The Effects of Pitch and Mode on the Perceived Emotional Valence of Melodies

Word Count: 4652

Adam Exley

New Philadelphia High School

April 2019

Table of Contents

Introduction

Music has always been an integral piece of human societies. Throughout history, nearly every civilization has had a form of music; music allowed people to pass down ideas, emotions, and stories even before written language. Today, with access to the internet, a person can listen to any one of millions of songs as they desire, each with its own meaning and purpose. Although many aspects of music and how it is created have changed with time and technology, the ability of music to convey emotions has remained a central feature. This remains evident when listening to highly emotional songs, like John Legend's "All of Me," but can also be experienced when listening to songs like "Weightless", a famously relaxing instrumental song by Marconi Union. The emotion expressed by a piece of music can be changed in numerous ways, from changing its instrumentation to changing the speed at which it is played. When composing music, these factors can be thoughtfully manipulated to give a piece of music a specific emotional connotation. This study will focus on how pitch and mode (a form of relative pitch) contribute to how simple melodies are perceived emotionally by listeners. By manipulating these types of pitch in otherwise constant melodies and measuring how subjects perceive the changed and unchanged melodies, relationships between these forms of pitch and emotional valence can be observed.

Literature Review

Musical Emotion

Music is a cornerstone of human culture and has been used extensively in societies to convey emotion. This ability for music to be used as a vehicle for emotion is widely accepted

(Hevner, Expression in music: a discussion of experimental studies and theories, 1935; Panksepp, 1995; Price, 2004), is an aspect of music that is taught to students (Elliott, 2005), and is a phenomenon that most people personally experience. Music's emotional aspect can even be leveraged as a form of therapy for physical and mental ailments (Degmečić, Požgain, & Filaković, 2005; Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011; Bareh & D'silva, 2017). Despite this universality, the exact method through which emotion is conveyed by music remains unknown; it is debated whether music evokes emotion in listeners or if listeners recognize the emotion present in music (Hevner, Expression in music: a discussion of experimental studies and theories, 1935; Krumhansl, 1997; Price, 2004; Elliott, 2005). Contrastingly, as shown by many past experiments, it is known that specific elements of musical structure affect the perceived emotion of a musical piece (Hevner, 1937; Gundlach, 1935; Rigg, 1940; Crowder, 1984; Gerardi & Gerken, 1995; Schellenberg, Krysciak, & Campbell, 2000; Gagnon & Peretz, 2003; Webster & Weir, 2005).

Affective Structural Factors of Musical Emotion

Musical emotion is affected by many factors. These factors may exist as an attribute of listeners, such as age or gender (Sopchak, 1955; Gerardi & Gerken, 1995), or as an aspect of the music itself, such as its structure or performance (Juslin & Lindström, 2010). Structural qualities are the most apt of the former to be studied, as they are the easiest of the factors to manipulate in an intentional manner. These factors include tempo (speed), mode (overall relative pitch), harmony, volume, pitch, interval (narrow relative pitch), timbre, articulation, and rhythm, along with many others (Gundlach, 1935; Hevner, 1937; Rigg, 1940; Schellenberg, Krysciak, & Campbell, 2000; Gagnon & Peretz, 2003; Webster & Weir, 2005; Juslin & Lindström, 2010). These structural factors interact in numerous ways with one another to create a complex structural-emotional framework behind each piece of music (Schellenberg, Krysciak, & Campbell, 2000; Gagnon & Peretz, 2003; Webster & Weir, 2005; Juslin & Lindström, 2010). Of the structural factors, the most universal are tempo, rhythm, pitch, and mode.

Mode & Pitch

Mode and pitch are two of the broad forms of acoustic frequency of a musical phrase or melody. The pitch of a phrase is characterized by exactly how 'high' that phrase's notes are in terms of frequency. Western music is based entirely upon 12 notes repeating in subsequent octaves such that the note written as A4 (an A in the middle of a piano) most commonly has a pitch frequency of 440Hz. The 12 notes in each octave are arranged mathematically such that the frequency of a note is double that of the same note an octave lower. Thus, A5 would have a frequency of 880Hz and A6 would have one of 1760Hz. If a phrase or melody were re-notated such that every note was one half step above the original, it could be said that that phrase had an overall increase in pitch. Hevner (1937) was the first to measure the effects of pitch on musical phrases but measured only two pitch levels separated by an octave. Her research showed that higher-pitched melodies were paired with more positive adjectives compared to those associated with lower pitched melodies. Some more extensive work has been done regarding pitch's effects on musical emotion (see Schellenberg, Krysciak, & Campbell, 2000), but smaller, less than one octave, changes in pitch have not been studied in relation to musical emotion. This raises the question as to if smaller changes in pitch are capable of changing the emotion perceived by listeners by a measurable degree.

The mode of a phrase is characterized by the overall relative pitch between each of the notes of the phrase; it is dependent upon the relative intervals between each of the notes used in a phrase’s primary scale. Most Western music relies on an 8-note diatonic scale, with the first and eighth notes being an octave apart. Each of the seven natural modes begins on a different note in the C scale and continues up the scale with no sharped or flatted notes. This results in seven modes that have a unique pattern of intervals. The most commonly used and studied modes are Ionian (natural major) and Aeolian (natural minor). Music in a major mode is consistently viewed as more positive and happier compared to that of the same music in a minor mode (Hevner, The Affective Character of the Major and Minor Modes in Music, 1935; Crowder, 1984; Gagnon & Peretz, 2003; Webster & Weir, 2005). This had been an accepted belief before it was proven through research, but Hevner (The Affective Character of the Major and Minor Modes in Music, 1935) was the first to provide a quantification for this by using the association of adjectives to melodies that varied in their modality only. Although this distinction has been researched, there has been little work done examining the gradient between the major and minor modes including the Locrian, Mixolydian, and Phrygian modes (Illustrated in Figure 1). Of the aforementioned modes, Ionian and Mixolydian are considered to be major, whereas Aeolian, Locrian, and Phrygian are considered to be minor based upon how they deviate from a natural major (Ionian) mode. Understanding how these differing modes relate to both the Ionian and Aeolian modes would not only provide insight into how music in these modes could be percieved, but could also provide another level of insight into why majorly and minorly moded pieces of music are percieved as they are emotionally.

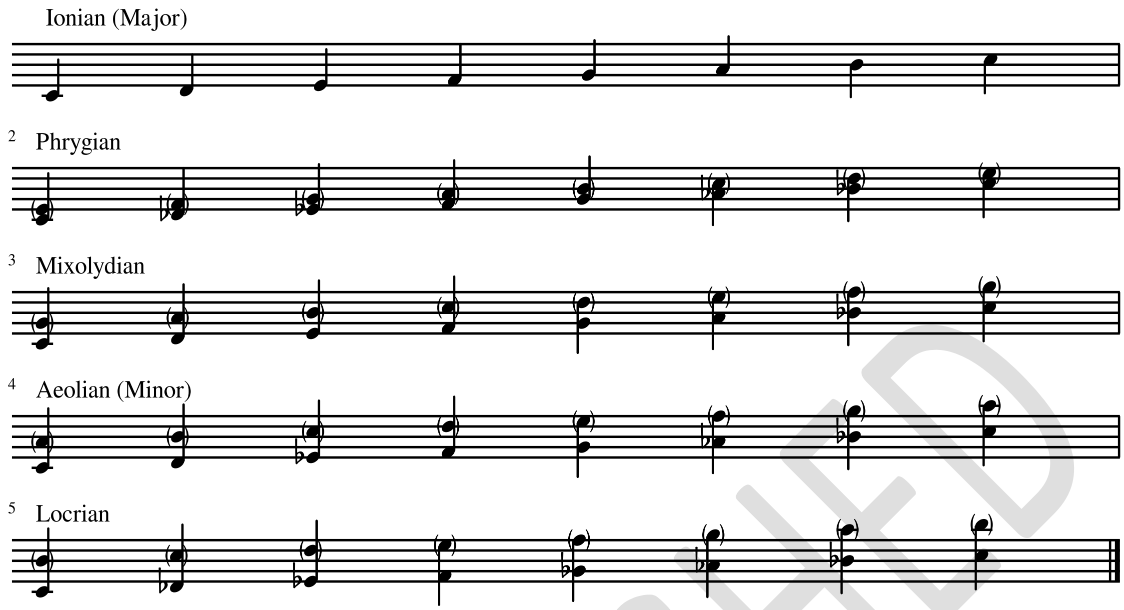

Figure 1. The modes mentioned previously. Notes in parenthesis are members of the mode's natural key. Notes not in parenthesis are the mode written in the key of C.

The Present Study

Based upon previous works and their limitations related to stimuli, this study will attempt to link slight changes in the pitch of melodies and multiple modalities to the perceived emotional valence of melodies. In pitch, large one-octave increases in pitch have been linked to more positive emotional responses (Hevner, 1937); it is presumed this correlation will remain true with smaller increases in pitch, but will be observed to a lesser degree. Regarding mode, the aforementioned observation that the major mode is perceived more positively than the minor mode is expected to remain true, as it has been well-established throughout multiple works (Hevner, The Affective Character of the Major and Minor Modes in Music, 1935; Crowder, 1984; Gagnon & Peretz, 2003; Webster & Weir, 2005). The characterization of other modes is hypothesized to relate to the similarity they have with the major (Ionian) mode, with increasing levels of deviance corresponding to a more negative response. Based upon this hypothesis, the remaining modes are predicted to fall in the order of Mixolydian, Aeolian, Phrygian, and Locrian (being most to least positive).

Methods

The present study was designed to obtain data on how both the mode and the pitch of musical melodies affected the perceived emotional valence of those melodies. Stimuli were designed to vary in overall pitch or mode to explore whether these manipulations affected the perceived emotion of the melodies.

Subjects

Subjects consisted of 287 high school students between the ages of 13 to 19, (average age = 15.4 years). The final data sample consisted of 268 subjects; 19 subjects' results were excluded for non-compliance with directions or a lack of differentiation in their responses. Of the 268 subjects, 122 were presented with mode-varying stimuli, and 146 were presented with pitch-varying stimuli. All students were enrolled in a rural high school and were tested during their scheduled English class as a group Each group consisted of 3 to 24 participants, with a mean group size of approximately 12 participants. Of the subjects, 173 were female, 88 subjects were male, and 7 subjects either identified with neither gender or preferred not to disclose their gender. 85 percent of subjects reported having had previous experience with music, although the extent to which they had experience was not measured.

Stimuli

The bases for all stimuli were nine melodies present in Arban's Complete Conservatory Methods for Trumpet (Arban, 1936), a widely-used methods book. All melodies that were used were in either 4/4 or 2/2 time signatures. To create stimuli, the first four measures of each melody were extracted and input into MuseScore, an open-source music notation program. Each of the nine melodies was then transposed into the key of C, F, or G major so that there were three melodies present in each key. This allowed for partial consistency while not making

Figure 2. Each of the base melodies used throughout this study.

the complete set of stimuli too monotonous for subjects. If the fourth (final) measure of any of the melodies ended in a way such that may have significantly changed the emotional response of a listener (i.e. an unresolved ending to a melody that was otherwise projected to be perceived in a positive manner), the last two beats of the melody were re-notated to match the body of the melody. All melodies had a designated tempo (speed) of 120 beats per minute. This resulted in nine 'base melodies', as shown in Figure 2.

Figure 3. Pitch variations of Blue Bells of Scotland, a melody used as stimulus.

To create pitch-varying melodies, each base melody was transposed either up or down: all notes in the melody were moved by the same amount musically such that the result was a melody that was otherwise identical to the base melody but having either a higher or lower frequency for each note. This was done in increments of four half steps (semitones), with two variations raised in pitch and two variations lowered in pitch. The result was a spectrum of five equally-spaced variations with a 16-semitone (1.33 octave) range between the highest and lowest variations of each base melody. As there were five variations of each of the nine melodies, the set of pitch-varying stimuli consisted of 45 individual stimuli. An example of the pitch variations of a melody can be seen in Figure 3.

Mode-varying melodies were created by transposing each base melody into four modes: Phrygian, Aeolian, Mixolydian, and Locrian. This consisted of flatting (lowering by one semitone) the appropriate notes for each mode any time they appeared in a melody. Given that each base melody was written in the Ionian (Major) mode, the result was each melody in five separate modes. In some infrequent cases, two of these variations would be identical, as the melody did not contain any of the notes to be flatted other than those flatted in another variation. In this case, both variations were left in the set of stimuli as the redundancy was not deemed detrimental, but rather it could determine the consistency of subjects' responses. An example of the modal variations of each melody can be seen in Figure 4.

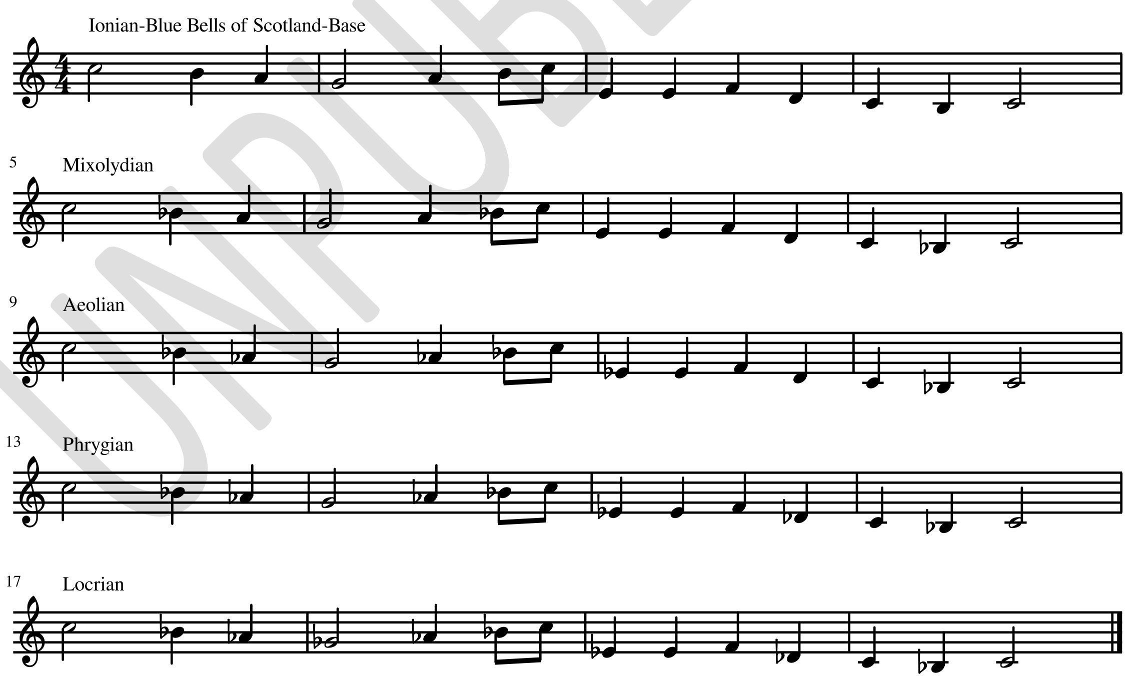

Figure 4. Modal variations of Blue Bells of Scotland.

After all modifications were completed, each of the 81 digitally-notated variations were then exported by MuseScore into an Ogg Vorbis (.ogg) audio file format. In these files, each of the variations was played by an electronically-synthesized piano. These files were separated so that all pitch-varying stimuli were in a separate set from all mode-varying stimuli. The nine base melodies were duplicated so that they would be present in both stimulus groups, leaving each group having 45 total stimuli.

Procedure

After gaining the appropriate parental consent, subjects were given a form and asked to fill out their age, gender, and whether they had previous musical experience[1]. Subjects were then instructed that they would be asked to assign each stimulus a rating between 1 and 10 (inclusive) corresponding to how positively or negatively they perceived each stimulus to be; it was explained that these ratings were to go on the numbered blanks 1 to 45 on the form they had been given. It was explained that a higher rating on the scale would correspond to a more positive emotional response. Examples of popular songs that could correspond to each extreme of the scale were given, like how the song "Walking on Sunshine" by Katrina and the Waves would likely correspond to a 10 on the scale, whereas "Mad World" by Gary Jules would likely correspond to a 1 on the same scale. It was also explained that there was no correct or incorrect answer for any stimulus, but it was instead based on personal experience and opinion.

[1] For the present study, 'musical experience' was defined in a broad sense; subjects were told that any vocal or instrumental music class would qualify as having musical experience. The extent of musical experience was also not measured.

All subjects in a session were then presented with either pitch-varying or mode-varying stimuli based upon a predetermined assignment made by the researcher to provide a similar demographic spread between the pitch and mode groups. The presentation was done by means of a Dell Inspiron 7373 Laptop running a custom instance of OpenSesame. This is an open-source stimulus presentation program that randomized the order in which individual stimuli were played, recorded this sequence, and played each stimulus through a Bose SoundLink Color II Bluetooth speaker. Each stimulus was 8 seconds long, and a response time of at least 4 seconds was given between each stimulus. Slightly more time was given if it was observed that many of the subjects in a session failed to respond within that amount of time. Subjects were reminded at regular intervals of five stimuli which stimulus had just played, to make sure no subject was on the wrong numbered response. At the conclusion of the entire stimulus set, subjects could withhold their data for any reason and were permitted to ask questions regarding the present research and its intentions.

Results

Base melodies were rated similarly between the pitch- and mode-varying groups, as shown in Table 1. Most base melodies had a difference between groups that was insignificant. These base melody (original, unaltered melody) ratings did not considerably vary by age[2] or musical experience, but gender did correlate somewhat to ratings. Females typically rated the base melodies higher than males did, as shown in Figure 5. Certain base melodies were rated

[2] Age groups with under 13 subjects (5% of the sample size) were omitted.

above other melodies that were tested. This natural order is evident in the average ratings of base melodies, and in the pitch-varying ratings. The same order was not seen in the mode-varying results as, unlike pitch changes, which uniformly affect a melody, only specific notes are changed by a mode; a difference in the notes used in a melody or the order in which notes appear can dictate how a mode change affects how subjects view a melody.

Table 1

Base Melody Average Ratings by Stimuli Group

	Group		
Melody	Pitch	Mode	Difference
1	5.57	5.57	0.01
2	6.25	6.71	0.47
3	5.72	5.80	0.08
4	6.51	7.16	0.64
5	6.39	6.51	0.12
6	5.54	5.37	0.17
7	6.59	6.99	0.40
8	5.52	6.03	0.51
9	6.38	6.41	0.03
Average Difference =			0.27

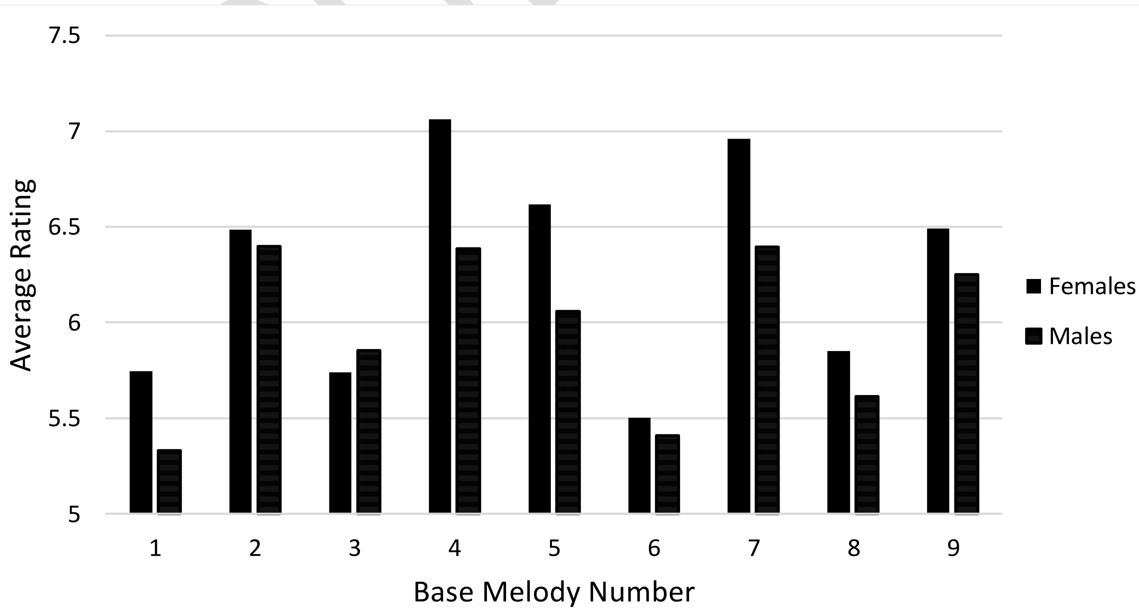

Figure 5. Average base melody rating by gender.

Pitch-varying Results

An analysis of variance (ANOVA) was done using each subject's mean rating for each pitch level. This revealed that ratings significantly varied based upon pitch level ($F[4, 725] = 26.11$, $p < .001$). Additional ANOVAs were done on subjects' mean rating of all pitch-varying melodies with respect to age[3], gender, and musical experience. Of these ANOVAs, the gender ($F[1, 140] = 6.36$, $p = .012$) and age ($F[3, 133] = 2.81$, $p = .042$) conditions were shown to have considerable correlation to subjects' average ratings, whereas musical experience ($F[1, 144] = 0.09$, $p = .761$) had no discernable link. Subjects' differences in rating between each of the five variations of each melody were then averaged, an overall ANOVA was taken, and accompanying age[2], gender, and musical experience ANOVAs were taken (See Appendix A for all pitch ANOVA data). The overall ANOVA revealed that the rating difference between each pitch level was uniform ($F[3, 580] = 0.74$, $p = .530$), implying that the data followed a linear trend. Of the demographic ANOVAs, only gender ($F[1, 140] = 7.10$, $p = .008$) was shown to have a considerable link to subjects' change in ratings between variations.

The general trend was for higher pitched variations to be assigned higher ratings by subjects. Despite the magnitude of this trend varying between both melodies and variations, it was evident in every melody tested, as shown in Figure 6 and Figure 7.

[3] Ages 13 and 19 were excluded from pitch-varying age ANOVAs as there were not enough subjects of either age to provide means that would be representative.

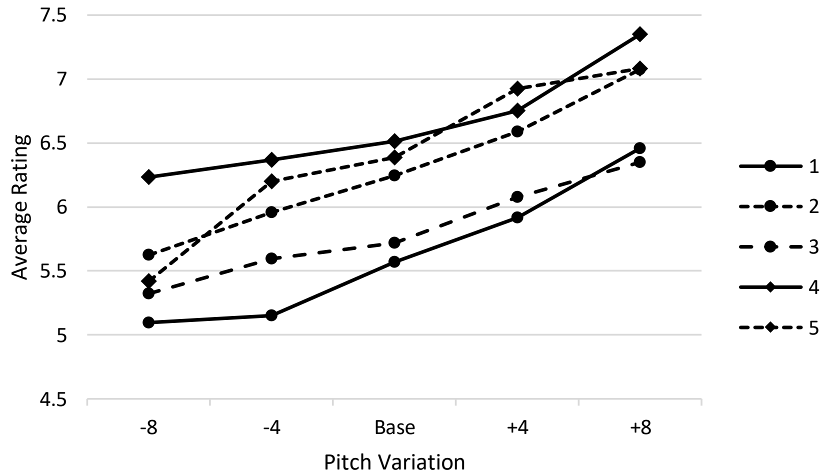

Figure 6. Average ratings of melodies 1 through 5 for all pitch variations.

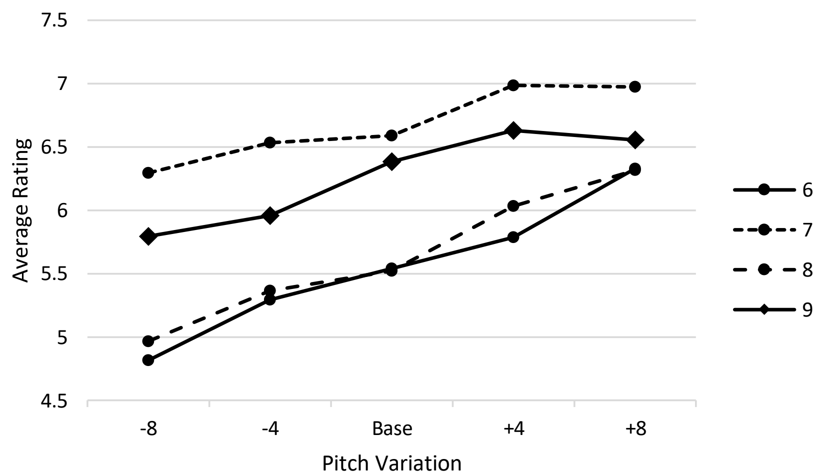

Figure 7. Average ratings of melodies 6 through 9 for all pitch variations.

Moderation of Pitch Results

Because subjects' average ratings of melodies varied by age but the associated change in ratings between variations did not, it was implied that all ages exhibited roughly the same trend in their ratings but that the ratings of each age were offset from each other. This conclusion was supported by the graphical representation of the data shown in Figure 8.

As for gender, females tended to assign higher ratings to all variations compared to males, although this gap narrowed with lower-pitched variations, as shown in Figure 9**.** This divergence may be due to the tested demographic; in the pitch-varying group there were 49 males compared to 93 females, making the male dataset more sensitive to individual responses. Both male and female datasets showed a reliable increase in ratings as pitch increased.

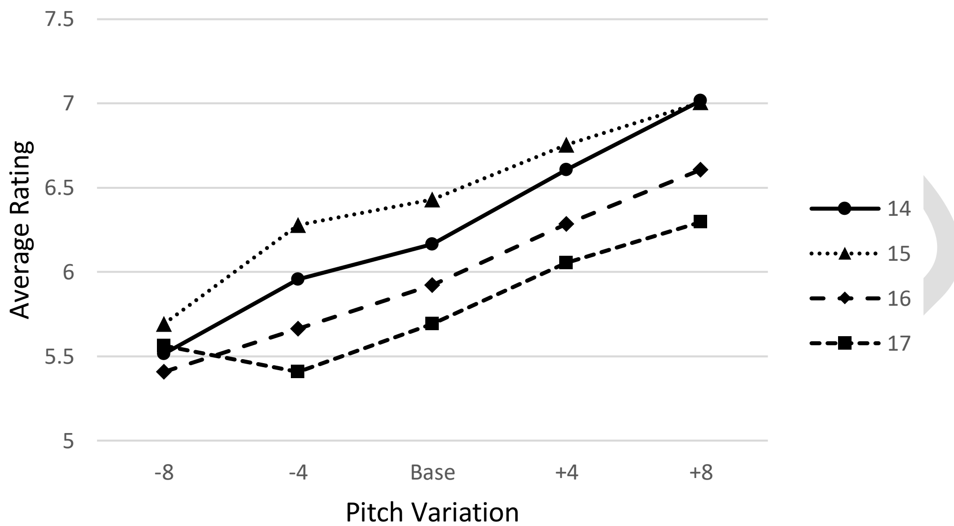

Figure 8. Average ratings for pitch levels by age.

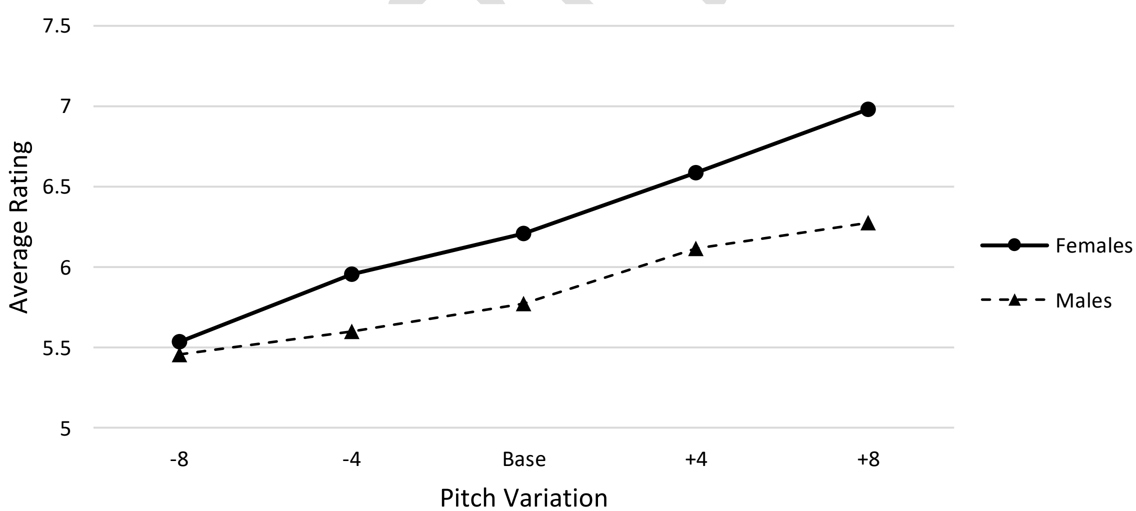

Figure 9. Average rating of pitch levels separated by gender.

Mode-varying Results

An ANOVA taken on subjects' average ratings for each mode revealed that ratings varied significantly based on mode ($F[4, 605] = 22.95$, $p < .001$). As with the pitch-varying dataset, ANOVAs were also done on subjects' mean rating of all mode-varying melodies with respect to age[4], gender, and musical experience (See Appendix B for all mode ANOVA data). Of these analyses, only the presence or absence of musical experience was shown to correlate to subjects' mean ratings ($F[1, 120] = 5.95$, $p = .016$), although this may be due to chance: 105 subjects reported musical experience and only 17 did not. Age ($F[3, 114] = 1.49$, $p = .221$) and gender ($F[1, 117] = 0.90$, $p = .344$) had minimal impact on subjects' mean ratings. Unlike in the analysis of pitch-varying data, ANOVAs were not conducted based upon subjects' change in ratings. These ANOVAS were not taken because the change in the independent variable, mode, was not linear, and subjects' change was expected to vary both between melodies and between variations within a melody.

To compare the ratings for each mode, averages were first taken for each modal variation. The overall averages for each mode were then taken to determine the order of positivity of the modes. The modes were rated most to least positive in the order Ionian, Mixolydian, Phrygian, Aeolian, and Locrian. This can be seen in Table 2. As for the most positively rated mode, the Ionian mode had the highest ratings in seven out of the nine melodies. Two of the three melodies that did not have Ionian as the most positively rated mode, melodies five and six, instead had the Mixolydian mode, the mode closest to Ionian in this study, as being rated most positively. On the other end of the spectrum, the Locrian mode was rated the most negative overall, having the lowest rating in five out of the nine melodies. Overall, subjects were consistent in rating the Ionian mode highest relative to the other modes.

[4] The age group of 13 was excluded from mode-varying age ANOVAs as only one subject was age 13.

The consistency in the relative ratings of other modes was lower than that of the Ionian mode, as seen in the standard deviations of rankings in Table 3.

Table 2

Average Ratings of Modal Varitions

Melody	Ion.	Mix.	Phr.	Aeo.	Loc.
1	5.57	5.18	5.12	4.70	4.80
2	6.71	6.04	5.89	5.57	5.40
3	5.80	5.33	4.02	4.68	4.16
4	7.16	6.82	6.27	6.06	5.84
5	6.51	6.59	5.74	6.22	4.92
6	5.37	5.66	4.87	4.81	5.00
7	6.99	6.50	6.32	6.29	5.85
8	6.03	5.57	5.31	5.57	5.11
9	6.41	5.74	6.43	4.98	6.04
Average	6.28	5.94	5.55	5.43	5.24

Table 3

Average Rankings of Modal Varitions

Melody	Ion.	Mix.	Phr.	Aeo.	Loc.
1	1	2	3	5	4
2	1	2	3	4	5
3	1	2	5	3	4
4	1	2	3	4	5
5	2	1	4	3	5
6	2	1	4	5	4
7	1	2	3	4	5
8	1	2	4	3	5
9	2	4	1	5	3
Average	1.33	2.00	3.33	4.00	4.44
St. Dev.	0.47	0.82	1.05	0.82	0.68

There was a distinct difference in ratings between the two modes most used in music, the Ionian and Aeolian (major and minor) modes. The Ionian mode was consistently rated higher than the Aeolian mode throughout melodies. This general tendency was also seen in individual subjects, as 78% of subjects had a higher average rating for Ionian variations than for Aeolian variations.

Compared to the pitch results, the results regarding mode had more cases in which a combination of a specific mode and melody went against the general trend. The occurrence of these anomalies is most likely due to the nature of mode changes being reliant upon the notes used in a melody. A change in mode does not equally affect every melody. A change in mode modifies only certain specific notes in a melody corresponding to the mode it is being put in. Depending on the notes used and the specific order of those notes, two or more melodies can react very differently to being put into the same mode.

Moderation of Mode Results

Differences in mode ratings only correlated with whether subjects reported having musical experience. The group reporting musical experience had similar trends between melodies, shown in Figure 10, whereas the group that did not report musical experience had many different trends, as shown in Figure 11. This difference is most likely due to the sample

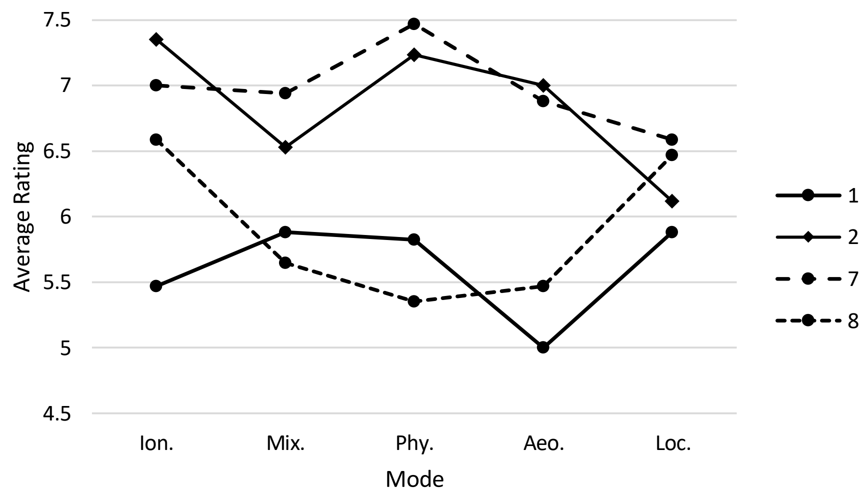

Figure 10. Ratings of melodies 1, 2, 7, and 8 by subjects reporting musical experience. These melodies were selected as they showed the most variation between one another.

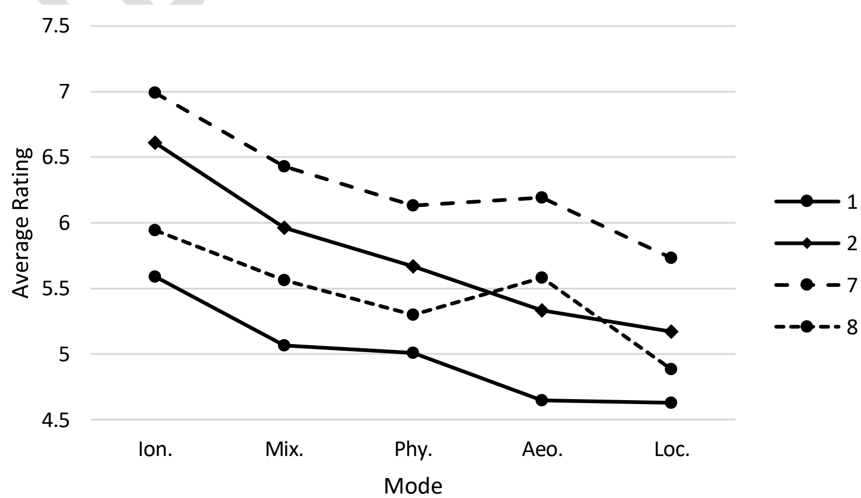

Figure 11. Ratings of melodies 1, 2, 7, and 8 by subjects not reporting having musical experience. These melodies were selected as they showed the most variation between one another.

size of both groups, as the group reporting musical experience had over six times the number of subjects as the group reporting no musical experience. This difference in sample size means that the group without musical experience was much more sensitive to individual responses, so trends may not be as thoroughly established compared to a group with a larger sample.

Discussion

Data regarding pitch did coincide with the previous conclusion made by Hevner and others that variations pitched one octave above otherwise constant variations were viewed more positively by subjects. Previously, only these increments of one octave had been studied in this light. The current study did extend the observation of higher pitched variations being perceived more positively, showing that smaller 4 semitone pitch differences do elicit the same emotional effect as octaves, but to a lesser degree. There was a strong positive correlation between higher pitch levels and a more positive valence as perceived by subjects. This correlation was evident in all demographic groups in the study.

Regarding mode, the long-established major versus minor positive-negative correlation observed in previous works (Hevner, The Affective Character of the Major and Minor Modes in Music, 1935; Gagnon & Peretz, 2003; Webster & Weir, 2005) was also observed consistently for all melodies in this study. This study worked primarily to provide data on the gradient of modes besides just the major and minor (Ionian and Aeolian) modes. The effects of the Mixolydian, Phrygian, and Locrian modes had been observed informally among musicians, but had not been quantitively documented before this study. The results of the data show Ionian as most positive, followed by Mixolydian, Phrygian, Aeolian, and Locrian. Of these modes, Ionian had the most consistency in its relative rank as the most positive melodic variation. The Mixolydian mode most often followed slightly behind the Ionian mode in terms of ratings, and in two melodies was narrowly rated higher on average than the Ionian mode. After a marginally larger gap in ratings came the Phrygian and Aeolian modes, which had ratings that, although not always close within each melody, had overall averages that were quite close. Below this duo of modes came the Locrian mode, which, despite being the lowest rated on average, was rated above other modes in four melodies, ranking third and fourth two times each.

The Phrygian mode was the most varied in its rank relative to the other modes, as it was placed in all rankings except for second, depending on the specific melody. The variation observed in the responses to the Phrygian mode is hypothesized to be due to it flatting nearly half the notes in a scale (four out of seven). This means that different melodical structures could have more varied changes due to a mode change to Phrygian compared to the other modes tested. Some melodies have close to half of their notes changed by the Phrygian mode but depending on the notes used, a specific melody may have either less or more than half of their notes changed, which could produce the varied results seen in the data regarding this mode. The relationship of accidentals, sharps and flats (notes raised or lowered by a half step out of key), both in and out of modes to emotional valence is something that remains to be tested and may provide insight into the causation of the mode results of this paper.

The conclusions of this study extend the knowledge of how music's structural composition correlates to how music is emotionally perceived. Understanding how and why we as humans perceive music as we do can provide insight into how it has come to be such an integral part of society. The findings discussed in this paper allow for a more objective view of the subjective relationship between music and emotions.

When used in tandem with previous research exploring the interaction of structural factors and the influence each of these factors has on perceived emotional valence, this research can allow for enhanced application of future projects and ideas regarding music and emotion. This knowledge may be used to enhance how music is used as therapy by being able to fine-tune the emotion of music. The same knowledge could even be applied to the use of algorithms to predict how music will be emotionally perceived based on its properties, like in MacDorman, Ough, and Ho's work (2007), which could be later implemented into music streaming services to replace their current method of music selection.

Limitations

This study's purpose was to examine how both pitch and mode related to the valence of musical melodies. In examining this specifically, many aspects of the vast number of styles of music may not have been represented. This study used nine short melodies to measure emotional response. Although this is like the tactic employed by previous researchers in this field, nine melodies taken from one music book cannot accurately represent all forms and genres of music. Controlled melodies can illustrate mode and pitch as individual factors contributing to the emotional response to music, but there are many other factors that interact to influence music's perceived emotion. Additionally, four-bar melodies, although allowing for many stimuli to be presented in a short length of time, may lack the emotional depth and intensity present in real compositions that are many times longer.

This study used a sizable group of high school students, unlike previous studies which used smaller groups of college students (Hevner, 1937; Schellenberg, Krysciak, & Campbell, 2000; Webster & Weir, 2005). No specific research was found regarding similarities and/or differences in how high school and college-aged subjects perceive musical stimuli. The differences between these groups' perception is hypothesized to be minimal, as 8-year-olds have been shown to perceive major and minor modes similarly to adults (Gerardi & Gerken, 1995). Replication of this work with subjects in college would eliminate any hesitancy in comparing these results to previous works. In addition to the age of participants, this study had many more female subjects as opposed to male subjects, making inter-gender analysis less reliable and conclusive than if the genders were represented equally. This same principle also applies to musical experience, as a vast majority of subjects reported having musical experience compared to those who reported having no musical experience.

Overall, future studies should provide a more comprehensive view of both pitch and mode. To do this, future researchers may use more melodies that are both longer and more diverse, while also measuring both the interactive and relative effects of pitch and mode. In their studies future researchers may also have more equal demographic distributions than used in this study to more accurately be able to measure the effects of demographic factors. Future research could also potentially fill in data regarding other modes not included in this study.

Summary

This study measured the effects of mode and pitch on the emotional valence of melodies as perceived by subjects. Nine melodies were modified to create both pitch and mode varying melodies to which subjects assigned ratings. The results of this study, consistent with previous research, concluded both that higher pitched melodies were perceived more positively and that the major mode was perceived more positively than the minor mode. In addition to these conclusions, this study also linked the previously mentioned pitch trend to smaller pitch variations and provided new data regarding previously unstudied modes. These findings have the potential to enhance how music is used as therapy, and how algorithms are designed to predict how listeners will perceive music.

References

Arban, J.-B. (1936). *Arban's Complete Conservatory Method for Trumpet.* (E. F. Goldman, & W. M. Smith, Eds.) New York, New York: Carl Fischer.

Bareh, S., & D'silva, F. (2017). Effect of Music Therapy on Pain and Quality of Life among Cancer Survivors. *Nitte University Journal of Health Science, 7*(3), 25-29. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=126447010&site=src pass:[_]ic-live&authtype=cookie,ip,custuid&custid=infohio

Chuen, L., Sears, D., & McAdams, S. (2016). Psychophysiological responses to auditory change. *Psychophysiology, 53*(6), 891-904. doi:10.1111/psyp.12633

Crowder, R. G. (1984). Perception of the major/minor distinction: I. Historical and theoretical foundations. *Psychomusicology: A Journal of Research in Music Cognition, 4*(1-2), 3-12.

Crowder, R. G. (1985). Perception of the major/minor distinction: II. Experimental investigations. *Psychomusicology: A Journal of Research in Music Cognition, 5*(1-2), 3-24. doi:10.1037/h0094203

Degmečić, D., Požgain, I., & Filaković, P. (2005). Music as Therapy / Glazba kao terapija. *International Review of the Aesthetics and Sociology of Music, 36*(2), 287-300. Retrieved from http://www.jstor.org/stable/30032173

Elliott, D. J. (2005). Musical Understanding, Musical Works, and Emotional Expression: Implications for education. *Educational Philosophy & Theory, 37*(1), 93-103.

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to 'happy-sad' judgements in equitone melodies. *Cognition & Emotion, 17*(1).

Gerardi, G., & Gerken, L. (1995). The Development of Affective Responses to Modality and Melodic Contour. *Music Perception: An Interdisciplinary Journal, 12*(3), 279-290. doi:10.2307/40286184

Gundlach, R. (1935). Factors Determining the Characterization of Musical Phrases. *The American Journal of Psychology, 47*(4), 624-643. doi:10.2307/1416007

Hevner, K. (1935). Expression in music: a discussion of experimental studies and theories. *Psychological Review, 42*(2), 186-204.

Hevner, K. (1935). The Affective Character of the Major and Minor Modes in Music. *The American Journal of Psychology, 47*(1), 103-118. doi:10.2307/1416710

Hevner, K. (1937). The Affective Value of Pitch and Tempo in Music. *The American Journal of Psychology, 49*(4), 621-630. doi:10.2307/1416385

Juslin, P. N., & Lindström, E. (2010). Musical Expression of Emotions: Modelling Listeners' Judgements of Composed and Performed Features. *Music Analysis, 29*(1-3), 334-364. doi:10.1111/j.1468-2249.2011.00323.x

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 51*(4), 336-353. doi:10.1037/1196-1961.51.4.336

Lind, T. (2007). Meaning, Power and Exoticism in Medicinal Music: A Case Study of Musicure in Denmark. *Ethnomusicology Forum, 16*(2), 209-242. Retrieved from http://www.jstor.org/stable/20184595

MacDorman, K. F., Ough, S., & Ho, C.-C. (2007). Automatic Emotion Prediction of Song Excerpts: Index Construction, Algorithm Design, and Empirical Comparison. *Journal of New Music Research, 36*(4), 281-299. doi:10.1080/09298210801927846

Panksepp, J. (1995). The Emotional Sources of "Chills" Induced by Music. *Music Perception: An Interdiciplinary Journal*, 171-207.

Price, K. (2004). How Can Music Seem to Be Emotional? *Philosophy Of Music Education Review, 12*(1), 30-42.

Quam, C., & Swingley, D. (2012). Development in Children's Interpretation of Pitch Cues to Emotions. *Child Development, 83*(1), 236-250. doi:10.1111/j.1467-8624.2011.01700.x

Quintin, E., Bhatara, A., Poissant, H., Fombonne, E., & Levitin, D. J. (2011). Emotion Perception in Music in High-Functioning Adolescents with Autism Spectrum Disorders. *Journal Of Autism And Developmental Disorders, 41*(9), 1240-1255.

Rigg, M. G. (1940). Speed as a determiner of musical mood. *Journal of Experimental Psychology, 27*(5), 566-571.

Schellenberg, E., Krysciak, A., & Campbell, R. (2000). Perceiving Emotion in Melody: Interactive Effects of Pitch and Rhythm. *Music Perception: An Interdisciplinary Journal, 18*(2), 155-171. doi:10.2307/40285907

Sopchak, A. L. (1955). Individual differences in responses to different types of music, in relation to sex, mood, and other variables. *Psychological Monographs: General and Applied, 69*(11), 1-20. doi:10.1037/h0093695

Webster, G. D., & Weir, C. G. (2005). Emotional Responses to Music: Interactive Effects of Mode, Texture, and Tempo. *Motivation & Emotion, 29*(1), 19-39. doi:10.1007/s11031-005-4414-0

Appendix A: Pitch ANOVAs

Overall
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
+8	146	981.2222	6.7207	1.471305
+4	146	936	6.410959	1.197168
Base	146	883.6944	6.052702	1.044335
-4	146	850.4444	5.824962	1.317639
-8	146	804	5.506849	1.34031

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	133.097	4	33.2742	26.1148	3.01E-20	2.38422
Within Groups	923.76	725	1.27415			
Total	1056.86	729				

ΔRating Overall
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
+4 to +8	146	45.22222	0.309741	0.747247
Base to +4	146	53.11111	0.363775	0.767394
-4 to Base	146	32.44444	0.222222	0.613027
-8 to -4	146	46.44444	0.318113	0.641401

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.53177	3	0.51059	0.73756	0.529906	2.62027
Within Groups	401.515	580	0.69227			
Total	403.047	583				

Musical Experience
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
No Musical Ex.	23	141.6222	6.157488	0.972342
Musical Ex.	123	749.451	6.093098	0.846633

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.08034	1	0.08034	0.09279	0.761104	3.90685
Within Groups	124.681	144	0.86584			
Total	124.761	145				

Gender
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Female	93	581.4955	6.252639	0.776668
Male	49	286.3111	5.843084	0.980873

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5.3829	1	5.3829	6.35764	0.012808	3.90874
Within Groups	118.535	140	0.84668			
Total	123.918	141				

Age
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
14 yrs	33	206.3111	6.251852	0.707058
15 yrs	34	218.7111	6.43268	1.062963
16 yrs	52	310.8288	5.977477	0.466327
17 yrs	18	104.4444	5.802469	1.468171

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6.74384	3	2.24795	2.80874	0.042044	2.6727
Within Groups	106.445	133	0.80034			
Total	113.189	136				

ΔRating Musical Ex.
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
No Musical Ex.	23	7.055556	0.306763	0.133872
Musical Ex.	123	37.25	0.302846	0.112192

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.0003	1	0.0003	0.00257	0.9596	3.90685
Within Groups	16.6326	144	0.1155			
Total	16.6328	145				

ΔRating Gender

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Females	93	33.63889	0.361708	0.113308
Males	49	10.02778	0.204649	0.108176

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.79163	1	0.79163	7.09673	0.008629	3.90874
Within Groups	15.6168	140	0.11155			
Total	16.4084	141				

ΔRating Age

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
14 yrs	33	12.38889	0.375421	0.111455
15 yrs	34	11.16667	0.328431	0.144195
16 yrs	52	15.58333	0.299679	0.08873
17 yrs	18	3.305556	0.183642	0.113575

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.44571	3	0.14857	1.33686	0.265152	2.6727
Within Groups	14.781	133	0.11114			
Total	15.2267	136				

Appendix B: Mode ANOVAs

Overall
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Aeo	122	662.3333	5.428962	1.06669
Ion	122	766.3611	6.281648	0.97369
Loc	122	638.5	5.233607	1.047339
Mix	122	724.2222	5.936248	0.859283
Phr	122	671.321	5.502631	0.847043

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	88.0027	4	22.0007	22.9458	1.14E-17	2.38666
Within Groups	580.079	605	0.95881			
Total	668.082	609				

Musical Experience
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
M.E.	105	590.0889	5.619894	0.516009
NONE	17	103.8338	6.107873	1.040858

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.48402	1	3.48402	5.94554	0.01622	3.92012
Within Groups	70.3186	120	0.58599			
Total	73.8026	121				

Gender
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Female	80	460.6015	5.757519	0.590565
Male	39	218.9212	5.613364	0.629545

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.54483	1	0.54483	0.9032	0.343884	3.92217
Within Groups	70.5773	117	0.60322			
Total	71.1221	118				

Age
Anova: Single Factor
SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
14 yrs	21	125.2939	5.966378	0.412278
15 yrs	40	227.4157	5.685391	0.451642
16 yrs	39	217.0606	5.565657	0.529247
17 yrs	18	100.4545	5.580808	0.911337

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.41043	3	0.80348	1.49025	0.220977	2.6842
Within Groups	61.4637	114	0.53916			
Total	63.8741	117				