Stability and Change in Rhythmic Patterning Across a Composer's Lifetime: A Study of Four Famous Composers Using the nPVI Equation Joseph R. Daniele & Aniruddh D. Patel

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# STABILITY AND CHANGE IN RHYTHMIC PATTERNING ACROSS A COMPOSER'S LIFETIME: A STUDY OF FOUR FAMOUS COMPOSERS USING THE NPVI EQUATION

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HISTORICAL TRENDS IN THE RHYTHM OF WESTERN European instrumental classical music between  $\sim 1650$ and 1950 have recently been studied using the nPVI equation. This equation measures the average degree of durational contrast between adjacent events in a sequence (such as notes in a musical theme). These historical studies (e.g., Daniele & Patel, 2013, Hansen et al., in press) have relied on assigning each composer's music a mean nPVI value in order to search for broad historical trends across composers. Here we address how mean nPVI might vary across different compositional periods within a composer's lifetime, focusing on four famous composers whose lives have been demarcated into different epochs by historical musicologists, and who were part of Daniele and Patel's original study: J. S. Bach, Mozart, Beethoven, and Brahms. For these composers, we find that the mean nPVI does not vary dramatically across compositional periods. Nevertheless, there are interesting trends within the lifetime of each composer which reflect the larger 'rising nPVI' trend seen across all Austro-German composers studied by Daniele and Patel (2013). These findings demonstrate the utility of studying historical patterns in musical rhythm at two distinct timescales: within the lifetimes of individual composers, and across composers from divergent musical eras.

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Key words: Rhythm, nPVI, historical musicology, musical rhythm, quantitative musicology, historical trends

**B** MPIRICAL METHODS HAVE RECENTLY BEEN used to explore historical trends in musical rhythm. One example comes from Daniele and Patel (2013), who reported a salient trend in the rhythm of German and Austrian instrumental classical music between ~1600 and 1950. Analyzing 3,195 themes from 21 composers, we found that the average degree of durational contrast between notes in musical themes (as measured by the normalized pairwise variability index, or nPVI) increased steadily over historical time, a trend not seen in Italian classical music during this same time period. This finding proved relevant to ideas in historical musicology regarding the changing influence of Italian music on Austro-German classical music (see Daniele & Patel, 2013, for details). Our findings were based on assigning each composer a single nPVI value, representing the mean nPVI of his themes from A Dictionary of Musical Themes (Barlow & Morgenstern, 1983). This approach was also used by Hansen et al. (in press) to study historical trends in the rhythm of French instrumental classical rhythm in the  $\sim$  1700-1950 timeframe. These researchers found an interesting nonlinear pattern of change in nPVI over time (a steady increase until the early 1800's, followed by a salient decrease), and related this pattern to research in historical musicology on the varying cultural influences on French music.

These studies show that assigning a composer a single mean nPVI value can be useful for the purpose of discovering broad historical trends. Yet it is important to keep in mind that composers are creative artists whose musical style evolves during their lifetimes. Hence it is of interest to know how much a composer's nPVI varies across different creative periods. That is, how representative is an average nPVI value as a measure of a composer's entire body of work? This question is made salient by a finding reported by VanHandel (2006), who used the nPVI to study the rhythm of French and German art songs from the 1800's. Among the 13 French composers examined (e.g., Bizet, Debussy, Gounod, Massenet, etc.), almost all showed a notable decrease of durational contrast between notes in their songs within their individual lifetimes. Interestingly, these microtrends reflected a larger macro-trend (across composers) in which French art song nPVI gradually declined during the 1800's. These findings raise the possibility that interesting intra-lifetime nPVI variation

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also exists in composers of instrumental classical music, and suggest that studying this variation could enrich historical analyses that focus on general trends by assigning a single nPVI value to a composer's work.

To address this issue, here we examine composers of instrumental music whose compositional lives have been well documented and demarcated into epochs by historical musicologists. By definition, such periods are meant to distinguish distinct periods in a composer's creative life. Hence comparing nPVI across these periods is one way of assessing the degree of stability in a composer's nPVI over his or her lifetime. In the current paper we use this approach to examine four famous European composers studied by Daniele and Patel (2013): J. S. Bach, W. A. Mozart, L. van Beethoven, and J. Brahms. These composers had a sufficient number of themes in The Dictionary of Musical Themes to allow an analysis of nPVI in different compositional periods. They are also of interest because their lives span the different eras of classical music (Baroque, Classical, Romantic), during which nPVI was steadily rising in Austro-German music (Daniele & Patel, 2013). Is this rising nPVI trend reflected within the lifetimes of individual composers? If so, the pattern would enrich the finding of the overall trend reported by Daniele and Patel (2013), and provide a mirror-image complement of VanHandel's (2006) findings for French art song composers.

Before turning to the methodological details of our study, it is worth briefly discussing the rationale for focusing on the nPVI as an empirical measure of rhythm in historical research, as well as the reason for focusing on musical themes as source material for historical analysis. The original impetus for using the nPVI to measure musical rhythm was to empirically test a long-standing claim in musicology that the prosody of culture's language is reflected in its instrumental classical music (e.g., Abraham, 1974). The nPVI equation was first developed by speech scientists to quantify rhythmic differences between languages in different "rhythm classes" (e.g., between English, a prototypical "stress-timed" language, and French, a prototypical "syllable-timed" language). Patel and Daniele (2003) and Patel, Iversen, and Rosenberg (2006) used the equation to compare English and French instrumental classical music from the late 1800's and early 1900's, and found that differences in linguistic rhythm were in fact reflected in musical rhythm. Thus, the nPVI was potentially capturing something perceptually relevant about rhythm, an idea supported by subsequent research showing that listeners could categorize instrumental melodies on the basis of their average degree of durational contrast

between notes, which is what the nPVI measures (Hannon, 2009). Thus, the potential perceptual relevance of the nPVI to a music's "national character" makes it an interesting measure to use in historical research on musical rhythm. That said, it should be noted that there are many other measures of rhythmic patterning that could be used in historical work (e.g., variability or entropy of note durations, etc.), and it may be that different measures will reveal different trends of interest for historical musicology (cf. Eerola, Himberg, Toiviainen, & Louhivuori, 2006; Shmulevich & Povel, 2000; Toussaint, 2013).

Turning to the issue of musical themes as the unit of analysis for historical work, a salient question is, "why focus on themes?" It is possible, for example, that themes are not good proxies for entire pieces from which they are drawn in terms of their average degree of durational contrast. This is an important question that can only be resolved by empirical work. Our choice of themes as a unit of analysis is based on our prior work comparing rhythm in language and music (Patel & Daniele, 2003). That work focused on musical material available in A Dictionary of Musical Themes. This dictionary of about 10,000 themes was assembled in the mid-1900's by two musicologists who sought to capture the most memorable and identifiable musical moments in famous pieces of Western European instrumental classical music (focusing on pieces that had been recorded). The result was something like a Bartlett's Familiar Quotations of music (Erskine, 1948/1983; see London, 2013, for an interesting discussion of the biases and constraints reflected in this dictionary). By using the themes from this dictionary for historical analysis, one is implicitly focusing on memorable/distinguishing passages within larger musical pieces. It remains an open and empirical question whether findings based on these themes will replicate if more material from each piece is included in the nPVI analysis, or if a different set of pieces (and/or composers) are studied (cf. London, 2013, for a the development of modern representative corpus of classical music).

## Method

Musical materials were drawn from *A Dictionary of Musical Themes, Revised Edition* (Barlow & Morgenstern, 1983). As in Daniele and Patel (2013), themes with grace notes or appoggiaturas were excluded due to durational uncertainties associated with such notes. For the purpose of computing nPVI values, any sequence of notes joined by a tie was assigned a single duration equal to the summed durations of the constituent notes, and if any rests occurred in a theme, the duration of each rest was added to the duration of the preceding sounded note. As a result, the sequence of durations for each theme represented the duration of its interonset intervals or IOIs. (IOIs have often been used in empirical studies of musical rhythm.) One nPVI value was computed for each theme (for an example of nPVI computation, see the Appendix in Daniele & Patel, 2013).

The year of composition for each theme was determined by cross referencing the piece name with the date it was composed, using the "Works" section of chapters regarding J. S. Bach, W. A. Mozart, L.van Beethoven, and J. Brahms, respectively, in *The New Grove Dictionary* of *Music* (J. S. Bach – Sadie, 1980a, pp. 818-836, Beethoven – Sadie, 1980b, pp. 394-410, Brahms – Sadie, 1980c, pp. 174-185, Mozart – Sadie, 1980d, pp. 725-747). If a piece was written over several years, the "average" year it was written was used (e.g., 1750-1753 was 1751.5). It was not possible to ascribe a compositional year to four themes by J. S. Bach (b99, b100, b297, and b300 in the dictionary) so these were not included in the data analysis involving compositional period. A list of themes analyzed for each composer can be found in Appendix B.

Each composer's life was divided into three or four epochs based on the writings of musicologists. For J. S. Bach, the periods were "apprenticeship" (1708-1713), "mastery" (1714-1740), and "transcendence" (1741-1750), as defined by Boyd (1997). For W. A. Mozart, the periods were the "traveling years" (1761-1773), "imitation/Vienna" (1774-1780); and "last years" (1781-1791), as defined by Sadie (1980d, pp. 680-752). For L. van Beethoven, the periods were "imitation" (1792-1800), "transition" (1801-1814), and "reflection" (1815-1827), as defined by Solomon (1998) and d'Indy (1970). For Brahms, the periods were "Young Kreisler/ Storm and Stress" (1833-1860), "Sense of the Past" (1861-1875), "Frei aber froh" (1876-1882), and "Final phase" (1883-1896), as defined by MacDonald (2001). For each compositional period, mean nPVI was computed from the nPVI of individual themes written during that period.

It should be noted that there is scholarly debate regarding the dates of compositional periods for these composers. For example, Bukofzer (1947) differs from Boyd (1997) in his delineation of Bach's compositional epochs, arguing for a "Weimar/Journeyman period" (1703-1717), a "Kothen period" (1717-1723), and a "Leipzig period" (1723-1750). One motivation for this division is that Bach's various appointments required the writing of different types of music. However, these dates give less emphasis on the middle period, which Boyd called the "mastery" period. Thus, when conducting studies of the type reported in this paper, it is worth



FIGURE 1. nPVI during different compositional periods of four composers. The midpoint year of each compositional period is plotted against the mean nPVI of musical themes during that period. Error bars reflect standard error of the mean (*SEM*).

keeping in mind that the results may depend on how compositional eras are chosen. (In the case of Bach, the two different schemes for dividing up his life give similar results, as noted below.)

### Results

Figure 1 shows the results of our analyses, plotting the mean nPVI of each composer during each compositional period. Mean and standard deviations of nPVI values for each period of each composer, along with the number of themes analyzed in each period, are also reported in Appendix A.

Separate one-way ANOVAs were performed for each composer to determine if mean nPVI showed significant differences across compositional periods. The results were as follows: J. S. Bach: F(2, 361) = 0.15, p = .86, Mozart: F(2, 457) = 2.12, p = .12, Beethoven: F(2, 486) = 0.53, p = .59, and Brahms: F(3, 358) = 0.13, p = .94. The mean nPVI values for Bach's compositional periods differed when Bukofzer's (1947) dates were used, but they still showed no statistically significant differences between epochs (Weimar/Journeyman = 20.8 (n = 15), Kothen = 26.7 (n = 190), Leipzig = 27.9 (n = 159); one-way ANOVA F(2, 361) = 0.84, p = .43. Thus, for no composer was mean nPVI significantly different across distinct compositional periods in his lifetime.

To put the amount of variation of mean nPVI within each composer's lifetime into broader historical perspective, Figure 2 shows the data from Figure 1 superimposed on the German and Austrian composer nPVI values from Daniele and Patel (2013). The data points in that study for J. S. Bach, Mozart, Beethoven, and Brahms are marked for reference. (The reader may be



FIGURE 2. Mean nPVI of individual compositional periods for J. S. Bach (yellow dots), Mozart (blue dots), Beethoven (red dots), and Brahms (green dots) in the context of the original data reported by Daniele and Patel (2013). Black and white dots indicate German and Austrian composers, respectively. Each black and white dot represents the mean nPVI value for one composer (minimum number of themes per composer = 15), plotted as a function of his midpoint year (the time point midway between birth year and death year). Colored dots are plotted as a function of midpoint year of each compositional period for that composer. The black line is the original regression line reported in Daniele and Patel (2013).

puzzled why the original data points for Bach and Beethoven lie close in time to the mean nPVI points for their first compositional period. This results from the fact that these composers did not start publishing music until their early twenties, about halfway into their lives, and to the fact that their middle compositional phase was much longer than either their early or late phases, which shifts the middle phase further toward their later years.)

While the ANOVAs did not render significant differences of nPVI values between compositional periods for our four composers, Figure 2 nevertheless suggests an interesting trend for nPVI to rise *within* the lifetime of each composer, a point taken up in the general discussion.

# Discussion

The current study extends the historical analysis of musical rhythm presented in Daniele and Patel (2013), which focused on broad historical trends in Austro-German and Italian instrumental classical music between  $\sim$  1650 and 1900. In that study, each composer was assigned a single nPVI value representing the average degree of durational contrast between successive notes in his musical themes (from *A Dictionary of Musical Themes, Revised Edition*). In the current study we asked how nPVI might vary within the lifetimes of

individual composers, focusing on four famous composers from Daniele and Patel (2013) who are represented by enough themes in the dictionary to make such analysis possible: J. S. Bach, Mozart, Beethoven, and Brahms. Using compositional periods taken from research in historical musicology, themes were assigned to distinct periods based on date of composition, and a mean nPVI for each period was computed.

Our primary result is that for each composer, mean nPVI values in different compositional periods were not dramatically different. We know from our prior research that the mean nPVI of a set of themes from a German or Austrian composer can be as low as 27.5 and as high as 63.9 (cf. Daniele & Patel, 2013, Table 1). This indicates that dramatic variation in mean nPVI is logically possible across different compositional periods, yet this is not what we observe. Instead, mean nPVI is fairly stable within a composer's lifetime. Our finding is reminiscent of other research in historical musicology that finds that some aspects of a composer's work remain relatively stable across their oeuvre. For example, Perttu (2007) has shown that levels of chromaticism are fairly stable across the lives of Mozart and Beethoven.

While differences in mean nPVI between compositional eras was not statistically significant for any composer, we hasten to add that each composer showed an interesting numerical trend, which may be musicologically significant. Specifically, the overall rising nPVI seen across Austro-German composers in Daniele and Patel (2013) seems reflected, to differing degrees, in the lives of each of our composers. To make this reflection visible, Figure 3 reproduces Figure 2 but adds the best fitting regression line for each composer. While the small number of data points for each composer makes any statistical inferences about the regression lines impossible, it is nevertheless intriguing that the best fitting lines for all composers have positive slopes, and these slopes are not dramatically different from the slope of the overall best-fitting line for Austro-German composers (numerical values of all slopes are given in caption of Figure 3.)

This pattern of results is strikingly reminiscent (if opposite in sign) to that reported by VanHandel (2006), who examined French art song in the 1800's and found declining nPVI values within each composer's lifetime as well as across composers (cf. the Introduction). In our own data, this "fractal" pattern of results (whereby larger-scale patterns are reflected at smaller scales) is further supported by comparing the overall Austro-German regression line from Daniele and Patel (2013) with a new regression line computed from the thirteen compositional periods analyzed in the



FIGURE 3. A version of Figure 2 with the best fitting regression lines added for Bach (yellow) Mozart (blue), Beethoven (red), and Brahms (green). The black dotted line is the original regression line reported in Daniele and Patel (2013). The equations for the regression lines are: Bach nPVI = 0.086\*(Epoch Midpoint Yr) - 121.09; Mozart nPVI = 0.111\*(Epoch Midpoint Yr) - 155.35; Beethoven nPVI = 0.147\*(Epoch Midpoint Yr) - 222.48; Brahms nPVI = 0.051\*(Epoch Midpoint Yr) - 51.46. The equation from the Daniel and Patel (2013) regression line data is: nPVI = 0.098\*(Composer Midpoint Yr) - 133.63.<sup>1</sup>

current study (Figure 4). The slopes of the two lines are virtually identical (see Figure 4 caption for exact values), and are not significantly different when compared using a *t*-test to compare slopes, t(30) = 0.0000036, p = .99. In both cases, the results suggest that during the transition from Baroque to Romantic classical music, the mean nPVI of German/Austrian composers increased at rate of about 10 points per century.

The rising nPVI trend within the lifetimes of each of our individual composers may seem to contradict the ANOVA findings of no statistically significant differences between mean nPVI values in different compositional periods for any of the composers. Yet it is worth remembering that for an ANOVA to reject the null hypothesis of no significant difference between mean values, the amount of variance underlying each mean value must be fairly small compared to the differences between mean values. In our data, the amount of variance underlying each mean value is fairly large (cf. the error bars in Figure 1 and standard deviation values in Appendix A), and thus the ANOVA does not find statistically significant differences between compositional periods for any composer. This does not imply, however,



FIGURE 4. A version of Figure 2 with the best fitting regression line computed across all 13 compositional epochs in the current study (solid gray line). The black dotted line is the original regression line reported in Daniele and Patel (2013), which has a regression equation of nPVI = 0.0981\*(Composer Midpoint Yr) - 133.63,  $R^2 = .52$ , df = 19, p = .0003. The equation for the solid gray line (J. S. Bach/Mozart/Beethoven/Brahms) is nPVI = 0.0973\*(Epoch Midpoint Yr) - 136.16,  $R^2 = .62$ , df = 11, p = .0013.

that mean nPVI values in different periods are identical. On the contrary, as shown in Figure 3, all composers show a rising nPVI trend within their lifetimes, reminiscent of the general Austro-German trend. In future research it would be worth studying these microtrends further, using larger musical samples for each composer. It would also be worth studying other Austro-German composers to see if this trend is unique to these four composers, or is seen more broadly.

Our current study and our earlier historical work (Daniele & Patel, 2013, cf. Hansen et al., in press) engage with the issue of how to assign dates to composers' lives and work. When using a single date for each composer we have used the "midpoint year," i.e., the year halfway between birth year and death year. We feel this is preferable to using birth year or death year as the midpoint year better captures the time when a composer was artistically active. An alternative approach — employed by Albrecht and Huron (2013) in a study of the emergence of the major-minor mode system — used the year when each composer turned 25 (based on the idea that a composer's cognitive development reaches full maturity at that point).<sup>2</sup> Other schemes are also conceivable. For example, one could determine the dates when each

<sup>&</sup>lt;sup>1</sup> The Austro-German linear regression equation reported in Daniele and Patel (2013) and in the current study are very slightly different due to a coding correction by David Huron in his computation of nPVI values. The basic findings and overall conclusions of the earlier paper remain the same.

<sup>&</sup>lt;sup>2</sup> When we use Albrecht and Huron's (2013) criterion for the 21 Austro-German composers studied in Daniele and Patel (2013), the resulting regression line relating mean nPVI to 25th year of life is still highly significant: Mean nPVI =  $0.0922 \times (\text{year of 25th birthday}) - 122.14$ ,  $R^2 = .46$ , p = .0007.

composer's major works were completed, then take the mean of these dates to find a single date representative of that composer's work. The larger point is that when conducting historical research, it is always worth asking how the results would differ if a different dating scheme had been used.

While the current study did not find statistically significant differences in mean nPVI values across compositional periods for any of the four composers examined, in addition to the general rising nPVI trend for each composer, there are other suggestive patterns in the data of Mozart and Beethoven that merit discussion. One of these is the jump in Mozart's mean nPVI values during his middle, "imitation/Vienna" period of 1774-1780. This coincides with the stylistic transition in Germany to write less Italianate and more "German" music, which started in 1760, gained wide acceptance by 1775, and ended in 1798 (Morrow, 1997, p. 20). What is unexpected, though, is the subsequent decrease in Mozart's mean nPVI value in his final phase. Perhaps the strong increase in nPVI during his middle phase had something to do with his term working for the ruler of Salzburg (Prince-Archbishop Hieronymus Colloredo), when Mozart was allowed to compose freely (Sadie, 1980d, pp. 680-752). Interestingly, Mozart wrote very few operas during this time. His major operas were written in the last phase of his career (e.g., Cosí Fan Tutte, 1790, Don Giovanni, 1787, Die Zauberflöte, 1791, La nozze di Figaro, 1786, Der Schauspieldirektor, 1786; Sadie, 1980d, pp. 725-747). While Die Zauberflöte and Der Schauspieldirektor were written to German librettos, the other operas mentioned were set to an Italian text. Thus, one can speculate that Italian influence on melody might have given his music a more "Italianate" style in his later years.

The data from Beethoven's three compositional periods is also interesting in terms of historical musicology. While the mean nPVI values in his first two phases are very similar, the mean nPVI in his final "reflection" phase (1815-1827) is the highest of any of the 13 compositional periods examined in the current work. This is interesting in light of the fact that Beethoven came to be known as the new voice of the "German aesthetic" (Morrow, 1997, pp. 111 pp. 156), and also in light of the fact that Beethoven's final period included the onset of his deafness. Thus, the mind that was defining "the sound of German music" inhabited a body that was increasingly disconnected to the actual sounds around it.

In conclusion, the current study further demonstrates the utility of the nPVI for quantitative research in historical musicology. In particular, examining the finer structure of nPVI values over different musicologically demarcated periods within a composer's lifetime can complement studies that examine larger historical trends in musical rhythm. Additional research with the nPVI will likely uncover further historical patterns in music that might have otherwise have remained hidden.

# Author Note

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# References

- ABRAHAM, G. (1974). *The tradition of Western music*. Berkeley, CA: University of California Press.
- ALBRECHT, J., & HURON, D. (2013). On the emergence of the major-minor system: Cluster analysis suggests the late 16th century collapse of the Dorian and Aeolian modes. In E. Cambouropoulos, C. Tsougras, P. Mavromatic, & K. Pastiadis (Eds.), Proceedings of the 12th International Conference of Music Perception and Cognition (pp. 44-53). Thessaloniki, Greece: ICMPC.

BARLOW, H., & MORGENSTERN, S. (1983). A dictionary of musical themes (Revised edition). London: Faber and Faber.
BOYD, M. (1997). Bach. New York: Schirmer Books.

- BUKOFZER, M. F. (1947) Music in the baroque era: From Monteverdi to Bach. New York: W.W. Norton.
- DANIELE J. R., & PATEL, A. D. (2013). An empirical study of historical patterns in musical rhythm: Analysis of German and Italian classical music using the nPVI equation. *Music Perception*, *31*, 10-18.

D'INDY, V. (1970). *Beethoven: A critical biography* (T. Baker, Trans.). Freeport, NY: Books for Libraries Press.

- EEROLA, T., HIMBERG, T., TOIVIAINEN, P., & LOUHIVUORI, J. (2006). Perceived complexity of Western and African folk melodies by Western and African listeners. *Psychology of Music*, 34, 337-371.
- ERSKINE, J. (1983). Introduction. In S. Barlow & H. Morgenstern (Eds.), *A dictionary of musical themes* (pp. vii-x). London: Faber and Faber. (Original work published 1948)
- HANNON, E. E. (2009). Perceiving speech rhythm in music: Listeners classify instrumental songs according to language of origin. *Cognition*, 111, 403-409.
- HANSEN N.C., SADAKATA, M., & PEARCE, M. (in press). Nonlinear changes in the rhythm of European art music: Quantitative support for historical musicology. *Music Perception*.
- LONDON, J. (2013). Building a representative corpus of classical music. *Music Perception*, *31*, 68-90.
- MACDONALD, M. (2001) *Brahms*. Oxford, UK: Oxford University Press.
- MORROW, M. S. (1997). German music criticism in the late eighteenth century: Aesthetic issues in instrumental music. Cambridge, UK: Cambridge University Press.
- PATEL, A. D., & DANIEL, J. R. (2003). An empirical comparison of rhythm in language and music. *Cognition*, *87*, B35-B45.
- PATEL, A. D., IVERSEN, J. R., & ROSENBERG, J.C. (2006). Comparing the rhythm and melody of speech and music: The case of British English and French. *Journal of the Acoustical Society of America*, 119, 3034-3047.

- PERTTU, D. (2007). A quantitative study of chromaticism: Changes observed in historical eras and individual composers. *Empirical Musicology Review*, 2, 47-54.
- SADIE, S. (Ed.) (1980a). The new Grove dictionary of music and musicians (Volume 1). Washington, DC: Grove's Dictionaries of Music.
- SADIE, S. (Ed.) (1980b). The new Grove dictionary of music and musicians (Volume 3). Washington, DC: Grove's Dictionaries of Music.
- SADIE, S. (Ed.) (1980c). The new Grove dictionary of music and musicians (Volume 2). Washington, DC: Grove's Dictionaries of Music.
- SADIE, S. (Ed.) (1980d). The new Grove dictionary of music and musicians (Volume 12). Washington, DC: Grove's Dictionaries of Music.
- SHMULEVICH, I., & POVEL, D. J. (2000). Complexity measures of musical rhythms. In P. Desain & L.Windsor (Eds.), *Rhythm perception and production* (pp. 239-244). Lisse, NL: Swets and Zeitlinger.

SOLOMON, M. (1998). Beethoven. New York: Schirmer Books.

- TOUSSAINT, G. (2013). *The geometry of musical rhythm*. Boca Raton, FL: Taylor and Francis.
- VANHANDEL, L. (2006) Trends in/over time: Rhythm in speech and music in 19th century art song. In M. Baroni, A. R. Addessi, R. Caterina, & M. Costa (Eds.), Proceedings of the 9th International Conference on Music and Perception and Cognition. Bologna, Italy (pp. 1153-1158). Bologna, Italy: Bononia University Press.

# Appendix A

# DESCRIPTIVE NPVI STATISTICS FOR EACH STUDIED COMPOSER'S STYLISTIC PERIODS

TABLE A1.					
Stylistic Period of JS Bach's Life	First (apprenticeship) (1708 – 1713)	Second (mastery) (1714 – 1740)	Third (transcendence) (1741 – 1750)		
Mean nPVI	25.9	26.8	28.9		
Standard deviation of PVI	23.3	20.5	22.1		
Standard Error of Mean	7.0	1.1	4.0		
# of Themes	11 (using all available)	323	30		

#### TABLE A2.

Stylistic Period of Mozart's Life	First (traveling years) (1761 – 1773)	Second (imitation/ Vienna) (1774 – 1780)	Third (last years) (1781 – 1791)
Mean nPVI	38.9	44.9	40.8
Standard deviation of PVI	21.6	27.1	23.5
Standard Error of Mean	3.4	2.5	1.4
# of Themes	41	116	303

# TABLE A3.

Stylistic Period of Beethoven's Life	First (imitation) (1792 – 1800)	Second (transition) (1801 – 1814)	Third (reflection) (1815 – 1827)
Degree of Deafness	Hearing	Progressively Impaired	Very hard of hearing, confirmed deaf (1820)
Mean nPVI	42.2	42.4	45.8
Standard deviation of PVI	27.2	27.6	26.4
Standard Error of Mean	2.1	1.8	3.0
# of Themes	168	243	78

#### TABLE A4.

Stylistic Period of Brahms' Life	First (young Kreisler) (1833 – 1860)	Second (sense of the past) (1860 – 1875)	Third ('frei aber froh') (1876 – 1882)	Fourth (final phase) (1883 – 1896)
Mean nPVI	42.2	43.1	43.1	44.6
Standard deviation of PVI	25.0	27.5	26.3	26.4
Standard Error of Mean	3.6	2.5	3.1	2.4
# of Themes	49	121	70	122

# Appendix B

#### COMPOSERS AND MUSICAL THEMES

Code numbers are those used in Barlow and Morgenstern (1983)

**J. S. Bach** - b102, b103, b104, b105, b106, b107, b108, b109, b110, b111, b112, b113, b114, b115, b116, b117, b118, b119, b120, b121, b122, b123, b124, b125, b126, b127, b128, b129, b130, b131, b132, b133, b134, b135, b136, b137, b138, b139, b140, b141, b142, b143, b145, b146, b147, b148, b150, b151, b152, b153, b154, b155, b156, b157, b158, b159, b160, b161, b162, b163, b164, b165, b166, b167, b168, b169, b170, b171, b173, b176, b178, b178a, b179, b180, b180a, b181, b182, b183, b184, b185, b186, b187, b188, b189, b190, b191, b192, b193, b194, b195, b196, b197, b199, b200, b201, b202, b203, b204, b206, b207, b208, b209, b210, b212, b213, b215, b218, b219, b220, b221, b222, b223, b224, b225, b226, b227, b228, b230, b231, b232, b233, b235, b236, b237, b238, b239, b240, b241, b242, b243, b244, b245, b246, b247, b248, b249, b25, b250, b251, b252, b253, b254, b255, b256, b257, b258, b259, b26, b260, b261, b262, b263, b265, b266, b267, b268, b269, b27, b270, b271, b272, b273, b274, b275, b276, b277, b278, b279, b28, b280, b281, b282, b283, b284, b285, b286, b287, b288, b289, b29, b290, b291, b292, b293, b294, b295, b296, b299, b29a, b29b, b30, b302, b303, b304, b305, b306, b307, b308, b309, b31, b310, b311, b312, b313, b314, b315, b316, b317, b318, b319, b32, b320, b321, b322, b324, b325, b326, b327, b328, b329, b33, b330, b331, b332, b333, b334, b335, b336, b337, b338, b339, b34, b340, b342, b343, b344, b346, b348, b349, b35, b350, b351, b352, b353, b354, b355, b356, b357, b358, b359, b36, b360, b361, b363, b364, b365, b366, b367, b368, b369, b37, b370, b371, b372, b373, b374, b375, b376, b377, b378, b379, b38, b380, b381, b382, b383, b384, b385, b386, b387, b388, b389, b39, b390, b391, b392, b393, b394, b395, b396, b397, b40, b41, b42, b43, b44, b45, b46, b47, b48, b49, b50, b51, b53, b54, b55, b56, b57, b58, b59, b60, b61, b62, b63, b65, b66, b67, b68, b69, b70, b71, b72, b73, b74, b75, b76, b77, b79, b80, b81, b82, b82, b83, b83, b84, b84, b85, b85, b86, b86, b87, b87, b88, b88, b89, b89, b90, b90, b91, b91, b92, b92, b93, b93, b94, b94, b95, b95, b96, b96, b97, b97, b98, b98

W. A. Mozart - m1000, m1001, m1002, m1003, m1005, m1006, m1007, m1008, m1009, m1010, m1011, m427, m428, m429, m430, m433, m434, m435, m436, m439, m440, m441, m443, m445, m446, m447, m448, m451, m452, m453, m454, m455, m456, m457, m458, m459, m460, m461, m462, m463, m464, m465, m466, m467, m468, m470, m471, m472, m473, m474, m475, m476, m477, m478, m479, m480, m481, m482, m484, m485, m486, m487, m488, m489, m490, m491, m492, m493, m494, m495, m496, m497, m499, m500, m501, m502, m503, m504, m505, m506, m508, m510, m512, m513, m515, m516, m517, m519, m522a, m524, m525, m528, m529, m530, m531, m532, m533, m534, m535, m536,

m537, m538, m539, m540, m541, m542, m543, m545, m546, m547, m548, m549, m550, m551, m553, m554, m555, m556, m557, m558, m559, m561, m562, m563, m566, m570, m571, m575, m577, m579, m580, m581, m582, m583, m584, m586, m588, m589, m590, m591, m592, m594a, m595, m597, m598, m600, m601, m602, m603, m604, m605, m606, m607, m608, m609, m610, m611, m614, m616, m617, m618, m620, m622, m623, m624, m625, m626, m627, m628, m630, m634, m636, m637, m638, m640, m641, m642, m643, m644, m645, m646, m647, m649, m651, m652, m653, m655, m656, m657, m658, m659, m660, m661, m662, m663, m664, m665, m667, m668, m669, m671, m672, m673, m674, m676, m677, m678, m679, m681, m682, m683, m684, m686, m687, m688, m689, m690, m691, m692, m693, m695, m696, m697, m698, m699, m701, m703, m704, m705, m706, m707, m708, m709, m712, m713, m716, m717, m718, m719, m720, m721, m722, m723, m724, m725, m726, m727, m732, m733, m737, m738, m739, m740, m741, m742, m743, m744, m745, m746, m748, m749, m750, m751, m752, m753, m754, m755, m757, m758, m759, m760, m761, m762, m763, m764, m765, m766, m767, m768, m770, m772, m773, m777, m782, m783, m784, m785, m787, m788, m789, m790, m792, m793, m795, m796, m797, m798, m799, m800, m801, m802, m803, m804, m805, m806, m808, m809, m810, m811, m813, m815, m816, m818, m819, m820, m821, m822, m823, m825, m827, m828, m829, m830, m832, m834, m840, m842, m844, m846, m847, m848, m849, m850, m851, m852, m853, m854, m855, m856, m857, m858, m859, m860, m861, m862, m863, m864, m865, m866, m867, m868, m869, m870, m871, m872, m873, m874, m875, m876, m878, m879, m881, m882, m883, m884, m885, m886, m887, m888, m889, m890, m891, m892, m893, m894, m896, m897, m898, m899, m901, m903, m904, m907, m908, m909, m910, m912, m913, m914, m915, m916, m917, m918, m919, m921, m922, m923, m924, m925, m926, m927, m928, m929, m930, m931, m934, m935, m936, m938, m939, m940, m941, m942, m943, m945, m948, m949, m951, m952, m953, m954, m955, m956, m957, m958, m959, m960, m961, m962, m963, m964, m965, m966, m967, m968, m969, m970, m971, m972, m973, m974, m975, m977, m979, m981, m982, m984, m985, m986, m987, m988, m989, m990, m991, m992, m993, m994, m995, m996, m999

L. van Beethoven - b1000, b1001, b1002, b1003, b1004, b1005, b1006, b1007, b1008, b1009, b1010, b1011, b1012, b1013, b1014, b1015, b1016, b1017, b1018, b1019, b1020, b1021, b1022, b1023, b1024, b1025, b1026, b1027, b1028, b1029, b1030, b1031, b1032, b1033, b1034, b1035, b1036, b1037, b1038, b1040,

b1041, b1042, b1043, b1044, b1045, b1046, b1047, b1048, b1049, b1050, b1051, b1053, b1054, b1055, b1056, b1057, b522, b523, b524, b525, b527, b528, b529, b530, b531, b533, b534, b535, b536, b537, b538, b540, b541, b543, b544, b545, b546, b547, b548, b549, b550, b551, b552, b553, b554, b555, b556, b557, b558, b559, b560, b561, b562, b563, b564, b565, b569, b570, b571, b572, b573, b574, b576, b578, b580, b582, b583, b584, b585, b586, b587, b588, b589, b590, b591, b594, b595, b596, b598, b599, b600, b601, b602, b602a, b603, b606, b607, b608, b609, b610, b611, b612, b613, b614, b615, b616, b617, b618, b619, b620, b621, b622, b623, b624, b625, b626, b627, b628, b629, b630, b631, b632, b633, b634, b635, b636, b637, b638, b639, b641, b642, b643, b644, b645, b646, b647, b648, b649, b650, b650a, b651, b652, b653, b654, b655, b656, b657, b658, b659, b660, b660a, b660b, b661, b662, b663, b663b, b664, b665, b666, b667, b667a, b667d, b668, b670, b671, b672, b673, b674, b675, b677, b678, b679, b679a, b679c, b679d, b679e, b679f, b679g, b679h, b680, b681, b683, b684, b685, b686, b686a, b686b, b687, b688, b688a, b689, b690, b692, b693, b694, b695, b696, b697, b698, b699, b700, b701, b702, b703, b705, b706, b707, b708, b709, b710, b711, b712, b713, b714, b715, b716, b717, b718, b719, b720, b721, b722, b723, b724, b725, b726, b727, b728, b729, b731, b732, b734, b735, b736, b737, b738, b739, b740, b741, b742, b743, b745, b746, b747, b750, b751, b752, b753, b754, b755, b756, b757, b758, b759, b760, b762, b763, b764, b765, b766, b767, b768, b769, b770, b771, b772, b773, b775, b776, b777, b780, b781, b782, b783, b784, b785, b786, b787, b788, b789, b790, b791, b792, b793, b794, b797, b798, b799, b801, b802, b803, b804, b805, b806, b808, b809, b810, b811, b812, b813, b814, b815, b816, b817, b819, b820, b821, b822, b823, b824, b825, b826, b827, b828, b829, b830, b831, b832, b833, b834, b835, b836, b837, b838, b840, b841, b842, b843, b844, b845, b846, b848, b849, b850, b851, b852, b853, b854, b855, b856, b857, b860, b862, b863, b864, b865, b866, b867, b868, b870, b871, b872, b874, b876, b878, b879, b881, b882, b883, b884, b886, b887, b888, b889, b890, b891, b892, b893, b894, b895, b896, b897, b898, b899, b900, b901, b902, b903, b904, b905, b906, b907, b908, b909, b910, b911, b912, b913, b914, b915, b916, b917, b918, b919, b920, b921, b922, b923, b925, b926, b928, b929, b930, b931, b932, b934, b935, b936, b937, b938, b940, b941, b942, b943, b946, b947, b948, b949, b950, b951, b952, b953, b954, b955, b956, b957, b958, b959, b960, b961, b962, b963, b964, b965, b966, b967, b968, b969, b971, b973, b976, b978, b979, b980, b981, b982, b983, b984, b986, b987, b989, b990, b991, b992, b993, b995, b997, b998, b999

J. Brahms - b1330, b1331, b1332, b1333, b1335, b1336, b1337, b1338, b1339, b1340, b1341, b1343, b1344, b1345, b1346, b1347, b1348, b1349, b1350, b1351, b1352, b1353, b1354, b1355, b1356, b1357, b1358, b1359, b1360, b1361, b1362, b1363, b1364, b1365, b1366, b1367, b1368, b1369, b1370, b1371, b1374, b1375, b1376, b1377, b1379, b1380, b1381, b1382, b1383, b1384, b1386, b1387, b1388, b1389, b1390, b1391, b1392, b1393, b1394, b1395, b1396, b1397, b1398, b1399, b1400, b1401, b1402, b1403, b1404, b1405, b1406, b1407, b1408, b1409, b1410, b1412, b1413, b1414, b1416, b1418, b1419, b1420, b1421, b1423, b1424, b1425, b1426, b1427, b1428, b1429, b1430, b1431, b1432, b1433, b1434, b1435, b1436, b1437, b1438, b1439, b1440, b1441, b1442, b1443, b1444, b1445, b1446, b1447, b1448, b1450, b1451, b1452, b1453, b1454, b1455, b1456, b1457, b1458, b1459, b1460, b1461, b1462, b1463, b1464, b1465, b1466, b1467, b1468, b1469, b1470, b1471, b1472, b1473, b1474, b1475, b1476, b1477, b1478, b1479, b1480, b1481, b1482, b1483, b1484, b1486, b1487, b1488, b1489, b1490, b1491, b1492, b1493, b1494, b1495, b1496, b1497, b1499, b1500, b1501, b1502, b1503, b1505, b1506, b1507, b1508, b1509, b1510, b1512, b1513, b1514, b1515, b1516, b1517, b1518, b1519, b1520, b1521, b1522, b1523, b1524, b1525, b1526, b1527, b1528, b1529, b1530, b1531, b1532, b1533, b1534, b1535, b1536, b1537, b1538, b1539, b1540, b1541, b1542, b1543, b1544, b1545, b1546, b1547, b1548, b1549, b1550, b1551, b1552, b1553, b1554, b1555, b1556, b1557, b1558, b1559, b1560, b1561, b1562, b1563, b1564, b1565, b1566, b1567, b1568, b1569, b1570, b1571, b1572, b1573, b1574, b1575, b1576, b1577, b1578, b1579, b1580, b1581, b1582, b1583, b1584, b1585, b1586, b1587, b1588, b1589, b1590, b1591, b1592, b1593, b1594, b1595, b1596, b1597, b1598, b1599, b1600, b1601, b1602, b1603, b1604, b1605, b1606, b1607, b1608, b1609, b1610, b1612, b1613, b1614, b1615, b1616, b1617, b1618, b1619, b1620, b1621, b1622, b1623, b1624, b1625, b1626, b1627, b1628, b1629, b1630, b1631, b1632, b1633, b1634, b1635, b1636, b1637, b1638, b1639, b1640, b1641, b1642, b1643, b1644, b1645, b1646, b1647, b1648, b1649, b1650, b1651, b1652, b1653, b1654, b1655, b1656, b1657, b1658, b1659, b1660, b1661, b1662, b1663, b1664, b1665, b1666, b1668, b1669, b1670, b1671, b1672, b1673, b1674, b1675, b1676, b1677, b1678, b1679, b1680, b1681, b1682, b1683, b1684, b1685, b1686, b1687, b1688, b1689, b1690, b1691, b1692, b1693, b1694, b1695, b1696, b1697, b1698, b1699, b1700, b1701, b1702, b1703, b1704, b1705, b1706, b1708, b1711