MUSICAL MODE PERCEPTION

By

Carson Kiriakopoulos

Department of Psychology

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Faculty of Arts and Social Science

Huron University College

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CERTIFICATE OF EXAMINATION

Advisor: Dr. Stephen Van Hedger

Reader: Dr. Tara Dumas

The thesis by:

Carson Kiriakopoulos

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Date	Chair of Department

Abstract

Listening to music can make us happy, or it can bolster our melancholy. To what extent are these reactions related to the collections of notes that are used in a piece of music? In the current study, we aimed to assess the perceptual differences between the six historical modes (scales) of the Western music system (Ionian, Lydian, Mixolydian, Aeolian, Dorian, Phrygian), to help answer this question. Participants listened to several kinds of musical stimuli, representing the six historical modes, that varied in ecological validity (ranging from random tone sequences to musical melodies). Participants rated the stimuli along several dimensions (*happy-sad*, *dark-light*, *exotic-familiar*, *tense-relaxed*, *unpleasant-pleasant*), using bipolar adjectives. We predicted that modes highest in pitch height (Lydian, Ionian) would be rated more positively, while modes lowest in pitch height (Aeolian, Phrygian) would be rated more negatively. Our results indicated that the overarching major-minor categorizations of the modes (i.e., whether the mode contains a major or minor third) influenced participant responses, with there being no discernible differences between modes within these general categories (e.g., between Lydian and Ionian, which are both major modes). When modifying the paradigm to have participants rate a less common mode (e.g., Lydian) against a common mode (e.g., Ionian), we found that the less commonly heard mode was generally rated more negatively (i.e., sadder, darker, more tense, etc.), regardless of pitch height. Overall, these results suggest that listeners base their judgments of musical modes on both their major-minor qualities and on familiarity. Implications for interpreting the results and further research are discussed.

*Keywords***:** music perception, emotion, cross-modal associations, musical modes

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Introduction

When we hear a song like *Africa*, by Toto, we might think the melody sounds particularly bright and cheerful. In contrast, when listening to a song like *Something in the Way* by Nirvana, we might think the melody sounds rather dark and brooding. Although there are many variables that differ between these songs (e.g., genre, instrumentation, vocal characteristics of the lead singer) that may contribute to these perceptions, one relatively unexplored factor is the fact that both songs differ in their musical *mode.* The present study investigates how musical mode influences both emotional and broader categorizations of music in Western listeners.

Overview of Historical Modes

In Western music, mode refers to the specific collection of pitches that are diatonic (i.e., sound like they belong) in a musical context. Although there are 12 distinct pitch classes in Western music, musical modes consist of different collections of seven notes each. Differences in musical modes are based on the intervallic structure of adjacent notes, as each mode is made up of different combinations and orders of half-tone (e.g., C to C#) and whole-tone (e.g., C to D) intervals. There are seven historical modes in the Western music system: Ionian, Lydian, Mixolydian, Aeolian, Dorian, Phrygian, and Locrian. Table 1 provides an overview of the defining intervallic features of each historical mode.

These historical modes have existed for thousands of years. The concept of scalar modes can be traced back to ancient Greece, and the scalar modes have been refined to suit the Western musical system. Even the names of the historical modes are derived from cultural groups stemming from different regions in ancient Greece. Although perceptions and underlying emotional associations have been tied to these modes since their inception, these associations have shifted over time and thus suggest a degree of cultural influence. For example, in Plato's

Republic, Socrates and Glaucon deliberate on the utility of "harmonies" (modes) as a function of their effect on peoples' actions. They conclude that the Mixolydian mode is a "lamenting" harmony that should be excluded as it does not help men and women "be as good as they should be" (Plato, ca. 375 B.C.E./2004, 80). Further to this, Glaucon responds to Socrates' inquiry about "soft harmonies, suitable for drinking parties" by providing him with the Ionian and Lydian modes (Plato, ca. 375 B.C.E./2004, 81). Discussion about musical modes and their associated qualities occurs in Aristotle's *Politics* as well, with claims such as, "The musical modes differ essentially from one another, and those who hear them are differently affected by each" (Aristotle, ca. 350 B.C.E./1887, 187). At this time, it was understood that Mixolydian makes men "sad and grave", Phrygian inspires enthusiasm, Dorian produces a "moderate and settled temper" and is an "ethical mode" thus it should be used for educational purposes (Aristotle, ca. 350 B.C.E./1887, 187-191).

Historical Modes and the Major-Minor Dichotomy

Although there are seven distinct historical modes, these modes can be divided based on their adherence to the "major" and "minor" modalities. The "major" modes contain a "major third" interval between scale degrees one and three, whereas the "minor" modes contain a "minor third" interval between scale degrees one and three. Using Table 1 as a reference, the "major" modes are (1) Ionian, (2) Lydian, and (3) Mixolydian, as these modes contain a major third between the first note (C) and the third note (E), and the "minor" modes are (1) Aeolian, (2) Dorian, (3) Phrygian, and (4) Locrian, as these modes contain a minor third between the first note (C) and the third note (Eb).

Table 1: Representation of different historical modes in Western music

Mode	Intervallic Structure	Sample Scale
Aeolian (Natural Minor)	**W-H-W-W-H-W-W**	**C-D-Eb-F-G-Ab-Bb-C**
Dorian	W-H-W-W-W-H-W	C-D-Eb-F-G-A-Bb-C
Phrygian	H-W-W-W-H-W-W	C-Db-Eb-F-G-Ab-Bb-C
Locrian	H-W-W-H-W-W-W	C-Db-Eb-F-Gb-Ab-Bb-C
Ionian (Major)	**W-W-H-W-W-W-H**	**C-D-E-F-G-A-B-C**
Lydian	W-W-W-H-W-W-H	C-D-E-F#-G-A-B-C
Mixolydian	W-W-H-W-W-H-W	C-D-E-F-G-A-Bb-C

Note: The major and minor modes, represented in bold, are commonly encountered in Western music, whereas the other historical modes are encountered less frequently and have been the subject of significantly less empirical work. In the middle column, W refers to a whole step and H refers to a half step between adjacent notes in the mode. In the rightmost column, a sample scale is provided for each mode beginning on the musical note C.

Thus, the seven historical modes listed in Table 1 can be broadly characterized in terms of whether they are “major” or “minor.” However, most contemporary tonal music adheres to just two of these seven modes, both in terms of frequency of use and existing empirical research. Specifically, the Ionian (major) and Aeolian (minor) modes are the most common modes in popular music (e.g., De Clercq & Temperley, 2011; Koelsch, 2009), and their broader emotional associations are also the most well researched (e.g., see Carraturo et al., 2023 for a recent meta-analysis). In fact, the Aeolian mode is often used interchangeably with the “minor” mode and the

Ionian mode is often used interchangeably with the "major" mode, even though a broader set of historical modes can be classified as major or minor as noted previously.

In terms of contemporary emotional associations, Western listeners tend to perceive the Aeolian mode as sad and the Ionian mode as happy (e.g., see Crowder, 1984; 1985, Parncutt, 2014). A recent meta-analysis concluded that the literature (69 surveyed studies) provided qualitative and quantitative evidence of distinct behavioural, and neural responses elicited by the major and minor modes. This supports the existence of a "major-minor mode dichotomy" and furthers the notion that there are salient differences that listeners experience when they listen to music with different modes (Carraturo et al., 2023). However, as alluded to previously, this work does not formally distinguish the contributions of less common modes (e.g., Phrygian, Lydian) and even if these modes are included in this work, the overrepresentation of Aeolian and Ionian modes in contemporary music makes it difficult to independently assess listener associations from this work.

Perceptions of major and minor modes have also been explored developmentally and cross-culturally. For example, Dalla Bella et al. (2001) investigated how Western children use both tempo (the speed of the music) and mode (major, minor) in making valenced judgments about a piece of music (specifically, whether it was perceived as happy or sad). The authors found that tempo emerged earlier as a reliable cue for indicating valence; however, children could reliably use mode as a means of determining emotional valence in music by 6-8 years old. These findings suggest that the association of musical modes with emotions are culturally learned. In support of these findings, Fang et al. (2017) investigated how the major and minor modes were perceived among Chinese listeners. The researchers reported that the major mode significantly induced greater feelings of pleasure and arousal, as well as higher liking ratings than the minor mode stimuli. They found that the minor mode stimuli induced greater tension than the major mode. Participants' preferences for musical mode were influenced by their previous exposure to Western music. Taken together, these results suggest that the robust associations seen between major and minor modes with happiness and sadness, respectively, require cultural shaping (i.e., the collections of notes do not inherently convey happiness or sadness). However, once again, this work has tended to focus on the Aeolian and Ionian modes as representative of minor and major modes, respectively.

Why might major and minor modes be associated with happiness and sadness, respectively? One possibility is that these are essentially arbitrary associations that are culturally determined. Support for this position in principle comes from the previously discussed developmental and cross-cultural research, suggesting that these associations are learned. However, just because these associations are culturally shaped does not necessarily mean that they are entirely arbitrary. Intriguing work has pointed to the use of the minor third in conveying sadness in speech (Curtis & Bharucha, 2010), suggesting that these associations are not just limited to musical contexts.

Another possibility is that because major and minor modes differ in their overall pitch height (as the minor third represents a smaller interval than the major third), listeners can use *conceptual metaphors* to map these differences in pitch height onto a variety of other dimensions, including emotional categories. This possibility is supported by several findings. First, listeners reliably describe higher pitches as (1) lighter, (2) happier, and (3) prettier, suggesting that the pitch height differences between major and minor modes could be driven in part by these more general associations with pitch height (Eitan & Timmers, 2010). Second, classification of musical sequences as major or minor is influenced by the pitch contours of the melody, such that major modes are easier to identify if the scale or melody has a rising contour and minor modes are easier to identify if the scale or melody has a falling contour (Burnham et al., 2021). Third, higher pitches are associated with happiness even within an unfamiliar musical tuning system, suggesting that listeners can apply a “higher-pitches-are-happier” conceptual metaphor to novel contexts (Friedman et al., 2018).

Contemporary Research on Historical Modes

Although the “higher-pitches-are-happier” metaphor should in principle apply to the historical modes beyond the Aeolian and Ionian modes, there has been relatively little work examining this research question. Based on this framework, however, clear predictions emerge with respect to how each mode might be perceived. As noted earlier, there are three “major” modes and four “minor” modes. Interestingly, the Ionian mode (i.e., the standard major scale) and the Aeolian mode (i.e., the natural minor scale) would *not* be predicted to be the happiest and saddest modes based on pitch height associations alone. Rather, the Lydian mode (which contains a raised fourth relative to the Ionian mode) would be expected to be rated the happiest, and the Phrygian or Locrian mode (which both contain lowered seconds relative to the Aeolian mode) would be expected to be rated the saddest. These findings were largely supported by a study conducted by Temperley and Tan (2013). This study assessed the emotional associations of different historical modes by asking participants to compare pairs of melodies (identical in pitch contour but differing in mode) and indicate which of the two was happier. They found that as scale-degrees are raised in modes, participants were more likely to report that the melody was happier. An exception to this was the Lydian mode, which was rated as less happy than Ionian, despite having a raised fourth degree and thus being predicted to sound the happiest based on an explanation of pitch height. Temperley and Tan (2013) suggest the perception of “happiness” is strongly influenced by familiarity for the Ionian mode as it is the most common mode, but for the less common modes, their “sharpness” or average pitch height may be the best clearest explanation of perceived happiness.

Another study by Ramos et al. (2011) assessed the effects of historic modes and tempo on emotional perception and arousal levels, specifically comparing responses from both musicians and non-musicians. Overall, the researchers found that the three major modes (Ionian, Lydian, Mixolydian) were more positively valenced than the minor modes. Additionally, increasing the tempo of the music increased the arousal ratings and had a mostly additive effect on the perceived valence (i.e., faster tempos were generally reported as more positively valenced).

Straehley and Loebach (2014) similarly assessed participants’ perceptions of emotion in stimuli differing in musical mode. In this study, participants were exposed to both scales and compositions derived from the seven historical modes. Participants were exposed to quasi-randomly generated melodies that either had an ascending pitch contour, a descending pitch contour, or a centered pitch contour. Researchers reported consistent emotional attributions, using a more detailed circumplex model of emotions, to the modes in line with prior work (i.e., that major modes were perceived more positively), which were consistent across variation in musical experience.

Taken together, these findings suggest that listeners possess consistent emotional associations with different historical modes beyond the commonly encountered Aeolian and Ionian modes. However, there are several unanswered questions within this relatively small body of research. First, it is unclear whether listeners also display broader conceptual associations, beyond emotional valence, with these historical modes in line with the reported cross-modal associations of auditory pitch (Eitan & Timmers, 2010). Anecdotally, these conceptual associations are used in lay descriptions of the historical modes – for example, referring to the Lydian mode as the “lightest” and the Phrygian mode as the “darkest” (Bennet, 2021; Leach, 2021), but it is unclear whether listeners hear these modes as actually differing in brightness, at least when divorced from additional relevant nonmusical context. For example, the *Main Theme* from the film *Jurassic Park*, composed by John Williams, has been described as hopeful and uplifting, which may be attributed to the piece’s use of the Lydian mode (which is commonly associated with similar labels like brightness) or may alternatively be driven be the larger context of the experience (as it is played the first time viewers see a dinosaur in the film). Second, the extant research examining perceptions of the historical modes have used highly variable stimuli, ranging from quasi-randomly generated pure tones (Straehley & Loebach, 2014) to well-formed compositions (e.g., Temperley & Tan, 2013). This makes it more difficult to assess whether consistent perceptions of historical modes vary as a function of *ecological validity* – i.e., how well the musical sequences emulate musical experienced outside of a research context. Gaining a better understanding of how perceptions vary as a function of ecological validity is important, as previous work has suggested that many listeners may not even be able to differentiate categories of major and minor chords when presented in a more artificial “tone scramble” (Chubb et al., 2013).

The Present Research Question

The present study addresses the two primary gaps identified in the previous paragraph, by (1) assessing listener ratings of historical modes beyond emotional valence, and (2) systematically varying the ecological validity of the presented musical sequences, ranging from randomly generated sequences to altered familiar pieces of music. Participants rated sounds adhering to the historical modes along several dimensions, including *happy-sad* (serving as a conceptual replication of previous work) but also *bright-dark*, *familiar-exotic*, *relaxed-tense*, and *pleasant-unpleasant*. Based on cross-modal associations with pitch height (Eitan & Timmers, 2010), we predicted that the modes highest in pitch height (e.g., Lydian, Ionian) would be rated as brighter and more pleasant than the modes lowest in pitch height (e.g., Aeolian, Phrygian). Based on Temperley and Tan (2013), who found strong effects of familiarity in listener ratings, we additionally predicted that participants would rate the Ionian and Aeolian modes as the most familiar, followed by Mixolydian and Dorian modes (as these are sometimes encountered in jazz and pop music), and then finally followed by Lydian and Phrygian modes. We additionally predicted that the *relaxed-tense* dimension would largely follow the same pattern of results as what was predicted for the familiarity dimension, perhaps with some movement in the Mixolydian mode, which lowers the seventh scale degree and thus attenuates the described tension between scale degree seven and scale degree one in other diatonic scales. Finally, we predicted that these patterns of ratings would become more pronounced as a function of ecological validity, as a higher degree of ecological validity would allow listeners to generate stronger predictions about the music (cf. Tillmann et al., 2013) and thus appreciate the subtle differences between the musical modes.

Method

Participants

Participants were primarily recruited from the Sona Systems (https://www.sona-systems.com) research participation system at Huron University. A total of 52 individuals participated in the study; however, six participants were excluded from analyses for failing auditory or visual attention checks, leaving 46 analyzable participants in the sample (M = 18.68 years old, SD = 1.22 years, range of 17 to 22 years old). The gender breakdown of the sample included 27 women, 16 men, 1 non-binary person, 2 people who responded that they did not identify with any of the provided options, or they preferred not to respond. Most of the participants reported spending most of their lives in either Canada or the United States (n = 43), with a small subset reporting African countries (South Africa: n = 1; Nigeria: n = 1) and one participant not responding. The study was approved by the Huron Research Ethics Board (17S-202411) and all participants were treated in accordance with the Declaration of Helsinki.

Materials

The experiment was programmed in jsPsych version 7 (de Leeuw et al., 2023) and participants accessed the study via their own computers. In the following subsections, the specific scales and stimuli used in the study are described in detail.

Musical Sophistication

Musical experience was assessed using the Goldsmiths Musical Sophistication Index (Gold-MSI; Müllensiefen et al., 2014). The Gold-MSI is a 40-item inventory, assessing an individual's (1) active engagement with music, (2) musical training history, (3) perceptual abilities, (4) singing abilities, and (5) emotional association with music. In the present study, a general sophistication measure was created from a subset (n = 18) of the total items, as noted by Müllensiefen et al. (2014).

Musical Stimuli

General Stimuli Parameters. For three stimulus types (random sequences, scales, novel melodies) we used six different starting notes/keys (G3, G#3, C4, C#4, F4, F#4) to control for variations in average pitch height as a confounding variable. The script randomly assigned one of the six historical modes (Phrygian, Aeolian, Dorian, Mixolydian, Ionian, Lydian) to one of the six starting notes/keys without replacement per stimulus type. For example, if the Ionian scale started on G3, no subsequent scale would start on G3. This approach prevented participants from relying exclusively on absolute pitch height to make distinctions between the stimuli, while also providing a more balanced distribution of white and black keys and ensuring that the relative occurrence of black and white keys was not confounded with mode. The balance of black and white keys is important as previous work has suggested that listeners have different aesthetic preferences for white versus black keys (Ben-Haim et al., 2014) and rate key signatures with greater numbers of black keys as more tense (Eitan et al., 2017).

Randomly Generated Sequences. Each randomly generated sequence consisted of 27 notes (200 ms per note, with a total duration of 5400 ms). Out of the 27 notes per sequence, the octaves (roots) were represented six times – three for the lower root, and three for the higher root. Moreover, the defining note for each mode (e.g., the sharpened fourth for the Lydian mode, the flattened seventh for the Mixolydian mode) was also played a total of six times to emphasize the differentiating qualities of each mode. The remaining five notes of the scale were relatively underemphasized, as they each occurred a total of five times. There were six versions of each randomly generated sequence – one per starting note/key (G3, G#3, C4, C#4, F4, F#4), with the specific assignment of mode to starting note/key being randomly determined for each participant. The randomly generated sequences were generated in Matlab (MathWorks: Natick, MA) with a customized, complex harmonic structure and a percussive sound envelope.

Scale Stimuli. Scale stimuli were created in MuseScore (Muse Group: Limassol, Cyprus) with a grand piano timbre. Each scale was first played in an ascending order, which was then followed by a descending order, with the root notes being held for longer (600 ms) than the interim notes (300 ms). The final root note of each scale was held for 2200 ms, meaning each scale stimulus was 7000 ms in length. Similar to the randomly generated sequences, there were six versions of each scale – one per starting note/key (G3, G#3, C4, C#4, F4, F#4), with the specific assignment of mode to starting note/key being randomly determined for each participant.

Novel Melodies. Similar to the scale stimuli, the novel melodies were created in MuseScore with a grand piano timbre. Six novel melodies (M = 16.63 s, SD = 2.75 s, range of 14.0 to 19.4 s) were composed specifically for this study, with one melody being originally composed for each of the six tested modes (i.e., a melody originally composed in Phrygian mode, a melody originally composed in Aeolian mode, etc.). Although the six composed melodies were originally written for one of the six modes, each melody was subsequently modified such that it had six different versions – one for each mode. This was done to ensure that any implicit biases in the compositional process (e.g., unintentionally composing the Lydian mode melody to be faster or "lighter" based on non-scalar features) would not be confounded with mode category. Given the manipulation of starting note/key, which was done in a similar manner as the random sequences and scales, there were thus 36 variants of each "base" melody (6 modal variants x 6 starting note/key variants). Each base melody was randomly assigned a specific mode/key combination without replacement (e.g., if base melody 1 was assigned to be Lydian and be in the key of C, no other melody could be Lydian or in the key of C for that participant). Importantly, each melody was composed to ensure that all 7 scale degrees were used, meaning each melody would be able to convey its modal characteristics regardless of the mode to which it was assigned. The average length of each melody was 16.63 seconds, with a standard deviation of 2.75 seconds. The shortest melody was 14.0 seconds, while the longest was 19.4 seconds.

Familiar Melodies. The familiar melodies were created in MuseScore with a string timbre. Four traditional melodies were used – two in the Ionian mode (*Jingle Bells*, *Joy to the World*) and two in the Aeolian mode (*Carol of the Bells, O Come, O Come, Emmanuel*). *Jingle Bells* was 10 seconds in duration, *Joy to the World* was 10 seconds in duration, *Carol of the Bells* was 7.8 seconds in duration, and *O Come, O Come, Emmanuel* was 14.5 seconds in duration. Altered versions of each melody were created by modifying the relevant scale degree (e.g., raising the fourth scale degree to create Lydian versions of *Jingle Bells* and *Joy to the World*). Altered versions of each melody stayed within the general major-minor distinction (e.g., *Jingle Bells* was not altered to be in any minor mode). In addition to the melodic line, each recording also contained a "drone" consisting of the root and fifth, in an effort to emphasize the altered scale degrees relative to these constant notes. Unlike the other stimulus types, the familiar melodies were always presented in the key of C major (Ionian) or A minor (Aeolian), meaning the unaltered versions of each familiar melody only used white key notes. Melody order was randomized; however, each trial always began with the standard (Ionian or Aeolian) version of the melody, followed by the altered version (Lydian or Mixolydian if Ionian, Phrygian or Dorian if Aeolian).

Procedure

When participants clicked on the study link, they were first presented with a Letter of Information describing the purpose of the study, and what would be required of them to participate in the study. Participants were then presented with a consent page, in which they were required to select "I agree to participate" to continue with the study. If they selected "I do not agree to participate" they were shown a message thanking them for their interest in the study, and no data were saved.

Following the consent procedure, participants completed a basic auditory calibration. During this calibration, participants listened to a sample of pink noise which was root-mean-square normalized to the same amplitude as the testing stimuli, and they were asked to adjust their volume levels to a comfortable listening level. Participants were also asked to report if they were wearing headphones (*Yes*, *No*). Although headphone use was not required, 17 of the 46 participants (37%) reported wearing headphones. Participants were also required to self-report the noise level of their listening environment on a Likert-type scale, ranging from 0 (*Quiet*) to 3 (*Very noisy*). The mean of the noise-level responses was 0.53, with a standard deviation of 0.58. This corresponds to a value that falls between *Quiet* and *A little noisy* on this response scale.

Once the participants completed the auditory calibration, they were then presented with the main task. There were four testing blocks of musical sounds, which were presented in a fixed order (random sequences, scales, novel melodies, familiar melodies). For the first three blocks (i.e., random sequences, scales, novel melodies), there were six trials (one per tested mode) in each block. For the familiar melody block, there were four trials (Aeolian – Phrygian comparison, Aeolian – Dorian comparison, Ionian – Mixolydian comparison, Ionian – Lydian comparison). For the familiar melodies, the “standard” melody was always presented first and the “altered” melody was always presented second. Following each sound (or sounds in the case of the familiar melody trials), participants were provided with a rating screen, which displayed five slider scales anchored with bipolar adjectives (*sad-happy, dark-light, tense-relaxed, exotic-familiar, unpleasant-pleasant*). Participants were instructed to rate each sound based on how strongly it represented each term. For the familiar melody trials, in which participants heard two melodies, the instructions were modified slightly to direct participants to rate the second (“altered”) melody relative to the first (“standard”) melody. Participants were also able to replay the sound (or sounds in the case of the familiar melody trials) on the rating screen by clicking on an on-screen button. Figure 1 provides a screenshot from the rating screen.

Immediately after the main task, participants were presented with an explicit mode identification task. Participants heard each of the six modes (in scale form) in a randomized order. On each trial, after hearing one of the randomly selected modes, they provided a forced-choice judgment as to which scale they heard (six buttons on the screen labeled with each mode). This was administered to assess whether participants had explicit categories for the modes tested in the present experiment.

Following the explicit identification task, participants completed the Gold-MSI and short demographic questionnaires. The demographic questions included participants' age, gender, and the country in which participants spent the majority of their childhood.

Following the questionnaires, participants were provided with a Debriefing Letter describing the purpose of the study. Participants were then given the option to either receive course research credit or be entered into a prize raffle. Participants were only able to select one option, and upon clicking on the option they were redirected to a secondary site (Sona if course credit and a Qualtrics form for entering their email if they selected prize raffle).

Attention Checks

Because this was a self-administered online study, attention checks were implemented to ensure the integrity of participant responses. Both auditory and visual attention checks were used. There were four auditory checks throughout the study: one per block of stimuli. There was no visual prompt in these checks, just an auditory prompt instructing participants to press the spacebar within five seconds. If participants failed to do this, the script moved on automatically, but the trial was logged as a “timeout”. Participants could not fail more than once; if they did, their responses were excluded from analysis (n = 3). Two visual attention checks were embedded within the Gold-MSI, instructing participants to respond in a certain manner (e.g., “Select *Strongly Disagree* on this trial”). Participants could not fail more than once, if they did, their responses were excluded (n = 3).

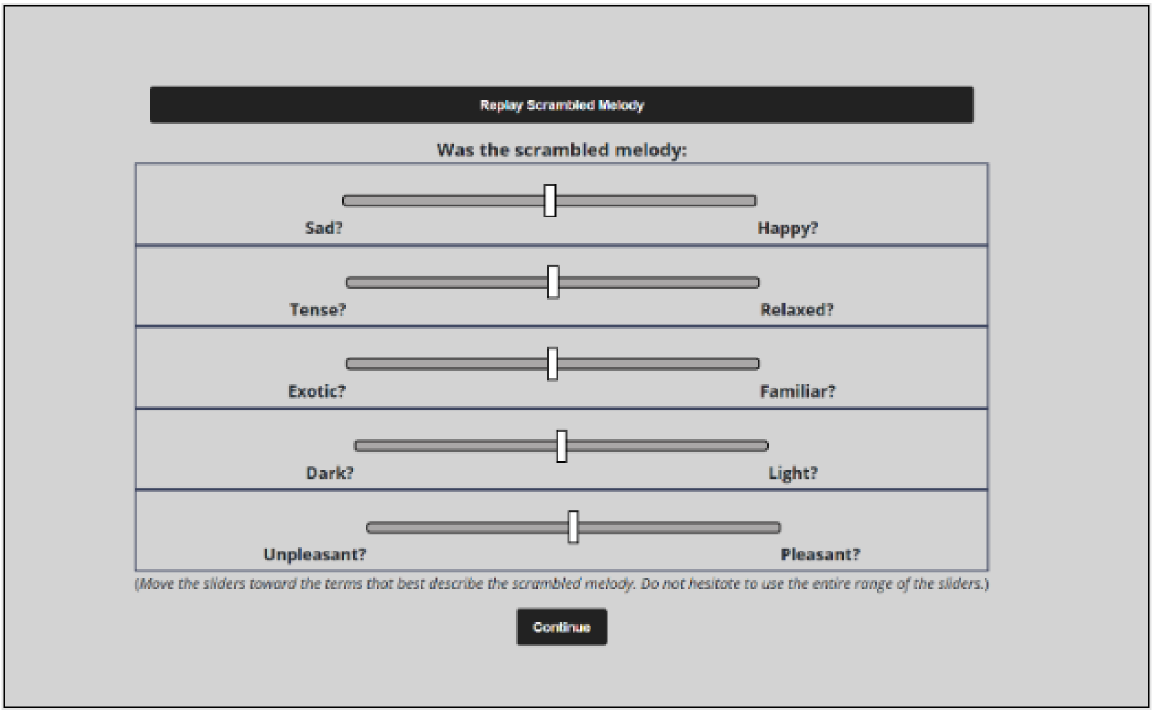
Data Analysis

Correlations among the different rating terms were assessed via Pearson Product-Moment Correlations. For the first three types of rated sounds (random sequences, scales, novel melodies), in which participants only heard a single mode on each trial, we used a 6 (mode: Phrygian, Aeolian, Dorian, Mixolydian, Ionian, Lydian) x 3 (type: random sequences, scales, novel melodies) repeated measures ANOVA. We created separate ANOVA models for each of the five ratings (*sad-happy*, *dark-light*, *tense-relaxed*, *exotic-familiar*, *unpleasant-pleasant*). Each ANOVA additionally included overall musical sophistication (assessed via the Gold-MSI) and explicit mode recognition accuracy as covariates. Post-hoc tests, when used, employed Bonferroni-Holm corrections.

For the final block of familiar melodies, in which participants listened to two versions on each trial (a “standard” version in either Aeolian or Ionian and an “altered” version in one of the historical modes), we changed the analytic approach as the ratings reflected a *relative* judgment (i.e., how the “altered” melody was perceived relative to the “standard” melody). We subtracted 50 from each rating which, given the 100-point scale, transformed the ratings such that a value of zero represented no discernible difference between the “standard” and the “altered” melody. We thus ran a series of one-sample *t*-tests against a known mean of zero to assess whether the “altered” melody was rated differently from the “standard” melody. Separate tests were run for each trial type (Aeolian-Phrygian, Aeolian-Dorian, Ionian-Mixolydian, Ionian-Lydian) and each rating (sad-happy, dark-light, tense-relaxed, exotic-familiar, unpleasant-pleasant).

Figure 1

Sample response screen from the study (random sequence trial)



Results

Correlations Among Terms

Table 2 report the Pearson correlations for each of the ratings terms across all stimuli. With the exception of one correlation (exotic-familiar ratings with sad-happy ratings), all other terms were significantly and positively correlated.

Table 2

Correlation matrix of slider ratings

	Sad-Happy	Tense-Relaxed	Exotic-Familiar	Dark-Light	Unpleasant-Pleasant
Sad-Happy	-				
Tense-Relaxed	.49***	-			
Exotic-Familiar	.26	.43**	-		
Dark-Light	.77***	.61***	.41**	-	
Unpleasant-Pleasant	.44**	.45*	.38**	.32*	-

Note: * $p < .05$ ** $p < .01$ *** $p < .001$

Single Judgment Trials

Sad-Happy Ratings

For the sad-happy ratings, there were significant main effects of both mode, $F(5, 215) = 7.90$, $p <.001$, $\eta^2 = .050$, and stimulus type, $F(2, 86) = 10.01$, $p < .001$, $\eta^2 = .033$. There was additionally a significant interaction between mode and stimulus type, $F(7.76, 333.61) = 3.37$, $p = .001$, $\eta^2 = .034$, suggesting that the ratings of mode differed across the stimulus types. There were no other significant terms in the model.

Post-hoc tests showed that there were no significant differences between any of the modes in the random sequence condition. In contrast, for the scale ratings, all the minor modes (Phrygian, Aeolian, Dorian) were rated as significantly sadder than all the major modes (Mixolydian, Ionian, Lydian), with the exceptions of Aeolian and Mixolydian ($p = .225$), and Mixolydian and Phrygian ($p = .068$). Within each category of mode (major, minor), there were no significant differences in ratings. For the novel melodies, the only significant differences were once again across mode categories (i.e., minor modes being rated as sadder than major modes);

however, there were fewer significant contrasts compared to the scales. Specifically, the contrasts between (1) Aeolian and Ionian, (p = .003) (2) Aeolian and Mixolydian (p = .021), (3) Dorian and Ionian (p = .003), (4) Dorian and Mixolydian (p. = .020), and (5) Ionian and Phrygian (p = .018) were all significant.

Tense-Relaxed Ratings

For the tense/relaxed ratings, there were significant main effects of both mode, $F(5, 215) = 4.01$, $p = .002$, $\eta^2 = .02$, and stimulus type, $F(2, 86) = 11.47$, $p < .001$, $\eta^2 = .029$. There was additionally an interaction between explicit mode accuracy and stimulus type, $F(2, 86) = 3.12$, $p = .049$, $\eta^2 = .008$. There were no other significant terms in the model.

Post-hoc tests showed that the interaction between explicit mode accuracy and stimulus type was driven by the novel melody ratings. Both the high and low explicit mode accuracy groups rated the random sequences as significantly more tense than scales (p = .019, p = .003, respectively). The high and low explicit mode accuracy groups also rated the scales and the novel melodies comparably (p = .067 and p= .088, respectively). However, participants low in explicit mode accuracy rated novel melodies as significantly more relaxed than the random sequences (p < .001), whereas participants who were high in explicit mode accuracy rated the novel melodies and the random sequences comparably (p = .540). The main effect of mode once again was characterized by a general major-minor differentiation. The only two contrasts that were significant once correcting for multiple comparisons were Ionian compared to Dorian (p = .020) and Ionian compared to Phrygian (p = .030).

Dark-Light Ratings

For the dark-light ratings, there was a significant effect of mode $F(5, 215) = 6.13$, $p < .001$, $\eta^2 = .035$, as well as a significant interaction between mode and stimulus type $F(10, 430) = 2.14$, $p = .021$, $\eta^2 = .023$. No other term was significant in the model.

Post-hoc tests showed no significant differences between any of the modes for the random sequences. In contrast, both the scales and novel melodies showed some significant differences as a function of mode, once again exclusively along major-minor categories. For the scales, the differences between Aeolian-Ionian ($p = .004$), Dorian-Ionian ($p = .001$), Dorian-Mixolydian ($p = .046$), Ionian-Phrygian ($p < .001$), and Mixolydian-Phrygian ($p = .029$) were all significant. For the novel melodies, the differences between Aeolian-Ionian ($p = .029$), Dorian-Ionian ($p = .029$), and Ionian-Phrygian ($p = .034$) were all significant.

Exotic-Familiar Ratings

For the exotic-familiar ratings, there was a significant effect of mode $F(5, 215) = 4.40$, $p < .001$, $\eta^2 = .02$, as well as a significant effect of stimulus type $F(2, 86) = 21.25$, $p < .001$, $\eta^2 = .10$. There was additionally a significant interaction between explicit mode accuracy and mode $F(5, 215) = 2.50$, $p =.032$, $\eta^2 = .01$.

Post-hoc tests showed that the interaction between explicit mode accuracy and mode was driven by the low explicit accuracy group. In the high explicit accuracy group, there were no significant differences between any of the modes. In the low explicit accuracy group, the differences were based around general Major/Minor differences. Contrasts of Aeolian-Ionian ($p = .025$), Dorian-Ionian ($p = .002$), Dorian-Lydian ($p = .025$), Ionian-Phrygian ($p = .001$), and

Lydian-Phrygian (p = .025) were all significant, with the minor modes in each contrast being rated as more exotic than the major modes.

Post-hoc tests to unpack the stimulus type main effect revealed that the scale stimuli were rated as most familiar, followed by novel melodies and then the random sequences. Random sequences were significantly more exotic than novel melodies (p = .029), novel melodies were significantly more exotic than scales (p < .001), and random sequences were significantly more exotic than scales (p < .001).

Unpleasant-Pleasant Ratings

For the unpleasant-pleasant ratings, there was a significant effect of mode, $F(3.42, 147.01) = 3.81$, $p = .009$, $\eta^2 = .02$, and a significant effect of stimulus type, $F(1.74, 74.77) = 3.36$, $p = .047$, $\eta^2 = .01$. There were additionally significant interactions between explicit mode accuracy and stimulus type, $F(1.74, 74.77) = 5.12$, $p = .011$, $\eta^2 = .016$, and between mode and stimulus type: $F(6.74, 290) = 2.22$, $p = .035$, $\eta^2 = .018$.

The stimulus type and mode post-hoc tests revealed that there were no differences between modes in the random stimuli condition. For scale stimuli, the differences followed general major/minor differences. Ionian was significantly more pleasant than Aeolian (p = .034), Dorian (p < .011), Phrygian (p = .006), and Lydian (p = .043) modes. The post-hoc revealed there were no significant differences between modes for the novel melody stimuli.

The explicit mode accuracy and stimulus type post-hoc revealed perceived differences in stimulus type for the high explicit mode accuracy group, but not for the low explicit accuracy group. In the high explicit mode accuracy group, the random stimuli were the most unpleasant.

Both novel melodies (p = .020) and scales (p = .001) were more pleasant than the random stimuli. There was no significant difference between the novel melodies and scales.

Comparisons of Standard and Altered Familiar Melodies

The results from the one-sample *t*-tests comparing ratings and modes for the familiar melodies are reported in Table 3.

Sad-Happy Ratings

For the major melodies, altering the melody to be Mixolydian resulted in it being perceived as significantly sadder. Altering the melody to be Lydian also resulted in nominally sadder ratings; however, the difference was not significant. For the minor melodies, altering the melody to be Dorian resulted in nominally happier ratings, although the difference was not significant. Altering the melody to be Phrygian resulted in significantly sadder ratings. Thus, overall, two of the four alterations (Mixolydian and Phrygian) resulted in statistically significant differences relative to the standard melodies, with both alterations leading to sadder ratings.

Dark-Light Ratings

For the major melodies, altering the melody to be either Mixolydian or Lydian resulted in the melody being perceived as significantly darker. For the minor melodies, altering the melody to be Dorian did not lead to a statistically significant difference relative to the standard melody. However, altering the melody to be Phrygian resulted in the melody being perceived as significantly darker. Thus, overall, three of the four alterations (Mixolydian, Lydian, and Phrygian) resulted in statistically significant differences relative to the standard melodies, with both alterations leading to darker ratings.

Table 3

Summary of one-sample *t*-tests from the familiar melody trials

Term	Mode	Mean (*SD*)	*t*	Cohen's *d*
Happy-Sad				
	Phrygian	**-6.89 (19.75)**	**-2.37***	**0.35**
	Dorian	3.20 (21.50)	1.00	0.15
	Mixolydian	**-6.33 (16.30)**	**-2.63***	**0.39**
	Lydian	-4.54 (17.49)	-1.76	0.26
Dark-Light				
	Phrygian	**-13.21 (21.03)**	**-4.26*****	**0.63**
	Dorian	-2.93 (24.60)	-0.81	0.12
	Mixolydian	**-10.28 (22.04)**	**-3.16****	**0.46**
	Lydian	**-7.76 (18.33)**	**-2.87****	**0.42**
Tense-Relaxed				
	Phrygian	**-17.24 (-19.25)**	**-6.04*****	**0.89**
	Dorian	**-7.80 (21.10)**	**-2.51***	**0.37**
	Mixolydian	**-9.72 (19.96)**	**-3.30****	**0.49**
	Lydian	**-7.98 (19.67)**	**-2.75****	**0.40**
Exotic-Familiar				
	Phrygian	-1.36 (23.09)	-0.43	0.06
	Dorian	-3.59 (21.67)	-1.12	0.17
	Mixolydian	0.30 (27.17)	0.08	0.01
	Lydian	-4.28 (22.61)	1.28	0.19
Unpleasant-Pleasant				
	Phrygian	-5.48 (26.14)	-1.42	0.21
	Dorian	-1.89 (22.65)	-0.47	0.08
	Mixolydian	**-9.26 (24.94)**	**-2.52***	**0.37**
	Lydian	**-9.70 (25.05)**	**-2.58***	**0.38**

Note: * $p < .05$ ** $p < .01$ *** $p < .001$

Tense-Relaxed Ratings

For the major melodies, altering the melody to be either Mixolydian or Lydian resulted in the melody being perceived as significantly more tense. For the minor melodies, altering the melody to be either Dorian or Phrygian resulted in the melody being perceived as significantly more tense. Thus, overall, *every* modal alteration led to increased tension ratings relative to the standard melody.

Exotic-Familiar Ratings

No melodic alteration significantly influenced participants' exotic-familiar ratings. In other words, all "altered" melodies (Mixolydian, Lydian, Dorian, Phrygian) were statistically comparable to the "standard" melodies (Ionian, Aeolian) in terms of familiarity.

Unpleasant-Pleasant Ratings

For the major melodies, altering the melody to be either Mixolydian or Lydian resulted in the melody being rated as significantly more unpleasant. However, this effect appeared to be limited to the major modes. In contrast, for minor melodies, altering the melody to be either Dorian or Phrygian did not significantly alter pleasant-unpleasant ratings.

Discussion

The present study assessed how listeners perceive the historical modes across a range of musical sounds varying in ecological validity. Although there has been extensive research assessing how general major and minor modal categories are perceived by listeners (e.g., Carraturo et al., 2023), there is relatively little empirical work examining how most listeners – not specifically selected for their musical expertise – perceive less commonly encountered historical modes within these broader major and minor category distinctions. Given that musical modes can be classified based on overall pitch height and given the cross-modal associations of pitch height and positive terms (with higher pitches being happier, brighter, and more pleasant; Eitan & Timmers, 2010), we predicted that participants' ratings would be largely determined by the pitch height of each mode.

This prediction based on pitch height was generally not supported by the present results. Rather, the current results can be more parsimoniously explained in terms of participants making their responses based on the broader modal category (i.e., treating the "minor" modes of Phrygian, Aeolian, and Dorian as functionally equivalent, and treating the "major" modes of Mixolydian, Ionian, and Lydian as functionally equivalent). During the trials in which participants heard a single version of each sound (random sequences, scales, novel melodies), the results revealed that our participants' responses varied systematically as a function of the broader "major-minor" category distinction. To illustrate this point, post-hoc tests to follow up on significant effects of mode failed to show any intra-category distinctions (e.g., between any of the subtypes of minor modes or between any of the subtypes of major modes). Thus, it seems as though participants were attending specifically to the third scale degree of each type of stimulus, responding that the stimulus was sadder, darker, and more tense when the mode contained a minor third between the first and third scale degrees and responding that the stimulus was happier, lighter, and more relaxed when the mode contained a major third between the first and third scale degrees. Simply put, there were no consistent differences between the standard Ionian and Aeolian modes and the various sub-modes that fall within their "major" or "minor" classifications.

For the trials in which participants were asked to directly compare a standard (Aeolian or Ionian) version of a familiar melody with an altered (Phrygian, Dorian, Mixolydian, or Lydian) version of the melody, we observed greater evidence for mode-specific effects. However, these effects seemed to be most parsimoniously explained in terms of a "familiar is good" heuristic (e.g., Zajonc, 2001). Specifically, participants rated the altered versions of each melody more negatively (i.e., sadder, darker, more tense, and less pleasant) compared to the standard versions – even if the altered version had a higher overall pitch height. Although the results from the familiar melody trials were consistent across most terms and modal comparisons, we did not observe any differences in the *exotic-familiar* ratings. In other words, the altered versions of the melodies were rated comparably to the standard versions in terms of familiarity. This null result, however, is likely a result of the design of these trials, as the "base" melodies were Christmas carols selected to be highly familiar to participants and thus participants might have been unsure what was meant by the *exotic-familiar* judgment in the present context.

We predicted that the modes would be judged based on their average pitch height, given previously described associations between pitch height and concepts such as lightness, prettiness, and happiness (Eitan & Timmers, 2010). However, our results indicated that this hypothesis was not supported. For example, *both* Mixolydian and Lydian modes were rated as significantly darker than Ionian in the familiar melody trials, when a pitch-height account would suggest that the Lydian mode should be rated as lighter than the Ionian mode. Overall, our results indicated that distinctions made between modes, and within the mode categories were largely based off of familiarity with the modes. None of our results support the notion that average pitch height was a dominant factor that influenced our participants' responses. Rather, familiarity appeared to be the driving factor influencing participant responses – both in terms of responding based on a salient "major-minor" distinction for the single-judgment items, and rating all of the historical modes in a similar manner when compared against the more familiar versions of the melodies.

Although the present results suggest that listeners use both “major-minor” categories and familiarity to make modal judgments, this does not necessarily mean that the historical modes do not have their own unique associations (e.g., Lydian with lightness), particularly among individuals with greater amounts of musical expertise. In support of this possibility, the present study found some evidence that explicit mode identification influenced some judgments (e.g., *tense-relaxed* and *exotic-familiar* judgments). Although these results should be interpreted cautiously, as overall participant performance on the explicit modal categorization task was low, these results point to the possibility that the ability to explicitly label historical modes could substantially influence the way that mode is perceived, providing support for familiarity (beyond Aeolian-Ionian familiarity) having an effect on how the modes are perceived.

One interpretation of the failure to find mode-specific effects in the single-judgment trials beyond general “major-minor” distinctions is that the subtleties defining the historical modes may not have been salient enough to listeners. Future research could potentially use the forced-choice design for all stimulus types (e.g., having participants explicitly compare an Ionian and a Lydian scale). This would allow researchers to get a better understanding of whether there are consistent perceptual differences between modes, while minimizing both extraneous variables (e.g., the qualities of the melody unrelated to mode) and confounding variables such as melodic familiarity (as was the case in the final block of stimuli in the present study). Such an approach was used in a recent study (Van Hedger et al., 2023), examining aesthetic preferences for absolute tuning. Specifically, Van Hedger et al. (2023) found null effects when participants listened to isolated musical excerpts that varied in tuning. However, when they compared the standard tuning (A440), to the non-standard tuning (A440 + 50 cents) in a forced-choice paradigm (i.e., one of the versions was standard and one was non-standard), they found consistent effects of absolute tuning. Participants preferred the standard tuned version when they were highly familiar with the recording. When participants heard unfamiliar stimuli, they tended to prefer the version which was highest in absolute pitch. Although the research question of Van Hedger et al. (2023) is different from the present research question, the conclusions surrounding single-judgment versus forced-choice paradigms could be applicable to the present findings. Specifically, it might be necessary to have a comparison condition (i.e., the standard Ionian/Aeolian) to allow participants to appropriately attend to the defining features of each historical mode, particularly when the sample population are largely musically untrained.

The observations that participants in the current study largely based their responses on the major-minor distinction is well grounded in previous work. A large body of research has identified the major-minor dichotomy as a salient dimension of Western music. It has been canonically discussed as a primary factor in representing emotion in music, alongside tempo (Peretz et al., 1998). Carraturo et al., (2023) conducted a meta-analysis of studies observing the effects of the major-minor dichotomy and found that it represented the primary emotional feature in Western music. Thus, when listening to isolated sounds, the salience of the major and minor modes might have resulted in a kind of "perceptual magnet" effect (e.g., Kuhl, 1991), in which the subtle variations of major (Lydian, Mixolydian) and minor (Phrygian, Dorian) might have not been appreciated or even perceptible by participants. The subtle differences between modes, however, could have been more salient to musically trained participants, and thus future work might extend the present paradigm to musically trained participants. In support of this possibility, Brattico et al., (2016) found that musical experts rated minor modes as equally pleasant as the major modes, whereas musical novices preferred the major modes. This supports the notion that familiarity with the modes may lead to greater enjoyment and more positive evaluations, and testing these paradigms with a musical population may result in more mode specific results, or at least an attenuation of the large "major-minor" dichotomous findings in the present study.

Previous research has shown that affective judgements can differ as a function of familiarity. When participants were repeatedly exposed to a set of stimuli that were initially unfamiliar, participants' self-reported increases in familiarity significantly enhanced their experienced pleasure (van den Bosch et al., 2013). Furthermore, listeners tend to gravitate to what they are familiar with. Researchers assessed the effects of both participant affective state and participant familiarity on their music selection and found that musical selection was influenced by familiarity more than participants' affective state (Kim, 2011). During our study, when listeners were forced to judge the historical modes against the more commonly encountered modes (Ionian and Aeolian), the historical modes were consistently rated as more negative (e.g., sadder, darker, more tense), which is interpretable in terms of participant familiarity with the standard major and minor modes. Even if participants were not explicitly acknowledging this familiarity as an influence, it is not particularly surprising that they felt more positively about the more familiar stimuli. However, one caveat in this conclusion is that the forced-choice judgments in the present study always used familiar melodies (Christmas carols), in which the standard (Ionian or Aeolian) was "correct" and the historical mode was a deviation from this. Thus, future work should aim to replicate the present findings using unfamiliar melodies to more robustly test whether the present effects generalize to novel musical sequences.

Although our results were largely explained based on general major/minor distinctions and familiarity with Ionian and Aeolian modes, the Dorian-Aeolian comparison was inconsistent with these trends. Although participants reported that the Dorian mode was more tense compared to the Aeolian mode, unlike the other comparisons it was not rated as less pleasant, darker, or sadder. This result can likely be explained in terms of modal familiarity, as the raised sixth scale degree found in the Dorian mode is also found in the "melodic" minor scale, which raises the sixth and seventh scale degrees and is quite common in Western music. Put another way, hearing a raised sixth degree in the context of a minor mode is not particularly uncommon. This may help to explain why the Dorian results are more equivocal compared to the other historical modes. Further to this, because the results of Dorian do not align with the other comparison trials, this may support the notion that participant responses are based on familiarity with the modes, not just familiarity with the melodies. If our results were driven entirely by familiarity with the melodies, the results for the Dorian comparisons should have mirrored those of the other historical modes, as raising the sixth scale degree for the selected songs (*Carol of the Bells*, *O Come, O Come, Emmanuel*) still represents an altered, incorrect version of that melody. However, because Dorian was relatively comparable to the standard Aeolian melody, we believe this may indicate that familiarity in the context of our procedure is more parsimoniously explained in terms of mode familiarity.

Given that pitch height is a salient dimension to most listeners (e.g., Bongiovanni et al., 2023) and given that higher pitches are typically associated with things like happiness, lightness, and pleasantness (Eitan & Timmers, 2010), it was initially surprising that we did not find clear effects of modal pitch height on ratings. However, apart from the alternative explanations already discussed (saliency of major-minor categories, familiarity with Aeolian and Ionian modes), one additional explanation for why we did not observe effects based on modal pitch height is that we ensured that absolute pitch height was not confounded with modal category in our design. This was done by systematically varying the starting note of each of the random sequences, scales, and novel melodies. We made this decision with the hope that any results we found could be attributed to the compositional differences between the modes; however, this may have ultimately made pitch height differences across modes even harder to perceive or appreciate. On the other hand, because we varied the starting pitch of our stimuli, this did not allow for the presence of absolute pitch height to be a significant concern as a confounding variable. By systematically varying the starting note, we discouraged participants from using the absolute pitch height to make distinctions between the modes, which has been shown in previous work to be correlated with happiness ratings. For example, Chubb et al., (2013), reported a positive correlation between pitch height and happiness ratings. They found that scrambled stimuli that had a higher average pitch height tended to be heard as major, while stimuli with a lower pitch height tended to be heard as minor. Further research has reported that higher pitches are likely to be classified as happier (Collier & Hubbard, 1998).

Our results suggest that there is a learning component involved in the creation of these associations. Our results do not show consistent systematic perceptual differences between the historical modes and their standard Major-Minor counterparts. It is difficult to assert where the association comes from: whether it is something inherent with the mode, or some innate reaction we have to these collections of intervals, or whether we develop these associations and assign them to the modes. However, based on our results, if there are inherent associations, the influence of the major (Ionian) and minor (Aeolian) modes is so dominant that it creates a framework that appears to influence the way our participants reported their associations.

Limitations and Future Directions

The present study has several limitations that limit the generalizability of the findings. First, as the participants proceeded with the study, we presented them with a changed paradigm (going from single-item judgments to forced-choice judgments comparing two sounds), and this paradigm change was also accompanied by a change in the familiarity of the stimuli (going from novel melodies to known Christmas carols). Thus, familiarity and the response paradigm were confounded in the present study. This limits the conclusions that we can draw from the final block of sounds, as the pattern of results could be also due to the fact that participants knew that the standard (Aeolian or Ionian) versions of the melodies were “correct”, and the historical modes were “incorrect.” This could potentially be addressed in future research by incorporating the forced-choice paradigm with the novel melodies, as well as modifying the wording of the task (e.g., not referring to the historical mode melody as an “altered” or “deviant” version of a standard).

Second, we relied on a convenience sample of participants. Our participant sample on average had little-to-no musical experience with these modes. This restricts the generalizability of our results, particularly in making broad claims that listeners do not perceive or cannot appreciate the subtle differences between historical modes. Future research could address this by collecting data from a musically trained population - particularly among individuals who have some explicit understanding of these historical modes.

Another limitation stems from the tested stimuli in the present study. We attempted to build off prior research which was constrained to stimuli with low ecological validity (Straehley & Loebach, 2014). To vary the ecological validity in our procedure, we used several kinds of musical sounds, ranging from randomly generated musical sequences to musical scales, to novel and known melodies. However, none of our stimuli were ecologically valid per se. By using computerized versions of these sequences, rendered from music notation software, our stimuli were still not representative of what one typically experiences when listening to music outside of research contexts. Thus, it is unclear how generalizable these findings are to perceptions of music outside of research contexts.

Conclusion

The present study investigated how listeners perceive different musical modes, which each make use of different subsets of the possible notes in Western music. Based on previous research associating pitch height with concepts such as happiness, lightness, and prettiness (Eitan & Timmers, 2010), we predicted that listeners would use pitch height as a salient cue to judge musical modes. Overall, these predictions were not supported. Rather, the familiarity of the major (Ionian) and minor (Aeolian) modes seemed to be the strongest predictor of participant ratings. When listening to isolated sounds, participants categorized modes based on their general “major” or “minor” distinctions, failing to show any subtle effects within each of these broad categories. When listening to two different versions of familiar melodies, participants generally rated the less commonly heard mode as sadder, darker, more tense, and more unpleasant than the more familiar Aeolian or Ionian version of the melody. Although our initial predictions were not supported, the present results emphasize the role of familiarity in making musical judgments and provide several considerations that future studies can incorporate to further explore how historical musical modes are perceived by listeners.

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Curriculum Vitae

Name:

Carson Kiriakopoulos

Place and Year of Birth:

Windsor, Ontario, Canada, 2003

Secondary School Diploma:

Ursuline College Chatham, Chatham-Kent, Ontario, Canada

Awards:

Dean's Honors List 2022-2025