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Varying Degrees of Difficulty in Melodic Dictation Examples According to Intervallic Content

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I am submitting herewith a thesis written by Michael Hines Robinson entitled "Varying Degrees of Difficulty in Melodic Dictation Examples According to Intervallic Content." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Music, with a major in Music.

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Varying Degrees of Difficulty in Melodic Dictation Examples According to Intervallic Content

A Thesis Presented for the
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Degree
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Michael Hines Robinson
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Dedication

I dedicate this thesis to my father, John H. Robinson, for giving me the inspiration to be a musician and to my mother, Pamella M. Robinson, for giving me a unique appreciation for music.

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Abstract

Melodic dictation has long been a daunting task for students in aural skills training. Past research has found that interval identification is a factor when taking melodic dictation and that some intervals are easier to identify than others. The goal of this thesis is to determine whether melodic dictation examples can be categorized by their intervallic content. A popular aural skills text, *Ear Training: A Technique for Listening, 7th Edition, Revised* by Benward and Kolosick (2010), was used as the source for the melodic dictation examples. Adjacent intervals in each melodic dictation example were counted and totaled by interval type. Rhythm was not observed. An analysis of the melodic dictation examples according to their intervallic content was then performed using an SPSS two-step cluster analysis. Two clusters emerged, indicating that there were natural groupings within the data. Cluster 1 examples contained mostly smaller motion, i.e., intervals of a minor second (m2) to Major third (M3), while cluster 2 examples were characterized by their larger intervallic content, i.e., intervals of a minor sixth (m6) to Major seventh (M7). Melodic dictation examples of both clusters were found to appear throughout the textbook organization, with the exception that no cluster 2 examples were found in the beginning units of the text. Other variables tracked were whether an example was composed (C) for the text or derived from music literature (L), the unit and melody number, and total number of intervals per melody. Cluster 2 examples were most frequently from literature (L).

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Chapter 1

Introduction and General Information

Melodic dictation can be a difficult task for college music majors in aural skills training. Both undergraduate and graduate students have difficulties in basic pitch pattern identification and melodic dictation tasks. Students that have the most difficulty in melodic dictation usually have difficulty in interval identification. Interval identification is a basic task that affects students' performance when taking melodic dictation.

The purpose of this study is to determine if melodic dictation examples can be categorized based on their intervallic content. Past research has found that certain intervals are more difficult to identify than other intervals. The analysis of intervallic data within melodic dictation examples could identify degrees of difficulty in melodic dictation examples.

Chapter 2 contains the literature review for this thesis. This chapter cites studies that have exemplified the facets of interval identification pertaining to aural skills training. The review of literature clearly shows that a hierarchy emerges in interval identification, which classifies certain intervals as being more difficult to identify than others. Research has shown that the identification of both isolated and melodic intervals are equally suspect to the hierarchy of interval difficulty. The consistency of the hierarchy is maintained across various studies and test subjects ranging from novice to expert musicians.

Chapter 3 contains a description of the materials used in the study and the methodology of the research in this thesis. This section describes the textbook from which the data was collected, *Ear Training: A Technique for Listening, 7th Edition*, *Revised* by Benward and Kolosick (2010), and outlines the procedure for the data collection and the basic methods of the statistical analysis of the data. It also describes the first steps in the statistical analysis and clustering analysis..

Chapter 4 presents the results of the statistical analysis. It explains two and three-dimensional scatterplots resulting from the analysis. It also interprets the descriptive statistics tables. Other aspects of the examples are investigated including the frequency of melodies composed for the text or derived from music literature and the frequency of examples by unit by cluster.

Chapter 5 is a discussion of the results. It also recommends future research into intervallic and contextual relationships in melodic dictation.

Chapter 2

Literature Review

The purpose of this research is to determine whether melodic dictation examples can be categorized based on their intervallic content. Researchers have argued that the identification of intervallic content is a factor for students when taking melodic dictation. The most influential studies for this research (Jeffries, 1967; Jeffries 1970; Maltzew, 1913) tested the difficulty of isolated and melodic intervals and have shown that intervals vary in degree of difficulty. Maltzew (1913) was one of the first researchers to classify isolated intervals according to degree of difficulty. Maltzew's dissertation, published in German and presented in English by Jeffries, "investigated adults' ability to identify the twelve ascending melodic intervals. Maltzew found that intervals judged correctly most often included the perfect octave, perfect fifth, and perfect fourth, while intervals judged correctly least often included the augmented fourth, the minor seventh, and the minor sixth" (Jeffries, 1967, p. 180). Maltzew's research, therefore, identified specific isolated intervals that were easier (perfect intervals) and harder (A4, m7, m6) to recognize aurally.

Ortmann (1934) showed that the intervallic content of melodies affected melodic dictation performance. Ortmann found students made the most errors where skips were involved (Ortmann, 1934); in melodic dictation, students made more errors when transcribing larger intervals and less errors when transcribing smaller ones. These results suggest that smaller intervals are more easily recognized in melodic dictation examples than larger intervals.

In 1967, Jeffries investigated the effectiveness of teaching melodic interval dictation through the use of programmed learning (Jeffries, 1967, p. 179). Jeffries defined programmed learning as instruction via a tape-recorder and playback system with no "live" teacher present (Jeffries, 1967, p. 179). The two basic guidelines for this study were "(a) the use of small steps of increasing difficulty for presentation of interval items and (b) the effects of knowledge of results (KR) for confirming interval judgments" (Jeffries, 1967, pp. 179-180). Seventy-three college students in music fundamentals classes were tested on melodic intervals (Jeffries, 1967). Based upon the number of mistakes the students made on the interval test, a hierarchy of the difficulty of melodic intervals emerged (Jeffries, 1967). The ordered sequence of intervals from easiest to most difficult to identify was: P8, M2, P5, M3, M7, m2, M6, P4, m3, A4, m7, m6 (Jeffries, 1967, p. 185). The spectrum that emerged in Jeffries results showed that the more difficult intervals to identify were the A4, m7, and m6, which incidentally were the same intervals identified by Maltzew.

Jeffries further tested the effect of a random order of the melodic intervals with the effect of knowledge of results (KR). Jeffries specifically asked two questions:

> " Is the introduction and drill of ascending melodic intervals in an order of increasing difficulty superior as a means of instruction to the introduction and drill of the same intervals in a random order of difficulty? (b) Is immediate KR superior to delayed KR for this learning task?" (Jeffries, 1967, p. 180)

Jeffries *randomly* sequenced the interval hierarchy resulting in the following order: M3, P4, m3, m2, A4, m7, P5, P8, M2, M7, M6, m6 (Jeffries, 1967, p. 185). Jeffries found that "drilling the intervals in the random order produced better learning results than drilling the intervals in the order of increasing difficulty (P8, M2, P5, M3, M7, m2, M6, P4, m3, A4, m7, m6)" (Jeffries, 1967, p. 188).

Jeffries also tested the effects of immediate knowledge of results (KR) versus delayed KR. Jeffries found that "random presentation with delayed KR produced the least number of errors, while ordered presentation with delayed KR produced the most errors" (Jeffries, 1967, p. 189). The timing of KR therefore seems to have little if any impact on the results, while the order of presentation of the intervals had more influence on the results.

There was a consistency in the difficulty of the intervals. Jeffries states that, "regardless of the order in which the intervals were introduced and drilled, in all variations of training and testing the A4, m7, and m6 were consistently among the three most frequently missed intervals" (Jeffries, 1967, p. 190). This result is the same as the Maltzew study.

Three years later (1970), Jeffries began another study into the difficulty of identifying melodic intervals. Jeffries's (1970) study was modeled after his 1967 study. However, instead of testing intervals in an ordered sequence or random presentation, Jeffries tested students' identification of intervals that were identified as "easy to identify" and "difficult to identify" by his 1967 study, along with immediate and delayed KR (Jeffries, 1970, p. 399). The ranked order of the ascending intervals from easiest to hardest, which was the result from the earlier study, is: P8, M2, P5, M3, M7, m2, M6, P4, m3, A4, m7, m6.

Subjects were undergraduate non-music majors who could not identify intervals on a screening test and had no prior interval dictation training (Jeffries, 1970, p. 400). Eighty students qualified as subjects and were divided into two groups for testing: one group identified intervals classified as “easy to identify,” and the other group identified intervals classified as “difficult to identify.” The intervals in the “easy to identify” group were the first five intervals from the increased difficulty list: P8, M2, M7, M3, P5. The intervals in the “difficult to identify” group were the last five intervals in the increased difficulty list: m7, P4, m3, m6, A4. The results showed that the intervals classified as easy to identify had fewer errors than subjects identifying intervals classified as difficult to identify. These results reinforce the order of difficulty of intervals in the previous study; Jeffries states in his conclusion that, “the results of this and the author’s earlier study appear to agree that certain ascending melodic intervals are more difficult than others to identify aurally” (Jeffries, 1970, p. 406).

Jeffries’ 1970 study differed from the 1967 study in regards to the effect of knowledge of results. The latter study showed that *immediate* KR produced fewer errors among subjects, unlike the earlier study that found that *delayed* KR produced fewer errors. Jeffries concluded that this finding made the knowledge of results inconsequential.

Shatzkin (1981) demonstrated the influence of the most basic introduction of context on the identification and perception of intervals. In his research he defined context as a melodic interval accompanied by other tones. Shatzkin tested college music majors on interval and pitch recognition that included specific context effects.

There were four conditions for Shatzkin's study and three experiments that used those conditions. The conditions were: (1) Students were tested to determine whether they could recognize 11 single tones ranging chromatically from F3 to D#4 to eliminate subjects with perfect pitch. (2) Isolated ascending intervals (ranging from the minor 2^{nd} E – F to the major seventh E – D#) were repeated four times each with ten seconds of silence between each example; students were asked to identify the quality of the interval and notate the second pitch of the interval heard above a printed E in treble clef on an index card. (3) The same interval pairs of condition 2 were *preceded* by a distractor tone (i.e., a pitch preceding the interval as to distract the listener). (4) The same intervals as condition 2 *followed* by a distractor tone (i.e., a pitch following the interval as to distract the listener) (Shatzkin, 1981, p. 111).

Shatzkin conducted three experiments using the four conditions. In the first experiment, students heard a distractor tone of a major 3^{rd} sounding above the tested interval. The second experiment used the same examples as the first experiment transposed one step lower. The third experiment changed the distractor tone to a minor 3^{rd} above the tested interval to investigate the effect of changing the preceding and following interval. The results of the three experiments showed that identification of intervals of a minor third, a tritone, and intervals of sixths were all affected by the addition of a distractor tone. During experiments 1 and 2, performance on the minor third was enhanced in condition 4, possibly due to the fact that the configuration of a minor third followed by a major 3^{rd} as a distractor tone builds a minor triad (Shatzkin, 1981). The tritone was not as readily recognized in isolation, but the students correctly identified it more in condition 4 of experiments 1 and 2 (Shatzkin, 1981). Shatzkin explains that the enhanced performance on the tritone was possibly due to having "the context of a following tone" and that "rather than distracting, the distractor tone may actually have been acting as a cue in some cases" (Shatzkin, 1981, p. 116). Simply, the tritone was more recognizable when set against the context of a major or minor third. Shatzkin also notes that, "intervals of sixths were of special interest in this study because the distractor intervals are all thirds, which are inversions of sixths" (Shatzkin, 1981, p. 116). Therefore, the addition of a major 3rd to a minor 6th would give some semblance of tonal familiarity in some of the examples, framing interval content in a more recognizable context. For instance, "Performance on the minor sixth (D – Bb – D, or minor sixth followed by a major third) was superior to the same item in condition 4a (D – Bb – E, or minor sixth followed by a tritone), while in condition 4, performance on the major sixth (D – B – D#, or major sixth followed by a major third) was inferior to that item in condition 4a (D – B – D, or major sixth followed by a minor third)" (Shatzkin, 1981, p. 116). Shatzkin points out that, "context may either enhance or interfere with the identification of an interval" (Shatzkin, 1981, p. 116). Shatzkin also concludes "performance on the intervals of a m3, TT, M6, m6 was enhanced by the context of a tone following the test interval, which apparently completed a unit of three tones that acted as a cue" (Shatzkin, 1981, p. 122). Most notable, for the purposes of this research, Shatzkin points out that the "minor seventh, both with and without a distractor, was usually the least recognized" (Shatzkin, 1981, p. 117) Shatzkin did not provide a clear ranked order of interval recognition, as Jeffries or Maltzew did.

The observances in Shatzkin's study showed the consequence of contextual factors on the perception of melodic intervals. Although thirds and sixths provided a framework of tonality when coupled with other tones, it would have been interesting if Shatzkin had chosen to elaborate upon the model to include additional tones other than thirds. Future research could extend this type of research to include tones of resolution or tones that create triads. It would be interesting to devise a test to determine if the students' performance on intervals would be affected when the intervals were placed in a familiar context. For instance, it would be interesting to see if an ascending M6 followed by a descending M3 to form the ever-popular "NBC" melody or an ascending M7 followed by an ascending m2 (forming P8) giving the context of a leading tone resolution. Perhaps this would be easier to hear than just the melodic interval of a M7 in isolation.

Killam, Lorton, and Schubert (1975) also measured student accuracy of simple interval identification. Their study involved 15 college undergraduate music students who had previously shown their competency in the identification of intervals by completing a Computer-Assisted Instruction (CAI) course. The study tested several sets of interval patterns in different durations. "Intervals presented in the experiment consisted of four series of intervals, ranging from a minor second to an octave above F-sharp to C (middle C) and below F-sharp to C . . . each set of 48 intervals (i.e. four sets of each of the 12 simple intervals derived as mentioned above for a total of 48 intervals) was presented in random order, so that each set of 48 intervals was different for each subject" (Killam, Lorton, & Schubert, 1975, p. 6). Intervals were the only component presented randomly in the experiment. The duration of the interval was either .1 or .2 seconds; only one duration was chosen per set (Killam, Lorton, & Schubert, 1975). Each interval set used only one form of presentation: ascending, descending, or simultaneous, (Killam, Lorton, & Schubert, 1975). "The resulting six modes of presentation were given to each subject, in the sequence as follows: (1) 48 simultaneous intervals at .2 seconds; (2) 48 ascending intervals at .2 seconds; (3) 48 descending intervals at .2 seconds; (4) 48 simultaneous intervals at .1 second; (5) 48 ascending intervals at .1 second; and (6) 48 descending intervals at .1 second . . . thus, a total of 288 intervals were presented to each subject in one session of approximately one hour" (Killam, Lorton, & Schubert, 1975, p. 217).

The results of the Killam, Lorton, and Schubert 1975 study showed an almost identical hierarchy of difficulty level of intervals as other studies. The study showed that intervals ranked from easiest to hardest (parentheses represent equal percentages) as follows: P8, M3, m2, (P4, M6, P5), (M2, m3), tritone, M7, m7, and m6. The results showed that "both the most and least accurately recognized intervals (P8 at 88% and m6 at 55%) are consonant in tonally oriented music" (Killam, Lorton, & Schubert, 1975, p. 218). It is interesting to note that the spectrum of intervals from easiest to most difficult to identify deviate little from findings in the aforementioned studies. In both of Jeffries' studies and Maltzew's study, smaller intervals (m2 or M3) are usually easier to identify, and larger intervals (m6, m7, and M7) are harder to identify. The results also showed that "the duration of the intervals tested was not found to be a significant source of variability in recognition. The average correct recognition of intervals at .2 sec was 77%, and at .1 sec, 76%" (Killam, Lorton, & Schubert, 1975, p. 219). The order in which the examples were presented also seemed to vary the results by interval type; "there was little difference in the interval least correctly identified (the m6) no matter what the mode of presentation and the interval most often correctly identified (the P8) varied considerably according to mode of presentation" (Killam, Lorton, & Schubert, 1975, p. 219). In regards to mode of presentation, "the mean percentage correct on simultaneous (harmonic) intervals was 67%, and that of both ascending and descending intervals 81%. This runs counter to the lore (in aural skills training) that descending intervals are most difficult to identify" (Killam, Lorton, & Schubert, 1975, p. 220). The authors explain that, "although the intervals themselves were presented in random order, the order of presentation mode (i.e., simultaneous, ascending, descending,) was constant for all subjects, so that the results may have been influenced by a subject learning factor" (Killam, Lorton, & Schubert, 1975, p. 220). The study also showed that the two intervals least used as a response by the subjects were the m6 and m7, and states that "since these intervals were both the intervals lowest in correct response and lowest in total times used, speculation is that if subjects judge intervals against a pre-existent image, they seem to have a less clear-cut image of m6 and m7" (Killam, Lorton, & Schubert, 1975, p. 228).

Pembrook studied melodic dictation rather than isolated intervallic content. In his research (1986), he attempted to define crucial strategies in taking melodic dictation and explore the results of each. One hundred and thirty-six students were randomly assigned to one of six dictation groups. The groups used three different approaches when taking melodic dictation: (1) simultaneous writing (writing while hearing), (2) concentration before notation, and (3) singing before writing (Pembrook, 1986). Students were presented 12 melodies and asked to notate them. In order to determine if any of the three strategies were "significantly more effective regardless of the number of presentations, the strategies were combined across single and dual melodic presentations" (Pembrook, 1986, p. 238). It was determined that none of the three strategies were more significant ($p < .05$) than the other (Pembrook, 1986). It was found that the correct response rate significantly increased upon hearing the melody twice (Pembrook, 1986). Also, Pembrook's hypothesis that "There will be no difference in the accuracy of student responses on the second half of melodies containing certain selected difficult intervals versus the second half of melodies containing only conjunct motion" yielded significant results (Pembrook, 1986, p. 240) revealing that, "accuracy was greater for conjunct melodies" than disjunct melodies (Pembrook, 1986, pp. 251, 252). These results suggest the possibility that *length* does not play as much a factor in melodic dictation examples as the *content* of an example. In this case, two melodies of the same length with conjunct motion in the first half were compared, one had conjunct motion in the second half of the example and one had disjunct motion in the second half of the example. The melody with conjunct motion in the second half of the example was more accurately identified. These results indicate that intervallic content matters within melodic context. However, Pembrook's study does not investigate why disjunct material is more difficult to identify than that of conjunct material.

The results of the above studies suggest that some intervals are more difficult to identify than others. The research presented shows that there are easy and difficult intervals (Jeffries, 1967; Jeffries 1970, Killam, et. al, 1975; Maltzew, 1913; Ortmann, 1934; Pembrook, 1986). The P8 and M3 tend to be the easiest, while the intervals of a m6, m7, and M7 are the most difficult (Jeffries, 1967; Jeffries, 1970; Maltzew, 1913). It is interesting to note that the musical background of subjects does not affect the difficulty of interval identification. Similar results were recorded in testing the recognition of intervals whether subjects were college undergraduate music majors who had already shown some level of proficiency in interval identification (Killam, Lorton, & Schubert, 1975), or whether they were non-music majors with no experience in interval identification (Jeffries, 1967). As revealed across various studies, interval example order and manner of presentation seem to be of little significance. Pembrook shows that length does not play as much a factor in the difficulty of a melodic dictation example as content. All of these factors suggest that the difficulty of intervallic content directly affects the difficulty of melodic dictation.

Chapter 3, Materials and Methodology, discusses the textbook used for the melodic dictation examples, the procedure of the data collection of intervals, and the stages of statistical analysis of the data.

Chapter 3

Materials and Methods

Based on the research of Maltzew, Jeffries, and Shatzkin, some intervals are more difficult to identify than others. Thus, melodies that contain more difficult intervals should be categorized differently than melodies with easier intervals. The purpose of this study was to determine if melodic dictation examples in a prominent aural skills textbook could be categorized based on their intervallic content. The melodic dictation examples from the instructor's edition of *Ear Training: A Technique for Listening, 7th Edition, Revised* by Benward and Kolosick (2010) were analyzed for their intervallic content[1]. The instructor's version of the text was used for the collection of the data since it contains the actual melodic dictation examples. Once the intervallic data was collected from the melodic dictation examples, it was analyzed to determine whether the melodic dictation examples could be categorized according to the intervallic content.

Text

Benward and Kolosick's (2010) textbook was chosen as the source of examples for this study because of its large number of melodic dictation examples and the textbook's organization. There are 224 melodic dictation examples in the 16 units of the text. (See Appendix A for a list of the units.) Each unit is divided into four skill areas: Melody, Harmony, Rhythm, and Transcription. Melodic Dictation examples are found in

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the first section (Melody) of each unit. Each melodic dictation section contains as few as 10 and as many as 30 examples. The title of the section describes the topics covered in that section. For example, melodic dictation sections in units 1-3 are titled: Unit 1, Melody 1A: *Melodic Dictation: Scalewise (Conjunct Diatonic) Melodies*; Unit 2, Melody 2A: *Melodic Dictation: Melodies Using m2, M2, m3, M3*; and Unit 3, Melody 3A: *Melodic Dictation: Melodies Using m2, M2, m3, M3, P4, P5* (Appendix A). The section identification, therefore, provides knowledge of the characteristics in the melodic dictation examples.

Procedure

Data Collection

The first step in the collection of intervallic data was to identify the intervals in each of the 224 melodic dictation examples. Only successive adjacent intervals were analyzed and identified; no non-adjacent intervals were analyzed (see Fig 3.1). Rhythm was not taken into consideration in the analysis. Once all of the intervals were identified, the total number of each interval was recorded in an Excel spreadsheet. Fig 3.2 shows the results of the tallying for the example shown in Fig 3.1. This line of data shows that there are three minor seconds (m2), five Major seconds (M2), and one minor third (m3) in this melody.

Other information about each melody was also recorded in the spreadsheet

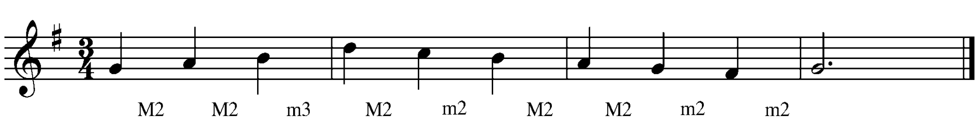

Figure 3.1 Example of Melodic Dictation, Unit 2, Melody 1

including the unit and melody number of the melodic dictation example, whether the example was composed (C) for the text or was taken from music literature (L), and the number of measures in the melody. Figure 3.2 shows that Melody 1 is a composed melody and is 4 measures in length. The entire spreadsheet is contained in an attachment to this thesis (File 1, Melodic Dictation Data Sheet.xlsx). This data was used for the statistical analysis.

Figure 3.2 Example of Excel Spreadsheet

4	**Chapter, Example, and Page #'s**	**Composed or Literature**	**Length in mm.**	**Unison**	**m2**	**M2**	**m3**	**M3**	**P4**	**Tritone**	**P5**	**m6**	**M6**	**m7**	**M7**	**P8**
5	Unit 2, Melody 2A, pg. 27-28															
6	Melody 1	c	4		3	5	1									
7	Melody 2	c	4		2	5	2									
8	Melody 3	c	4		1	5	1	2								
9	Melody 4	c	4		3	3	1	2								
0	Melody 5	c	4	1	2	5		1								
1	Melody 6	c	4	1	4		2	2								
2	Melody 7	c	4		2	3	2	2								
3	Melody 8	c	4		3	4	1	1								
4	Melody 9	c	4		2	4	2	1								

Statistical Analysis Method

IBM's Statistical Package for the Social Sciences (SPSS Version 19) was used for the statistical analysis. To find groups in the data, a clustering analysis was deemed as the most appropriate type of analysis. Before the clustering analysis could be undertaken, a principal components analysis needed to be performed.

Principal Component Analysis

A principal component analysis is a variable reduction procedure that is used when there is data obtained on a large number of *observed* variables (SAS Support: Principal Component Analysis, 2-3). A reduced number of variables (called principal components) can be created that will account for the maximum *variance* in the original variables (SAS Support: Principal Component Analysis,2-3). A principal components analysis is useful because it can take a set of original variables (in this case, 13 observed variables) and reduces them to only a few principal components (UCLA: Academic Technology Services, Statistical Consulting Group). The principal components themselves are *linear combinations* of optimally weighted observed variables, similar to a weighted average (SAS Support: Principal Component Analysis, 5). The principal components (PC) are derived in order of decreasing variance, meaning that PC 1 has the greatest variance, PC 2 has the next greatest variance, and PC 3 has the next greatest variance, etc. The first three principal components account for the maximum amount of the variance in the data (85% of the variance). The two principal components can be plotted in a two-dimensional scatterplot and the first three principal components can be plotted in a three-dimensional scatterplot. The scatterplots allow for a visualization of the distribution of the data (UCLA: Academic Technology Services, Statistical Consulting Group).

The principal components analysis (variable reduction procedure) was performed on the original 13 variables in this study in order to create principal components (linear combinations of the original variables). In this research, it was found that only 11 of the original 13 variables needed to be used for the principal components analysis; tritones and unisons were not used because they showed no major impact in the principal component analysis. The reduction in principal components simplified the principal component analysis. In a principal components analysis, the same number of principal components is created as there are variables used for the analysis (Terzi, Principal Components Analysis – Step by Step). So, 11 principal components were created. These principal components were then ranked according to variation. The variation is determined by an eigenvalue which represents the amount of variance that is accounted for by a given component in a dataset (SAS Support: Principal Component Analysis, 22). An eigenvalue of .7 is a typical value for capturing variation; principal components with an eigenvalue *greater* than .7 were retained. Seven of the original eleven principal components had an eigenvalue greater than the cutoff value of .7, so those seven principal components were retained. The first few principal components in a principal components analysis account for the greatest amount of variance (85%); therefore, they can be used in scatterplots to observe the distribution of the data (SAS Support: Principal Component

Analysis, 7). In scatterplots, only two and three principal components can be plotted, because humans can only see in two and three-dimensions.

Clustering Analysis

After the principal components analysis was completed, the clustering analysis was performed using the SPSS two-step clustering algorithm. The purpose of a two-step clustering analysis is to discover natural groupings of data. In this research, the clustering analysis identified groupings of melodic dictation examples based on their intervallic content. The seven principal components that were retained were used as continuous variables for the clustering analysis. A continuous variable is one that can take on any value between its minimum value and its maximum value (Sinauer Glossary, page C). The separation of data into clusters is based on distance. The distance between the data was calculated with a log-likelihood distance formula (IBM SPSS Statistics, Log-Likelihood Distance). A *smaller* distance between examples means that melodies are *more similar*. A *larger* distance between examples means that melodies are *less similar*. The SPSS two-step clustering algorithm found two clusters in the data. Once the algorithm found the two clusters, the first two and three principal components were re-plotted *by cluster*, superimposing the cluster data onto the scatterplots; this allowed for the clusters themselves to be visually represented showing the distribution of the data *by cluster*.

Chapter 4, Results and Discussion, displays the results from the principal components analysis as well as the results from the cluster analysis. The descriptive tables show how melodies were defined by their intervallic content and the data from these tables are discussed.

Chapter 4

Results and Discussion

The purpose of this research was to determine groupings of melodic dictation examples based on their intervallic content. Data was collected on melodic dictation examples from Benward & Kolosick 2010, a principal components analysis was performed, and a two-step clustering algorithm was used to find natural groupings of melodic dictation examples according to their intervallic content.

The principal components analysis made the variation of the observations obvious. The first few principal components (i.e., PC1, PC2, PC3) derived from the principal components analysis were plotted so distribution of the data could be visually represented in a scatterplot. The principal components were derived in an order of

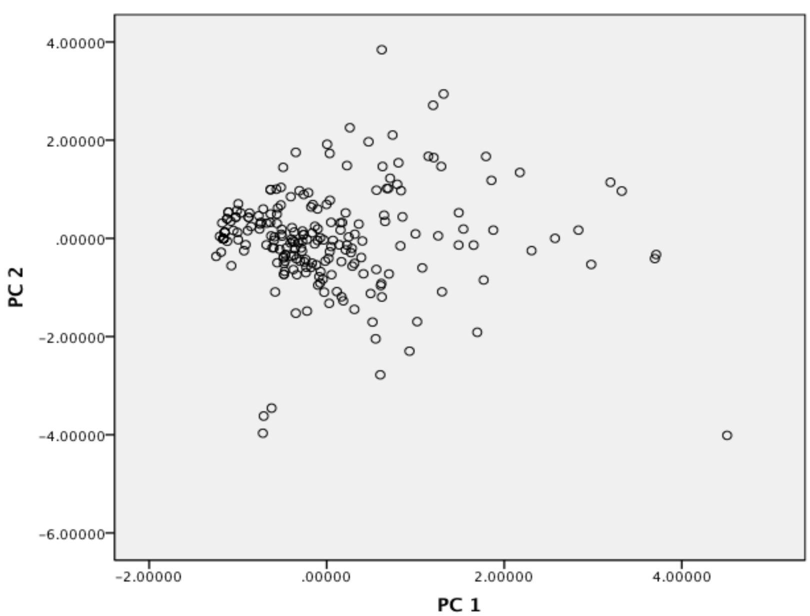

Figure 4.1 Plot of First Two Principal Components

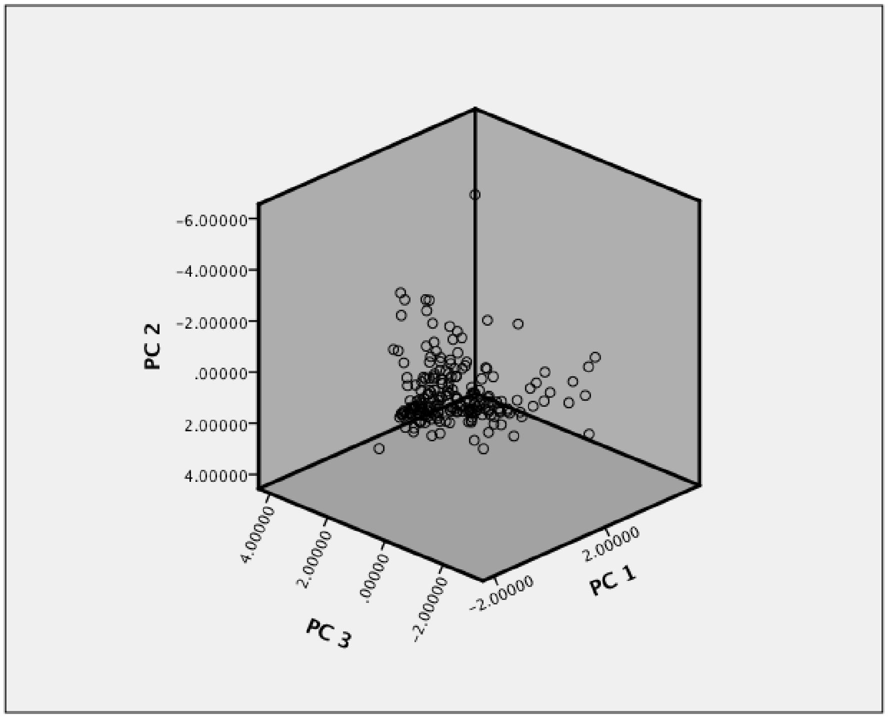

Figure 4.2 Plot of the First Three Principal Components

decreasing variance, meaning that the first three principal components accounted for the largest variance in the data (85%); thus, the first three principal components were used for the scatterplots. The plot of the first two principal components is shown in Figure 4.1 and shows the distribution of the melodic dictation examples in a two-dimensional space. The three-dimensional scatterplot is shown in Figure 4.2.

Next, a two-step clustering analysis was performed on the seven principal components that were retained in the principal components analysis. The information in Figure 4.3 indicates that the outcome of the two-step clustering algorithm using seven inputs (the seven principal components) resulted in two clusters at a fair level of clustering. A fair level of clustering means clusters were distinguishable and acceptable. After the clustering analysis was completed, the principal components could then be

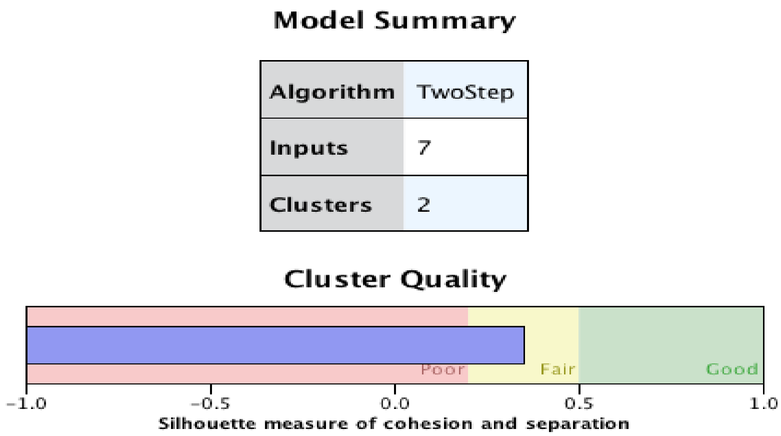

Figure 4.3 Two Step Cluster Model Summary and Quality

plotted *by cluster*; the clusters could be superimposed onto scatterplots so that they could be seen. The first two principal components were plotted *by cluster* as shown in the two -dimensional scatterplot in Figure 4.4. The first three principal components were also plotted *by cluster* and are shown in a three-dimensional visual representation in Figure 4.5. Melodies in cluster 1 can be seen as blue. Melodies in cluster 2 are shown in green.

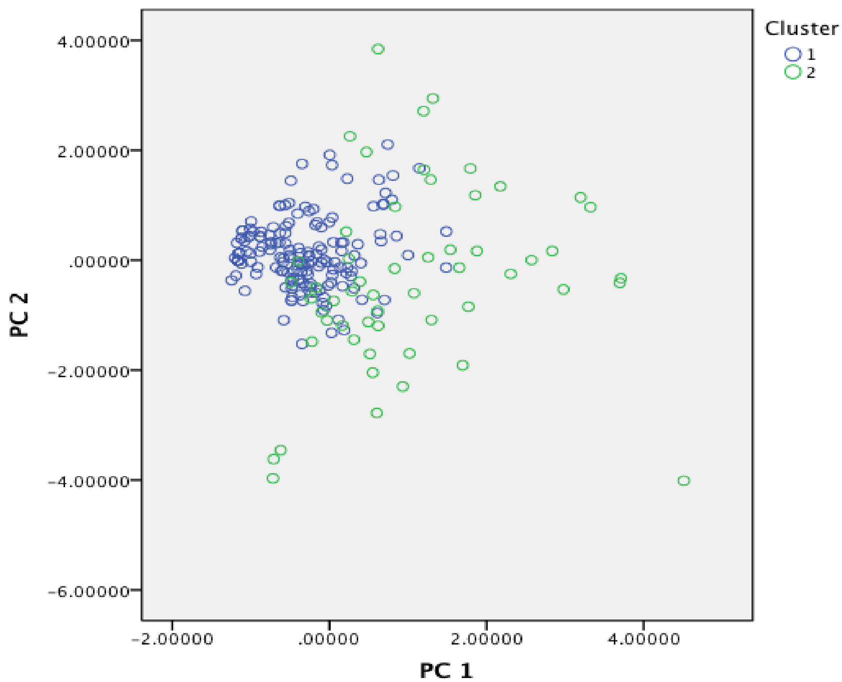

Figure 4.4 Plot of First Two Principal Components by Cluster

As can be seen in Figures 4.4 and 4.5, melodies in cluster 2 (shown in green) are slightly intermingled with cluster 1, but extend out from the blue group. The loose grouping of melodic dictation examples in cluster 2 (green) indicates that there is less similarity between the melodic dictation examples in this group. Although the melodic dictation examples are dissimilar (more distanced) within cluster 2, they are still more like one another within the cluster than they are like examples in cluster 1.

Again, melodies in cluster 1 are shown in blue and those in cluster 2 are green.

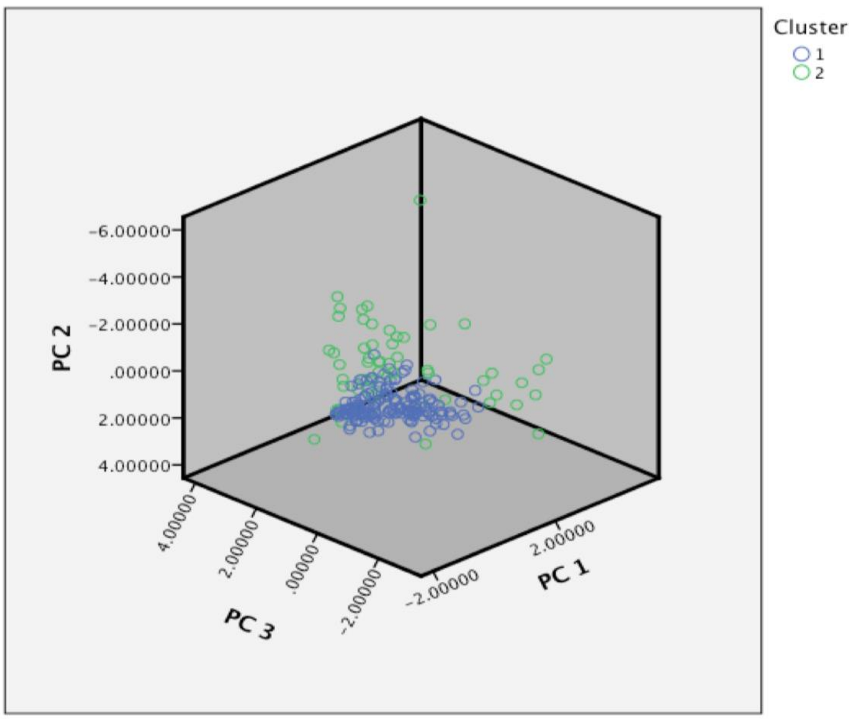

Figure 4.5 Plot of First Three Principal Components by Cluster

Since two clusters were found, the variables (intervals) that defined the melodic dictation examples into the clusters need to be determined. Aspects of the 13 original variables (the intervals) were undertaken. Descriptive statistics for the melodic dictation examples that belong to cluster 1 are shown in Table 4.1, while descriptive statistics for the melodic dictation examples that belong to cluster 2 are shown in Table 4.2. Both tables are sorted by the mean for the 13 original variables.

Table 4.1 Descriptive Statistics of Melodic Dictation Examples in Cluster 1

Descriptive Statistics

	Range	Minimum	Maximum	Mean	Std. Deviation
M2	10	0	10	3.48	2.423
m2	7	0	7	2.47	1.476
m3	7	0	7	1.10	1.317
M3	5	0	5	.88	1.045
P4	4	0	4	.77	1.069
Unison	8	0	8	.66	1.277
P5	2	0	2	.30	.552
M6	3	0	3	.12	.406
m6	1	0	1	.09	.294
Tritone	2	0	2	.08	.289
P8	1	0	1	.04	.186
m7	0	0	0	.00	.000
M7	0	0	0	.00	.000
Total Intervals per example	23	4	27	9.90	4.031
Length in measures	8	1	9	3.85	1.778
N = 169 (examples)					

Table 4.2 Descriptive Statistics of Melodic Dictation Examples for Cluster 2

Descriptive Statistics

	Range	Minimum	Maximum	Mean	Std. Deviation
M2	14	0	14	4.45	3.516
m2	15	0	15	3.29	2.813
m3	11	0	11	1.96	2.403
M3	7	0	7	1.49	1.720
P4	8	0	8	1.24	1.465
Unison	8	0	8	1.16	2.016
P5	4	0	4	1.05	1.145
m6	4	0	4	.71	1.012
M6	5	0	5	.71	1.031
P8	2	0	2	.45	.633
m7	2	0	2	.36	.589
Tritone	3	0	3	.27	.651
M7	1	0	1	.05	.229
Total Intervals per example	28	5	33	16.95	8.363
Length in measures	8	1	9	5.36	2.724
N = 55 (examples)					

The first three columns in the descriptives tables contain range, minimum, and maximum values. The minimum value is the least number of times a variable occurred in a melody. The maximum value is the largest number of times a variable occurred in a melody. The range is the maximum number minus the minimum number of a variable. In cluster 1 (Table 4.1), the smallest range is 0 (for minor and Major sevenths) meaning that these two intervals did not occur in the melodies in this cluster. The largest range was 10 for Major seconds; some melodies contained no Major seconds (minimum of 0) while at least one melody contained 10 major seconds (maximum value). In cluster 2

(Table 4.2), the smallest range is 1 for Major sevenths; some melodies contained no Major sevenths (minimum of 0) while at least one melody contained 1 Major seventh. The largest range in cluster 2 was 15 for minor seconds; some melodies contained no minor seconds (minimum of 0) while at least one melody contained 15 minor second.

The fourth column in both Tables 4.1 and 4.2 is the mean – the average number of an interval in the examples. The largest mean in cluster 1 (Table 4.1) is 3.48 for Major seconds. The smallest mean is 0 for both the minor seventh and Major seventh, indicating that neither of these intervals occurred in cluster 1. The largest mean in cluster 2 (Table 4.2) is 4.45 for Major seconds. The smallest mean is .05 for the interval of Major seventh. Smaller interval motion was more prevalent in both clusters: the means for M2 (mean = 3.48 for cluster 1 and mean = 4.45 for cluster 2), m2 (mean = 2.47 for cluster 1 and mean = 3.29 for cluster 2), m3 (mean = 1.10 for cluster 1 and m3 mean = 1.96 for cluster 2), and M3 (mean = .88 for cluster 1 and mean = 1.49 for cluster 2) were the largest in both clusters.

Although the averages were not high, larger interval motion, especially of minor sevenths (mean = 0.36) and Major sevenths (mean = 0.05) are a unique characterization of cluster 2 (Table 4.2) since those intervals did not occur at all in cluster 1 (Table 4.1). The m6 had an average of .71 intervals per example in cluster 2 compared to a mean of .09 for m6 in cluster 1; the M6 also had an average of .71 intervals per example in cluster 2 and .12 for M6 in cluster 1 (Table 4.1 and 4.2). Perfect fourths were found more often in cluster 2 (mean = 1.24) than in cluster 1 (mean = .77). Similarly, perfect fifths were found more often in cluster 2 (mean = 1.05) than in cluster 1 (mean = .30). The tritone

(TT) was also found more often in cluster 2 (mean = .27) than in cluster 1 (mean = .08). There were more intervals in the examples in cluster 2 (mean = 16.9 intervals per example) than in cluster 1 (mean = 9.9 intervals per example), indicating that the examples in cluster 2 had more notes in them (Tables 4.1 and 4.2).

The standard deviation indicates the amount of variation there is from the mean. The higher the standard deviation, the more dispersed the variables are from the mean; a lower standard deviation indicates that the observations are centered more closely around the mean (Sinauer Glossary, page S). In Table 4.1 (cluster 1), the highest standard deviation is 2.423 for the interval of a Major second. Alternatively, the lowest standard of deviation in cluster 1 was .186 for the Perfect octave (Table 4.1). Thus, the values of P8 are less spread out than the values for the M2. In cluster 2 (Table 4.2), the highest standard of deviation is 3.516 for the interval of a Major second. The lowest standard of deviation in cluster 2 is .229 for the Major seventh.

Even though the information in the above tables was interesting, it was difficult to see how many of each interval was contained in each cluster since the tables only showed averages. To see the actual numbers better, the original dataset was sorted by cluster in SPSS. Then, the number of each interval for the melodies in both clusters was totaled and the percentage of the total number of intervals was calculated for each interval. Cluster 1 contained 1,673 intervals, 64% of the total intervallic content. Cluster 2 contained 932 intervals, 36% of the total intervallic content. Table 4.3 shows the percentages of intervals in cluster 1 and Table 4.4 shows the percentages for intervals in cluster 2.

The increase in the percentage of intervals from cluster 1 to cluster 2 supports the larger intervallic content as a “unique descriptor” or characterization for cluster 2 melodic dictation examples. The increase in the overall number of intervals per example (as shown Table 4.1 and 4.2) could be construed as possible culprits for cluster separation. However, the separation was dependent on the seven principal components that were used, which were based on the original variables. Therefore, the increase of intervallic content in cluster 2 was NOT a unique descriptor of the categories; the key factor that determined the clusters was that more large intervals occurred in melodies in cluster 2 than in cluster 1.

Tables 4.3 and 4.4 also show the total number and percentage of each. The information is sorted by percentage. The intervals occurring the most are shown in the red shaded area, while the intervals occurring the least are shown in the blue shaded area.

Table 4.3 Percentages of Intervals in Cluster 1		
M2	588	35.15%
m2	417	24.93%
m3	186	11.12%
M3	149	8.91%
SUB-TOTAL		**80.11**
P4	130	7.77%
Unison	111	6.63%
P5	50	2.99%
SUB-TOTAL		**17.39**
M6	20	1.20%
m6	16	0.96%
TT	13	0.78%
P8	6	0.36%
m7	0	0.00%
M7	0	0.00%
SUB-TOTAL		**3.3**
Total Intervals in Cluster 1 = 1,673		

Table 4.4 Percentages of Intervals in Cluster 2		
M2	245	26.29%
m2	181	19.42%
m3	108	11.59%
M3	82	8.80%
SUB-TOTAL		**66.1**
P4	68	7.30%
Unison	64	6.87%
P5	58	6.22%
SUB-TOTAL		**20.39**
m6	39	4.18%
M6	39	4.18%
P8	25	2.68%
m7	20	2.15%
TT	15	1.61%
M7	3	0.32%
SUB-TOTAL		**15.12**
Total Intervals in Cluster 2 = 932		

It is interesting that the order of the intervals in both the red (most occurring) and the white areas is exactly the same in both Tables 4.3 and 4.4 and thus in both clusters. The red shaded area contains the smallest intervals (m2, M2, m3 and M3). In cluster 1 (Table 4.3), 80.11% of the total intervals are smaller intervals (m2 – M3) while in cluster 2 only 66.1% of all intervals are smaller intervals (Table 4.4), a 14% decrease. Thus, smaller intervals are more prevalent in cluster 1 than in cluster 2.

The intervals shown in the white area (P4, unison, P5) are also identical in order between the two clusters. The total number of these intervals is also similar between clusters – 17.39% for cluster 1 and 20.39% in cluster 2. The P4 and unison have very similar percentages between cluster 1 and 2; the P5 increased from 2.99% in cluster 1 to 6.22% in cluster 2 (Table 4.3, Table 4.4).

The intervals shown in the blue shaded area are larger intervals and include the tritone (TT, m6, M6, m7, M7 and P8). Unlike the intervals contained in the red and white shaded areas, the intervals contained in the blue shaded area were not in an identical order between clusters (see Table 4.3, Table 4.4). The order in cluster 1 intervals is M6, m6, TT, P8, m7, M7; the order in cluster 2 is m6, M6, P8, m7, TT, M7. These intervals account for only 3.3% of the total intervals in cluster 1 as opposed to 15.12% of total intervals in cluster 2 melodies, an 11.82% increase from cluster 1. Larger intervals (m6-M7) occurred in melodic dictation examples in cluster 2 at much higher percentages (m6 = 4.18%, M6 = 4.18%, m7 = 2.15%, M7 = .32%) compared to melodic dictation examples in cluster 1 (m6 = .96%, M6 = 1.20%, m7 = 0.0%, M7 = 0.0%). The tritone (TT) and the perfect octave (P8) were also found at higher percentages; for cluster 1 (TT= .78%, P8 = 0.36%) and cluster 2 (TT = 1.61%, P8 = 2.68%). Larger intervals are a unique descriptor for cluster 2 melodies.

Next, frequency tables showing whether examples were composed or derived from music literature were examined. Frequency tables tracked examples by whether they were composed or selected from music literature, and show the percentage of those examples in each cluster. Table 4.5 displays the frequencies for cluster 1 and Table 4.6 displays the frequencies for cluster 2. The frequencies indicate that 74.6% of examples in cluster 1 were composed for the text and only 25.4% of examples in cluster 1 were from literature. In cluster 2, 41.8% of examples were composed and 58.2% of examples were from literature. The possible significance of more literature examples being in cluster 2 melodies is discussed in Chapter 5.

Table 4.5 Frequencies of Composed or Literature Examples in Cluster 1

Composed or Literature

	Frequency of Examples	Percent	Cumulative Percent
Composed	126	74.6	74.6
Literature	43	25.4	100.0
Total	169	100.0	

Table 4.6 Frequencies of Composed or Literature Examples in Cluster 2

Composed or Literature

	Frequency of Examples	Percent	Cumulative Percent
Composed	23	41.8	41.8
Literature	32	58.2	100.0
Total	55	100.0	

Next, the examples were examined by which textbook unit they occurred in for each cluster. The frequencies of the examples by cluster within units of the textbook are shown in Table 4.7 for cluster 1and Table 4.8 for cluster 2. The Unit column shows the unit number of the textbook to which the melody belongs. The frequency and percentage columns show the number and percent of melodic dictation examples from each unit that occurred in each cluster.

No examples from Unit 1 or Unit 2 of the text fell into cluster 2. All of the melodic dictation examples in Unit 1 (30 out of 30) and Unit 2 (14 out of 14) contained only smaller intervals (see File 1, Melodic Dictation Data Sheet.xlsx); none of the examples in Unit 1 contained an interval above a M2 and the examples in Unit 2 did not contain an interval above a M3. The data in Table 4.8 shows that there was a large increase in examples within the cluster for Unit 6 (3.0% in cluster 1 vs. 14.5% of cluster 2 melodies) and Unit 7 (2.4% in cluster 1 vs. 10.9% of cluster 2 melodies). The Unit 6 title for melodic dictation examples in Benward & Kolosick 2010 is *Intervals of a 7th*, so it is evident that this section would have lots of larger intervals. The frequency tables of examples in cluster by unit helped to show that an increase of larger intervals in cluster 2 from cluster 1 is indeed present.

Table 4.7 Frequency of Examples in Cluster 1 by Unit

Unit of Text	Frequency of Examples in Cluster 1	Total Examples	Percent in Cluster 1
1	30	30	17.8
2	14	14	8.3
3	13	14	7.7
4	17	18	10.1
5	9	13	5.3
6	5	13	3.0
7	4	10	2.4
8	9	14	5.3
9	10	14	5.9
10	14	18	8.3
11	7	10	4.1
12	7	10	4.1
13	4	10	2.4
14	2	10	1.2
15	13	14	7.7
16	11	12	6.5
Total	169	224	100.0

Table 4.8 Frequency of Examples in Cluster 2 by Unit

Unit of Text	Frequency of Examples in Cluster 2	Total Examples	Percent in Cluster 2
3	1	14	1.8
4	1	18	1.8
5	4	13	7.3
6	8	13	14.5
7	6	10	10.9
8	5	14	9.1
9	4	14	7.3
10	4	18	7.3
11	3	10	5.5
12	3	10	5.5
13	6	10	10.9
14	8	10	14.5
15	1	14	1.8
16	1	12	1.8
Total	55	224	100.0

Interestingly, in the Frequency column of Table 4.8, Unit 1 and 2 are not present, Unit 3 and Unit 4 (the first two units present in the cluster) contain only 1 of 14 and 1 of 18 examples in cluster 2; Unit 15 and Unit 16 (the last two units in the cluster and of the textbook) contain only 1 of 14 and 1 of 12 examples in cluster 2. Table 4.8 shows that the presence of cluster 2 melodies are scarce both at the beginning of the text and at the end of the text. It is doubtful that this is coincidence and possibly suggests text organization is controlling melody placement and interval content.

This research shows that melodic dictation examples belong to one of two groups or clusters characterized by intervallic content. One group contains melodies with a larger number of smaller intervals (cluster 1) and the other group of melodies contains a larger number of larger intervals (cluster 2). The majority of cluster 2 examples come from examples that were selected from musical literature and the majority of composed examples are in cluster 1. On average there were more intervals per example in cluster 2, yet that was not a unique descriptor of the cluster. The main distinction was cluster 2's increase in large intervallic content. Although dissimilar within their cluster, it is important to note that the examples in cluster 2 are still more similar to each other than they are to examples in cluster 1.

The next chapter discusses the conclusions of this research and further recommendations for future research.

Chapter 5

Conclusions and Recommendations

The purpose of this research was to determine if melodic dictation examples could be categorized based on their intervallic content. The results of this research show that melodic dictation examples can be divided into two groups based on intervallic content. Melodies with smaller intervals (i.e., intervals of a m2 through a M3) were similar in their content, appearing most often in cluster 1. Melodies containing larger intervals (i.e., intervals of a m6, M6, m7, M7) occurred in cluster 2, even though they are more scattered within the cluster and thus less similar to each other the separation of melodies into two clusters based on their interval content shows that natural groupings of intervallic data exist. However, the melodies in the two clusters were not necessarily separated in the Benward & Kolosick 2010 textbook from which they were taken. Instead, the melodies from the two clusters were intermingled in the units of the textbook suggesting that the text organization is controlling the placement of the melodies through the introduction of new concepts.

According to the descriptives tables for cluster 1 and cluster 2, there were few larger intervals per example meaning that larger intervals were lacking in the text overall. Melodies in cluster 2, those melodies with a greater number of larger intervals, were scattered through Units 3 through 16 (Table 4.8). The lack of larger intervals in the text and their scattered presence could be attributed to the organization of the textbook and the concepts that were introduced, however, this could not be determined entirely. It is clear, due to the titles in the Benward & Kolosick 2010, that larger intervals are present during the middle of the text. Data in Table 4.8 shows that 14.5% (the highest percentage) of the melodies that belong to cluster 2 are in Unit 6: Intervals of a 7th, which further shows that larger intervals are a characterization of cluster 2. Unit 6 is the most apparent example that text organization controls intervallic content through the placement of melodies. The last two units in the Benward & Kolosick 2010 were almost entirely comprised of cluster 1 melodies, 13 out of 14 examples in Unit 15 and 11 out of 12 examples in Unit 16 (see Table 4.7). Having units made up of melodies belonging to cluster 1, the cluster containing a greater number of smaller intervals, at the end of the book is unusual. Larger intervals would be expected at this point in the book. However, Units 15 and 16 are both titled, *Nondiatonic Tones*. Possibly, as new material or concepts are introduced into the text, the intervallic content is reduced to contain smaller interval motion, resulting in more cluster 1 melodies.

It is very interesting that there is a lack of large intervals in this aural skills textbook. For example, out of the 2,605 intervals in 224 melodic dictation examples, there are only 3 major sevenths in the entire textbook (see File 1, Melodic Dictation Data Sheet.xlsx). There are also only 20 minor sevenths (0.007%), 55 minor sixths (0.021%), and 59 major sixths (0.022%) (see File 1, Melodic Dictation Data Sheet.xlsx). The lack of larger interval content in this textbook could reflect that these larger intervals show up less often in tonal music than smaller intervals; in cluster 2, where most of the larger intervals occurred, 58.2% of examples were from music literature, yet there are very few larger intervals. As discovered by Killam, Lorton, and Schubert (1975), the two intervals least used as a response by the subjects were the m6 and m7. "Since these intervals were both the intervals lowest in correct response and lowest in total times used, speculation is that if subjects judge intervals against a pre-existent image, they seem to have a less clear-cut image of m6 and m7" (Killam, Lorton, & Schubert, 1975, p. 228). According to Jeffries, the intervals of m6 and m7 were consistently more difficult for students to identify. Familiarity with larger intervals seems to be an issue in aural skills training and it's no coincidence that this aural skills textbook has a lack of larger intervals. These findings could have pedagogical implications. Should theory instructors drill the identification of larger intervals in isolation if they rarely show up in melodies? Or, should theory instructors spend more time on how these larger intervals present themselves in melodies? Perhaps, the lack of larger intervallic content in this textbook suggests that there *is a lack of familiarity* altogether with larger intervals, especially intervals of m6, M6, m7, and M7, and should be addressed in the classroom. Or, if they do not occur in music as often, should we teachers spend so much time on them?

Now that the categorization of these melodic dictation examples has been determined, the next step in research on the examples is to examine and determine whether the melodies in cluster 2 are more difficult to identify than the melodies in cluster 1. If subjects have more difficulty identifying cluster 2 melodies than cluster 1 melodies, then intervallic content will prove to be factor of melodic dictation difficulty.

Context and how it affects intervallic content should also be the subject of future research. How do contextual settings, such as triads, and chords fit into the groupings of melodic dictation examples found in this research? Some researchers (Dowling, 1986;

Telesco, 1990; Paney, 2007) have already investigated the effects of contextual parameters on melodic dictation, but with limited reference to intervallic content and the role it plays in melodic dictation. Paney's (2007) dissertation suggests that intervallic content has little to do with difficulty and that contextual factors reign supreme (Paney, 2007). Dowling, et al., also argue that understanding and retaining contour in melodic dictation is a key component when approaching aural skills training among other contextual factors (Dowling & Fujitani, 1971; Dowling, 1986; Edworthy, 1985). Future research should take into consideration both intervallic content and context as a mutual influence on the difficulty of melodic dictation.

Through multivariate analysis, this research found that melodic dictation examples could be divided into groups based on their intervallic content. It was tempting during the course of this research to make intuitive claims about the difficulty of melodic dictation examples based on intervallic content. Now that the melodic dictation examples are grouped based on their intervallic content, further examination can be made to determine whether there are some melodies and therefore intervals that are in fact more difficult than others to identify.

List of References

Benward, B., & Kolosick, J. T. (2010). *Ear Training: A Technique for Listening.* New York: McGraw-Hill.

Dowling, W. J. (1986). Context Effects on Melody Recognition: Scale-Step versus Interval Representations. *Music Perception: An Interdisciplinary Journal , 3* (3), 281-296.

Dowling, W. J., & Fujitani, D. S. (1971). Contour, Interval, and Pitch Recognition in Memory for Melodies. *The Journal of the Acoustical Society of America , 49* (2(2)), 524-531.

Edworthy, J. (1985). Interval and Contour in Melody Processing. *International Conference on Psychology and the Arts. 2*, pp. 375-388. University of California Press.

IBM SPSS Statistics. (n.d.). *Log-Likelihood Distance (TwoStep clustering algorithms)*. Retrieved 2012 йил 19-04

IBM SPSS Statistics. (n.d.). *Principal Components Extraction (PC) (factor analysis algorithms)*. Retrieved 2012 йил 19-04 from http://publib.boulder.ibm.com/infocenter/spssstat/v20r0m0/index.jsp?topic=%2Fcom.ibm.spss.statistics.help%2Falg_twostep_distance_loglikelihood.htm

Jeffries, T. B. (1970). A Further Investigation of Certain Learning Aspects in the Aural Recognition of Melodic Intervals. *Journal of Research in Music Education , 18* (4), 399-406.

Jeffries, T. B. (1967). The Effects of Order of Presentation and Knowledge of Results on the Aural Recognition of Melodic Intervals. *Journal of Research in Music Education* , 179-190.

Killam, R. N., Lorton, P. V., & Schubert, E. D. (1975). Interval Recognition: Identification of Harmonic and Melodic Intervals. *Journal of Music Theory , 19* (2), 212-234.

Maltzew, C. V. (1913). Das Erkennen sukzessiv gebener musikalischer Intervalle in den äusseren Tonregionen. *Zeitschrift für Psychologie , LXIV*, 161-257.

Ortmann, O. (1934). Problems in the Elements of Ear-Dictation. *Research Studies in Music , 2*.

Paney, A. S. (2007 йил May). Directing attention in melodic dictation. Texas Tech University.

Pembrook, R. G. (1986). Interference of the Transcription Process and Other Selected Variables on Perception and Memory during Melodic Dictation. *Journal of Research in Music Education , 34* (4), 238-261.

SAS Support: Principal Component Analysis. (n.d.). Retrieved 2012 йил 22-April from http://support.sas.com/publishing/pubcat/chaps/55129.pdf

Shatzkin, M. (1981). Interval and Pitch Recognition in and out of Immediate Context. *Journal of Research in Music Education , 29* (2), 111-123.

Sinauer Glossary. (n.d.). From http://www.sinauer.com/fmri2e/html/glossary.html#S

Telesco, P. (1991). Contextual Ear Training. *Journal of Music Theory Pedagogy* , 179-190.

Terzi. (n.d.). *Principal Components Analysis - Step by Step (Part 1)*. Retrieved 2012 йил 21-04 from StatisticsPedia: http://www.statisticspedia.com/articles/statistical-research/pca-step-by-step1/

UCLA: Academic Technology Services, Statistical Consulting Group. (n.d.). *Annotated SPSS Output: Principal Components Analysis*. Retrieved 2011 йил 8-12 from http://www.ats.ucla.edu/stat/SPSS/output/principal_components.htm

Appendix

Appendix A: Benward & Kolosick 2010 Table of Contents

Melody 3D Interval Review: m2, M2, m3, M3, P4, P5
Melody 3E Models and Embellishments: Simple Melodic Structures

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Harmony 3B Chords in Music Literature: I, ii, and V Triads
Harmony 3C Cadence Identification: Cadence Types
Harmony 3D Harmonic Dictation: I(i), IV(iv), and V Triads in Four-Part Phrases
Harmony 3E Chord Quality Identification: Writing Major, Minor, Diminished, and Augmented Triads

Rhythm 3A Rhythmic Dictation: Rhythmic Figures Including Half-Beat Values
Rhythm 3B Error Detection: Dotted Rhythm Values

Transcription 3

Unit 4

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Harmony 4C Nonharmonic Tones: Two-Voice Examples
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Harmony 4E Chord Quality Identification: Major, Minor, Diminished, and Augmented Triads

Rhythm 4A Rhythmic Dictation: Half-Beat Values in Syncopation
Rhythm 4B Error Detection: Half-Beat Values in Syncopation

Transcription 4

Unit 5

Melody 5A Melodic Dictation: Melodies Outlining the I, IV, V (and vii06) Triads
Melody 5B Error Detection: Excerpts from Music Literature
Melody 5C Melodic Figure Identification: Sequence and Rhythmic Repetition
Melody 5D New Interval: The Tritone
Melody 5E Models and Embellishments: Descending 6ths in Two Voices

Harmony 5A Chord Function Identification: I(i), ii (ii0), IV(iv), and V Triads and

Inversions
Harmony 5B Chords in Music Literature: I(i), ii(ii0), IV(iv) and V Triads
Harmony 5C Harmonic Rhythm and Nonharmonic Tones
Harmony 5D Harmonic Dictation: I(i), ii, IV(iv), and V Triads in Chorale Phrases
Harmony 5E Error Detection: Single Triads in Four Parts

Rhythm 5A Rhythmic Dictation: Introduction to Quarter- Beat Values
Rhythm 5B Error Detection: Quarter-Beat Values

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Unit 6

Melody 6A Melodic Dictation: Intervals of a 7th
Melody 6B Error Detection: Schubert Melodies
Melody 6C Melodic Figure Identification: Sequence, False Sequence, and Rhythmic Repetition
Melody 6D New Intervals: m7 and M7
Melody 6E Models and Embellishments: 7-3 Pattern in Two Voices

Harmony 6A Chord Function Identification: I, ii, IV, V, and vi Triads
Harmony 6B Chords in Music Literature: Emphasis on ii, IV, and vi
Harmony 6C Nonharmonic Tones: Four-Voice Examples
Harmony 6D Harmonic Dictation: The I(i), ii(ii0), IV (iv) and V Triads in Chorale Phrases
Harmony 6E Error Detection: Triads in Four Parts

Rhythm 6A Rhythmic Dictation: Quarter-Beat Values
Rhythm 6B Error Detection: Triplet Figures

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Unit 7

Melody 7A Melodic Dictation: Two-Phrase Melodies
Melody 7B Error Detection: Handel Melodies
Melody 7C Melodic Figure Identification: Melodic Devices
Rhythm 7D Intervals: All Diatonic Intervals
Melody 7E Models and Embellishments: Cadence Formulas in Two Voices

Harmony 7A Chord Function Identification: I(i), ii (ii0), iii(III,III+) IV(iv), V, and vi(VI) Triads
Harmony 7B Chords in Music Literature: Emphasis on iii and vi
Harmony 7C Harmonic Rhythm and Harmonic Analysis: I, ii, IV, V, and vi

Triads
Harmony 7D Harmonic Dictation: I(i), ii(ii0), IV(iv), V, and vi(VI) Triads in Chorale Phrases
Harmony 7E Error Detection: Triads in Four Parts

Rhythm 7A Rhythmic Dictation: Quarter-Beat Values
Rhythm 7B Rhythmic Dictation: Beat Units Divided into Triplets

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Unit 8

Melody 8A Melodic Dictation: Melodies with Larger Leaps
Melody 8B Error Detection: Franck Melodies
Melody 8C Harmonic Rhythm, Harmonic Analysis, Sequences, Phrase Relationships, and Cadences
Melody 8D Intervals: All Diatonic Intervals
Melody 8E Models and Embellishments: 5-6 Patterns in Three Voices

Harmony 8A Chord Function Identification: Diatonic Triads (Major Mode)
Harmony 8B Chords in Music Literature: All Triads
Harmony 8C Nonharmonic Tones: Bach Chorales (1)
Harmony 8D Harmonic Dictation: I(i), ii, IV(iv), V, vi (VI), and Vii0 Triads in Chorale Phrases
Harmony 8E Error Detection: Triads in Four Parts

Rhythm 8A Rhythmic Dictation: Quarter-Beat Values
Rhythm 8B Error Detection: Quarter-Beat Values

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Unit 9

Melody 9A Melodic Dictation: Short Melodies from Music Literature
Melody 9B Error Detection: Bach Melodies
Melody 9C Melodic Dictation: Two-Part Dictation
Melody 9D Intervals: Harmonic Intervals of the m3, Tritone, P5, m6, M6, m7
Melody 9E Models and Embellishments: Descending First Inversion Triads

Harmony 9A Chord Function Identification: Six-Four Chords
Harmony 9B Chords in Music Literature: Six-Four Chords
Harmony 9C Harmonic Rhythm and Harmonic Analysis of Folk Melodies
Harmony 9D Harmonic Dictation: All Diatonic Triads in Chorale Phrases
Harmony 9E Error Detection: Triads in Four Parts

Rhythm 9A Rhythmic Dictation: Compound Meters with Quarter-Beat Values

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Unit 10

Melody 10A Melodic Dictation: Sequences
Melody 10B Error Detection: Themes from Music Literature Lacking Accidentals
Melody 10C Two-Voice Dictation
Melody 10D Intervals: All Intervals Played Harmonically
Melody 10E Models and Embellishments: 7th Chord Patterns in Three Voices

Harmony 10A Chord Function Identification: Dominant 7th Chords
Harmony 10B Chords in Music Literature: Dominant 7th Chords (All Inversions)
Harmony 10C Nonharmonic Tones: Bach Chorales (2)
Harmony 10D Harmonic Dictation: The Dominant 7th Chord in Chorale Phrases
Harmony 10E Error Detection: Triads or Dominant 7th Chords

Rhythm 10A Rhythmic Dictation: Triple and Triplet Subdivisions
Rhythm 10B Rhythmic Dictation: Two-Voice Rhythms

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Unit 11

Melody 11A Melodic Dictation: Short Melodies That Modulate to Closely Related Keys
Melody 11B Error Detection: Excerpts from Music Literature
Melody 11C Phrase Relationships and Cadences
Melody 11D Intervals: All Intervals Played Harmonically
Melody 11E Models and Embellishments: Chord Progression with Melodic Embellishments

Harmony 11A Chord Function Identification: vii07 (Diminished 7th Chord)
Harmony 11B Chords in Music Literature: vii07 (Diminished 7th Chord)
Harmony 11C Aural Analysis: Aspects of Two-Phrases That Modulate
Harmony 11D Harmonic Dictation: Chorale Phrases That Modulate
Harmony 11E Chord Quality Identification: MM, Mm, mm, dm, and dd 7th Chords

Rhythm 11A Rhythmic Dictation: The Quartolet
Rhythm 11B Error Detection: More Difficult Rhythmic Errors

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Unit 12

Melody 12A Melodic Dictation: Modulations to Closely Related Keys
Melody 12B Error Detection: Two-Voice Compositions
Melody 12C Binary, Rounded Binary, and Three-Part Form
Melody 12D Interval Dictation: Two Intervals in Succession
Melody 12E Models and Embellishments: I-V-I Progression with Melodic Embellishments

Harmony 12A Chord Function Identification: Nondominant 7th Chords
Harmony 12B Chords in Music Literature: Nondominant 7th Chords
Harmony 12C Aural Analysis: Harmonic and Melodic Relationships in Musical Periods from Haydn Sonatas
Harmony 12D Harmonic Dictation: Modulations to Closely Related Keys
Harmony 12E Chord Quality Identification: MM, Mm, mm, dm, and dd 7th Chords

Rhythm 12A Rhythmic Dictation: Eighth-Beat Values
Rhythm 12B Error Detection: Eighth-Beat Values

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Unit 13

Melody 13A Melodic Dictation: Modulation in Two-Phrase Periods
Melody 13B Error Detection: Brahms Melodies
Melody 13C Binary, Rounded, Binary, and Three-Part Form
Melody 13D Interval Dictation: Two and Three Intervals in Succession
Melody 13E Models and Embellishments: I-V-I Progression with Diatonic Melodic Embellishments

Harmony 13A Chord Function Identification: Secondary Dominants of V and ii
Harmony 13B Chords in Music Literature: Secondary Dominants of ii, IV, and V
Harmony 13C Aural Analysis: Key, Phrase, and Cadence Relationships in Musical Excerpts
Harmony 13D Harmonic Dictation: Chorale Phrases Containing 7th Chords
Harmony 13E Error Detection: Triads and 7th Chords

Rhythm 13A Rhythmic Dictation: Introduction to the Supertriplet
Rhythm 13B Error Detection: Eighth-Beat Values

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Unit 14

Melody 14A Melodic Dictation: Modulation in Two-Phrase Melodies
Melody 14B Error Detection: Excerpts from Music Literature
Melody 14C Mode Identification: Dorian, Phrygian, Lydian, and Mixolydian Modes
Melody 14D Interval Dictation: Three Intervals in Succession
Melody 14E Models and Embellishments: I-V-I Progression with Chromatic Melodic Embellishments

Harmony 14A Chord Function Identification: Secondary Dominants of IV(iv) and vi(VI)
Harmony 14B Chords in Music Literature: Secondary Dominants and Leading Tone Chords of iii and IV
Harmony 14C Aural Analysis: Four-Phrase Excerpt from a Beethoven Piano Sonata
Harmony 14D Harmonic Dictation: Chorale Phrases Containing Secondary Dominants
Harmony 14E Error Detection: Triads and 7th Chords

Rhythm 14A Rhythmic Dictation: Subtriplet in Simple and Compound Meter
Rhythm 14B Error Detection: Subtriplet in Simple and Compound Meter

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Unit 15

Melody 15A Melodic Dictation: Nondiatonic Tones
Melody 15B Error Detection: Five Note Melodic Figures
Melody 15C Mode Identification: Dorian, Phrygian, Lydian, Mixolydian and Aeolian Modes
Melody 15D Interval Dictation: Adding Proper Accidentals to Modal Melodies
Melody 15E Models and Embellishments: Harmonic Structure with Melodic and

Harmonic Embellishments
Harmony 15A Chord Function Identification: All Secondary Dominants
Harmony 15B Chords in Music Literature: All Secondary Dominants and Leading Tone Chords
Harmony 15C Aural Analysis: Phrase, Key, Cadence, and Harmonic Relationships in a Five-Phrase Excerpt from a Beethoven Piano Sonata
Harmony 15D Harmonic Dictation: Modulation in Chorale Phrases
Harmony 15E Error Detection: Triads and 7th Chords
Harmony 15F Identifying Modulations to Closely Related and Foreign Keys

Rhythm 15A Rhythmic Dictation: More Difficult Rhythms
Rhythm 15B Error Detection: More Difficult Rhythmic Errors

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Unit 16

Melody 16A Melodic Dictation: Nondiatonic Tones
Melody 16B Error Detection: Short Melodic Segments Based on Intervals
Melody 16C Melodic Dictation: Typical Blues Figures
Melody 16D Interval Dictation: Two-Voice Modal Compositions
Melody 16E Models and Embellishments: Harmonic Structure with Melodic and Harmonic Embellishments

Harmony 16A Chord Function Identification: German and French Augmented 6th Chords and the Neapolitan 6th Chords
Harmony 16B Chords in Music Literature: Neapolitan 6th Chords and Augmented 6th Chords
Harmony 16C Aural Analysis: Binary, Rounded Binary, and Three-Part Forms
Harmony 16D Harmonic Dictation: Chorale Phrases Containing Neapolitan 6th and Augmented 6th Chords
Harmony 16E Error Detection: Triads and 7th Chords

Rhythm 16A Rhythmic Dictation: Changing Meters
Rhythm 16B Error Detection: Review

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Vita

Michael H. Robinson was born in Decatur, AL. He came to the University of Tennessee, Knoxville as a Jazz Studies Major in 2000. In 2004, he graduated with an undergraduate degree in Theory/Composition at the University of Tennessee, Knoxville. He then pursued a business career in technical sales for the next four years. In the fall of 2008, he was afforded the opportunity to return yet again to UTK and pursue his Master of Music degree.