$, $p < .001$. Significant main

effects were observed for country, $F(1,347) = 15.7$, $p < .001$, $\eta^2_p = 0.04$, and induced negative emotion, $F(2,347) = 6.3$, $p = .002$, $\eta^2_p = 0.04$. However, no significant interaction was observed between country and induced negative emotion, $F(2,347) = 1.24$, $p = .290$. Post-hoc Holm-Bonferroni corrected pairwise comparisons revealed that rated anxiety was generally higher in Japan than the US ($t(347) = 3.97$, $p < .001$, Cohen's d = 0.42). Rated anxiety was also higher in the induced anxiety condition than in the induced anger condition ($t(347) = -3.52$, $p = .001$, Cohen's d = 0.47), but no significant differences were observed between induced anxiety and induced sadness conditions ($t(347) = 1.39$, $p = .165$, Cohen's d = 0.18).

Finally, for rated anger, the model was significant, $F(5,347) = 11.3$, $p < .001$. Significant main effects were observed for country, $F(1,347) = 16.6$, $p < .001$, $\eta^2_p = 0.05$, and induced negative emotion, $F(2,347) = 21.6$, $p < .001$, $\eta^2_p = 0.11$. However, no significant interaction was observed between country and induced negative emotion, $F(2,347) = 0.26$, $p = .769$. Post-hoc Holm-Bonferroni corrected pairwise comparisons revealed that rated anger was generally higher in Japan than the US ($t(347) = 4.07$, $p < .001$, Cohen's d = 0.44). Rated anger was also higher in the induced anger condition than in the induced anxiety ($t(347) = 6.41$, $p < .001$, Cohen's d = 0.86), and induced sadness conditions ($t(347) = 4.65$, $p < .001$, Cohen's d = 0.61). On the whole, we note that the emotion induction tasks were largely successful, though participants induced to feel anxiety also felt more intense sadness alongside anxiety, and Japanese participants appeared to have higher scores for emotion ratings than US participants (see Figure 3).

energy Differences Across Culture and Induced Emotions. An Analysis of Covariance (ANCOVA) model was fitted with country and negative emotions as independent variables, and Spotify's energy as the dependent variable. As age and gender have established effects on music preference (LeBlanc, Jin, Stamou, & McCrary, 1999), they were included as control variables in the model. The overall model was significant, $F(6,346) = 7.03$, $p < .001$, and significant effects were observed for Country, $F(1,346) = 23.3$, $p < .001$, $\eta^2_p = 0.063$, induced negative emotion, $F(2,346) = 4.18$, $p = .016$, $\eta^2_p = 0.024$, gender, $F(2,346) = 3.17$, $p = .043$, $\eta^2_p = 0.018$, and age, $F(1,346) = 18.3$, $p < .001$, $\eta^2_p = 0.050$. All categorical variables were simple coded, which involves centering to zero and comparing means with the reference level (Country: Japan, negative emotion: Anger, Gender: Female). As the interaction term between negative emotion and country was not significant, $F(2,344) = 2.96$, p

= .053, we excluded it from the model. In interpreting the effects, post-hoc Holm-Bonferroni corrected pairwise comparisons revealed significant differences between countries, in that Japan was higher than the US in energy (t(344) = 4.80, $p < .001$, Cohen's d = 0.56). Energy was significantly higher in the anger inductions than anxiety (t(346) = 2.68, $p = .023$, Cohen's d = 0.36), and sadness (t(346) = 2.34, $p = .040$, Cohen's d = 0.31), but no significant differences were observed for sadness and anxiety inductions (t(346) = -0.41, $p = .681$. Overall, energy appeared higher in songs listed by Japanese participants than US participants. Regardless of culture, energy also appeared higher in songs listed for anger downregulation than sadness or anxiety downregulation (see Figure 4).

We then examined the relationship between rated emotion scores for anger, sadness, anxiety, and general negative valence, and the energy levels of their listed songs. Using separate linear regression models, we regressed energy on the rated emotion terms, with controls for gender, age, and country. No significant association was observed for anger (model $R^2 = 0.092$; b =0.009, SE = 0.009, 95%CI[-0.004, 0.02], t = 1.32, $p = .189$), sadness (model $R^2 = 0.087$; b = 0.002, SE = 0.007, 95%CI[-0.01, 0.02], t = 0.29, $p = .769$), and anxiety (model $R^2 = 0.088$; b = 0.004, SE = 0.007, 95%CI[-0.01, 0.02], t = 0.52, $p = .769$), but a significant association was observed for general negative valence, in that higher ratings of negative valence (of participants' subjective emotional states) were associated with higher energy in their listed songs (model $R^2 = 0.098$; b = 0.01, SE = 0.007, 95%CI[0.0003, 0.03], t = 2.01, $p = .046$).

Additional analyses: Valence, danceability and Loudness. In addition to energy, we also examined valence and other measures of arousal in music: danceability, as a measure of rhythmic arousal, and Loudness, a measure of acoustic intensity arousal (Dean, Bailes, & Schubert, 2011), that is also a component of the 'energy' feature. Separate ANCOVA models were fitted with country and induced negative emotions as independent variables, gender and age as control variables, and Valence, danceability, or Loudness as the dependent variables. For valence, no significant effects were found: The overall model was not significant, F(6,346) = 0.73, $p = .632$, and no significant effects were observed for induced negative emotions, F(2,346) = 0.07, $p = .937$, or country, F(1,346) = 3.03, $p = .083$. Similarly, no significant effects were observed for danceability: The overall model was not significant, F(6,346) = 0.97, $p = .443$, and no significant effects were observed for induced negative emotions, F(2,346) = 0.48, $p = .617$, or country, F(1,346) = 0.55, $p = .457$. Finally, no

significant effects were observed for loudness: The overall model was not significant, $F(6,346) = 0.72$, $p = .632$, and no significant effects were observed for induced negative emotions, $F(2,346) = 0.07$, $p = .937$, or country, $F(1,346) = 3.03$, $p = .083$.

General Discussion

Both the secondary analyses and the conducted studies converge in showing two main results. 1) Rather than negative emotions in general, energy in music appears specifically associated with anger: In Secondary Analysis 2, the prevalence of Negative Emotions were consistently and robustly associated with the energy feature of the Spotify Top-50 charts, above and beyond the other indicators (music features) associated with rhythmic arousal (danceability), intensity (loudness), and valence. Furthermore, in Study 1, the energy of a song was robustly associated with its anger content in the lyrics, and in Study 2, participants induced to feel anger, would prefer to listen to high energy music for emotion regulation, than sadness or anxiety. 2) energy is robustly higher in the East than the West: The eight-country comparison in Secondary Analysis 1 showed that preferences for Energetic music was higher in East Asia than in the English-speaking West. Study 1 showed that energy was higher in Singaporean Top-50 songs than US Top-50 songs, and Study 2 showed that participants in Japan would choose to listen to more Energetic songs for negative emotion downregulation than participants in the US. Secondary Analysis 2 provides a brief insight into possible explanations: collectivistic countries, of which most East Asian countries can be categorised under, had Top-50 songs with more Energetic content.

How can we make sense of these findings? On their own, these main results point towards a simple interpretation. Energy, much like danceability, is a measure of the arousal of a song. Given that discharge regulation is a known function of music listening, Energetic music may be reflective of a tendency towards being used for downregulating anger in the listener (Study 2). As such, the higher energy scores of Top-50 music in countries with higher negative emotion prevalence would also be expected (Secondary Analysis 2). However, this contrasts with the previous explanation once we consider danceability. While energy and danceability scores are only weakly correlated (Secondary Analysis 2), danceability also robustly reflects the prevalence of negative emotions across cultures and the cultural tendencies towards discharge regulation in music (Liew et al., 2021a). Yet, where danceability

appeared to reflect the openness of a society towards HAN emotions, energy, with its association to collectivism, appears to reflect the opposite, and focuses specially on anger, rather than a more general spectrum of negative emotions or HAN emotions. We propose a potential explanation through a differing process of discharge regulation between danceability and energy. Danceability may reflect the externalizing, expressive tendencies of cathartic listening and is thus more common in loose societies which encourage the outward expression of negative emotions. Energy may reflect the internalizing tendencies of cathartic listening, and may be more common in collectivistic societies where anger control (see Spielberger, 2010) may be comparatively widely used as a regulatory strategy (as opposed to expression or suppression), and outward displays of negative emotions are also socially discouraged (Akutsu et al., 2016; Boiger, Mesquita, Uchida, & Barrett, 2013; Kitayama et al., 2015).

As anger is a resource-intensive emotion (Wilkowski & Robinson, 2007), it may require more resources to control and downregulate. For collectivistic societies, this may be through an internalization process: Energetic music, that is perceptually loud and sometimes noisy, may be needed to 'drown out' anger to keep it under control. Here, we speculate that these may necessitate defining rhythmic arousal as separate from intensity arousal as two distinct aspects of musical arousal with different uses, functions, and effects. However, more research is needed to clarify the role of these mechanisms for discharge regulation in cathartic listening. Furthermore, there could also be other reasons behind the relationship between collectivism and energy, such as collectivistic societies having a longer tradition of collective events and activities (Uchida et al., 2019), so they may simply be more accepting of louder, noisier music given the traditional use of such music in accompanying such festivities. Either way, more research is needed to validate these explanations, and we offer only a preliminary explanation on our findings on cultural differences in intensity and rhythmic arousal for HAN emotion downregulation through music.

Limitations

One large limitation of the study would be the difficulty we faced in defining Spotify's energy, which is defined by the service as a combination score of 'intensity' and 'activity'. On one hand, our results validate the intensity component, observed through a moderate to strong correlation with loudness, but on the other hand, we are yet unable to adequately

define 'activity'. Moreover, no significant differences were observed between emotion conditions for loudness in Study 2, and negative emotions were significantly associated with energy after controlling for loudness in Pilot Analysis 2. This suggests that the 'activity' component of energy may be important to studying the role of intensity arousal for anger or other HAN emotion downregulation. However, due to the proprietary nature of the energy feature, our results remain somewhat ambiguous, at least until future research can disambiguate the key elements behind this feature. Secondly, we note that for manipulation checks, Japanese participants generally rated higher scores on felt negative emotions than American participants. One explanation could be that Americans have strong motivations to reduce or avoid negative emotional experiences due to negative psychophysiological reactions to these emotions that are not experienced by Japanese (e.g., see Miyamoto et al., 2013; J. Park, Kitayama, Miyamoto, & Coe, 2019). I.e., Japanese participants in our study may have experienced stronger experiences of negative emotions from the recall task, as culturally they may not have been as incentivised to avoid these negative emotions as American participants, and may therefore have been more immersed in the task. In any case, we did not examine measurement equivalence or control for response bias between Japanese and Americans participants for the emotion manipulation task.

Finally, while 60-country and wider-scale East-West comparisons detect cultural differences in danceability, in Study 2, danceability did not differ significantly between music for downregulating recalled negative emotions, nor between Japan and the US. We think that danceability in Top-50 charts may represent a cultural phenomenon (overall usage/popularity) and a macro-level tendency for rhythmic arousal to downregulate negative emotions, which may not have been captured by our 2-country, individual-level study. At least, this shows the difference in usage and connotation between rhythmic and intensity arousal for emotion regulation, and more studies are needed into the specifics of both forms of arousal and their underlying mechanisms. Future studies can also take into account additional domains of music features for emotion regulation in music, beyond just valence and arousal (e.g., Cowen, Fang, Sauter, & Keltner, 2020).

In conclusion, we demonstrate that the two identified main results appeared robust and present even in real-world data, across a number of methods and approaches. Energetic music appears widely used to reflect cultural prevalence of anger, through cathartic listening and

downregulation effects. However, Energetic music appears stronger in music from East Asian, collectivistic societies, than Anglo-Western, individualistic cultures, which we speculate as being due to an internalization process ('drowning out') in anger downregulation.

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	danceability	energy	Loudness	Valence
danceability	-			
energy	0.162***	-		
Loudness	0.338***	0.730***	-	
Valence	0.297***	0.271***	0.271***	-

Table 1

*Correlations between danceability, energy, Loudness, and Valence of songs on global Top-50 charts from 60 Countries. Coefficiants are from Spearman's ρ, and *** indicates $p < .001$.*

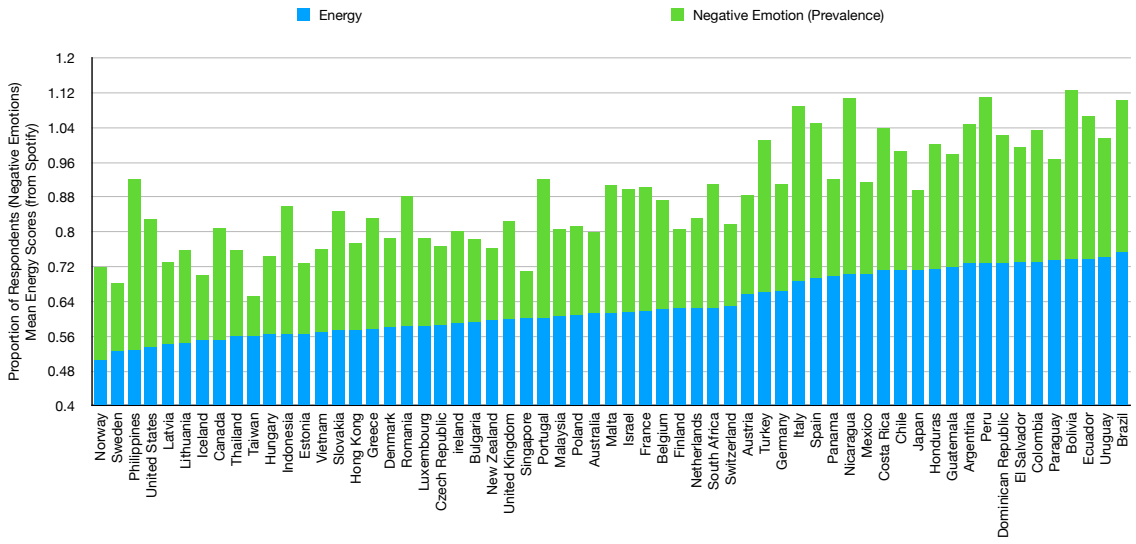

Figure 1. Ranking of countries' negative emotion prevalence. These are the proportion of participants who experienced anger, sadness, or worry, in the day prior to survey participation (Helliwell et al., 2019). For these countries, we also display the mean energy score, averaged from their Top-50 charts. Values from both indexes were ranged between 0 to 1, and are visualized on the same axis.

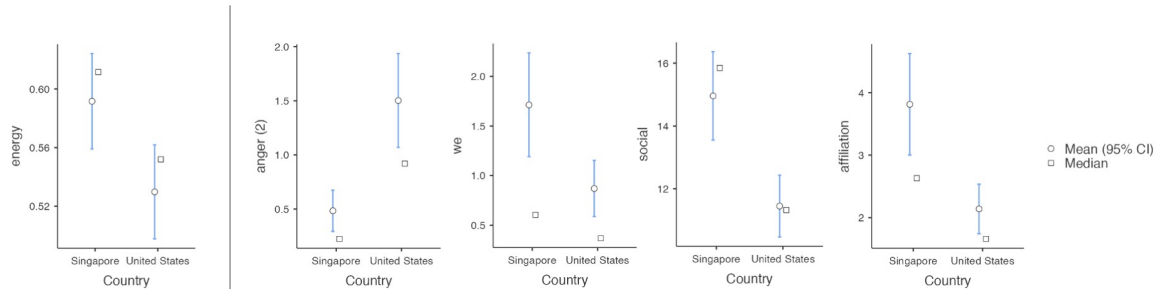

Figure 2. Pairwise comparisons of significant differences between Singapore and US Top-50 English songs for energy and LIWC collectivism/individualism and emotion-related categories.

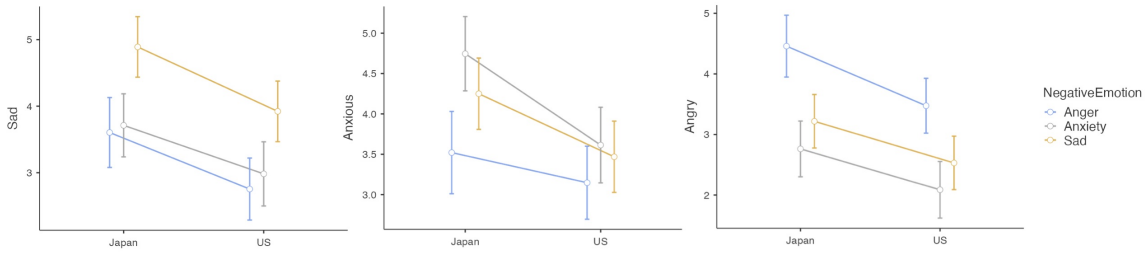

Figure 3. Participant ratings of anger, sadness and anxiety, for each of the induced negative emotions (sadness, anxiety, and anger), from the US and Japan.

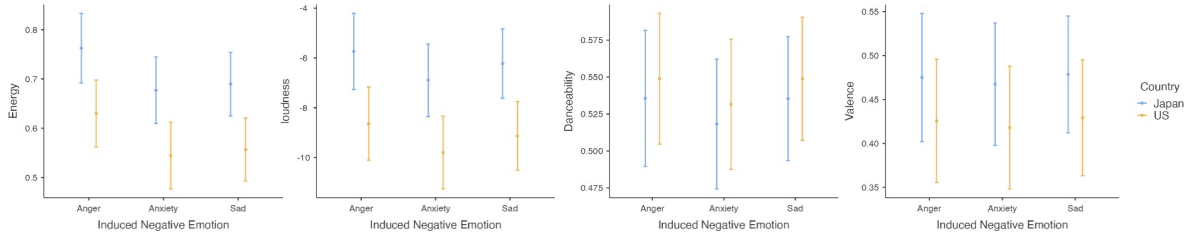

Figure 4. energy, Loudness, danceability, and Valence in participant-provided songs for negative emotion downregulation, sorted by induced negative emotion and culture.