Rhythmic Variability in European Vocal Music

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Rhythmic variability in the vocal music of four European nations was examined, using the nPVI measure (normalized pairwise variability index). It was predicted that English and German songs would show higher nPVI than French and Italian ones, mirroring the differences between these nations in speech rhythm, and in accord with previous studies of instrumental music. Surprisingly, there was no evidence of this pattern, and some evidence of the opposite pattern: nPVI is higher in French and Italian vocal music than in English and German vocal music. This casts doubt on the theory that the differences in instrumental rhythm between these nations are due to differences in speech rhythm.

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In an influential study, Patel and Daniele (2003) examined rhythmic variability in French and English instrumental themes from around 1900, measured using the normalized pairwise variability index, or nPVI. The nPVI formula assigns a value to a series of durations:

$$\text{nPVI} = \frac{100}{\text{m} - 1} \times \sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| \qquad (1)$$

where d_k is the kth duration and m is the number of durations. The value reflects the amount of contrast between adjacent durations; if short notes tend to alternate with long ones, the nPVI will be high. The minimum possible nPVI is zero (if all durations are the same); the theoretical maximum is 200, though this could never occur in practice (unless some durations had a value of zero). Some simple rhythmic patterns with their nPVI's are shown in Figure 1.

Patel and Daniele (2003) showed that English instrumental themes had higher rhythmic variability than French themes. They attributed this difference to the influence of language: English speech has been shown to have higher variability in syllable length than French (Grabe & Low, 2002). Several subsequent studies have further explored cross-cultural correlations between music and language using nPVI. Huron and Ollen (2003) repeated Patel and Daniele's procedure with a larger sample of instrumental melodies, and again found English melodies to have higher nPVI than French; they also found that German instrumental melodies had relatively low nPVI, which is notable since the speech nPVI of German is relatively high. Daniele and Patel (2013) suggest that this may be due to the influence of Italian music on German composers (Italian speech, like French, has fairly low nPVI); they show that the nPVI of German instrumental music increases in the 19th century, as Italian influence wanes. This line of reasoning is pursued by Hansen, Sadakata, and Pearce (2016), who examined nPVI in Italian, German, and French instrumental themes, finding evidence for a complex pattern of influence between the three nations. McGowan and Levitt (2011) examined nPVI in the speech and instrumental music of three English-speaking cultures—Irish, Scottish, and Appalachian—and found that regions whose dialects had higher nPVIs had a higher musical nPVI as well.

Patel and Daniele deliberately focused on instrumental music in their 2003 study because, in their words, "if music is based on words, and words have different rhythmic properties in the languages under study, then it would be no surprise if musical rhythm reflected linguistic rhythm." In short, it is simply taken for granted that differences in speech nPVI will be reflected in vocal music. This is an understandable assumption, especially now that differences in nPVI have been found in instrumental music. Nevertheless, several studies have examined nPVI in vocal music. VanHandel and Song (2010)

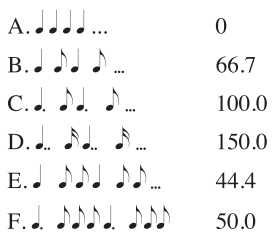

FIGURE 1. Some simple rhythmic patterns with their nPVI's. (Assume each pattern repeats indefinitely.)

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TABLE 1. *The Six Song Books Used In The Study*

Nation	Book	# songs	# measures	mean nPVI
English	Hatton, J., & Faning, E. (Eds.) 1900. *Songs of England, Vol. 1.* London: Boosey & Co.	102	4351	45.2
French	[No editor identified]. 1904. *Songs of France*. London: Boosey & Co.	60	4252	60.6
	Jameson, R. P., & Heacox, A. E. (Eds.) 1920. *Chants de France*. London: Heath & Co.	61	1493	49.1
	Both French books (excluding duplicates)	117	5641	54.4
German	Max Spicker (Ed.). 1904. *Songs of Germany*: *Eighty-one German Folk and Popular Songs.* New York: Schirmer.	81	1391	45.4
Italian	[No editor identified]. 1880. *Songs of Italy.* London: Boosey & Co.	54	2329	52.1
	Marzo, E. (Ed). 1904. *Songs of Italy.* New York: Schirmer.	65	1650	48.9
	Both Italian books (excluding duplicates)	101	3353	49.8

examined melodies in 19th-century German and French art songs, and found almost no difference between them in nPVI. Jekiel (2014) found that English nPVI exceeds Polish nPVI in vocal music (in accord with the nPVI difference in speech between the two languages) but not in instrumental music. And Lee, Brown, and Müllensiefen (2017) found that popular songs by artists speaking multicultural London English had lower nPVI than those by artists speaking southern British English, mirroring the difference in nPVI between the two dialects.

The current study presents data regarding nPVI in vocal music, focusing on four important nations in the European musical tradition: Germany, France, Italy, and England. These languages differ markedly in nPVI, with German and (British) English having higher values than French and Italian. (Grabe and Low, 2002, report values of 57.2 for English, 59.7 for German, and 43.5 for French; Arvanti, 2012, reports 59.9 for English, 53.6 for German, and 48.5 for Italian; Ramus, 2002, reports similar values.) The data for the current study are taken from songbooks published in the late 19th and early 20th centuries, a period during which it has been found that English instrumental themes exceed French ones in nPVI (Patel & Daniele, 2003), and German instrumental melodies exceed Italian ones (Daniele & Patel, 2013).[1] Following Patel and Daniele's reasoning, the study was undertaken with the expectation that nPVI in vocal music would follow a similar pattern (though VanHandel and Song's 2010 study raises some doubt about this in the case of French and German). The intent was to examine the more specific causes of this supposed difference. In particular, the "Scotch snap" pattern—in which a sixteenth note on a strong beat is followed by a longer note on a weak beat—has been shown to occur much more often in English vocal music than in German or Italian (Temperley & Temperley, 2011); it was thought that this pattern might have had the effect of increasing the nPVI of English vocal music relative to the other three languages. The results of the investigation were surprising, and led the study in a rather different direction.

CORPUS ANALYSIS

As a corpus, six songbooks were used, each one representing songs of a single nation: England, France, Germany, or Italy (see Table 1). The books all have similar titles (*Songs of X*, where *X* is a country name), and were all published around 1900; the earliest is from 1880, the latest from 1920. (Not all of the songs in the books were *composed* during this period, however; more on this below.) The six books are also similar in content, all of them containing a mixture of folk songs (i.e., songs with no known composer), popular songs (songs with known composers intended for a mass audience), and art songs (songs with known composers intended for a more sophisticated audience—though the distinction between popular and art songs was less clear-cut than it is today). The books were all published in English-speaking countries (see Table 1). The lyrics are printed in the original languages, though all the books except *Chants de France* have English translations as well. In occasional cases, the songbooks provide different musical rhythms for the English and non-English lyrics; in such cases, the rhythm for the non-English lyric was used.

All songs in all six books were encoded. Durations were encoded in sixteenth notes. (Since the nPVI only

[1] The themes in Patel and Daniele (2003) were by English and French composers who were born the 19th century and died in the 20th. Regarding German and Italian music, Daniele and Patel (2013)'s main finding concerns *change* in nPVI; they show that German instrumental themes show an increase in nPVI in the 18th and 19th centuries while Italian themes do not. However, they also observe that German themes "rise above" Italian themes in nPVI sometime in the late 18th century (2013, p. 16).

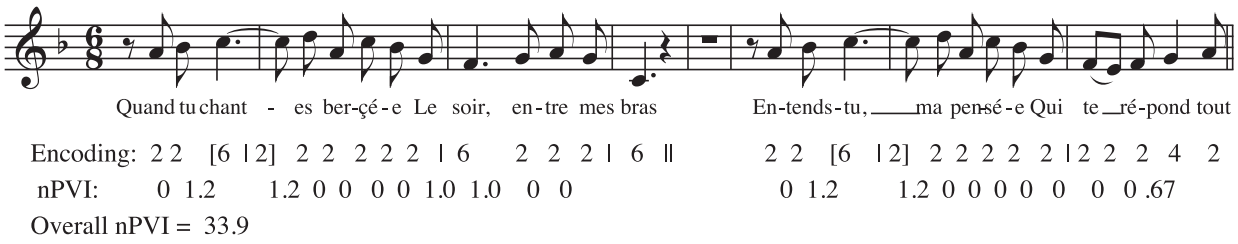

FIGURE 2. Charles Gounod, "Serenade," from *Songs of France*, mm. 7-13. The first row of symbols shows the encoding of the melody. Durations are encoded in sixteenth notes; the duration of a tied note (marked with square brackets) is the sum of the two tied notes, e.g. [6 | 2] = 8. Non-integer values are used when necessary, e.g. 0.5 for a 32nd note or 1.33 for an eighth-note triplet. The second row shows the nPVI values for each pair of durations; the overall nPVI (treating this portion of the melody as an entire song) is the mean of these values multiplied by 100. The one-measure rest is treated as a phrase break (marked in the encoding as ||), meaning that no duration is calculated for the note just before it; this means that no nPVI value can be calculated for the previous note either. (The note before a phrase break is encoded with its actual duration, but this has no effect on the nPVI values.) The same applies at the end of the melody.

considers the relative size of adjacent duration pairs, the unit of encoding makes no difference; using quarter notes or measures would yield the same results.) Grace notes and other notes in small noteheads were omitted, except in the very rare cases where they carried their own syllable. For each song, an nPVI value was calculated, using the formula in equation (1) above. Two related issues that arise with nPVI encoding of musical rhythm are the handling of rests and the handling of phrase boundaries. In music cognition research, durations of notes are often defined as *interonset intervals*, the time interval between the start of one note and the start of the next (e.g., Povel & Essens, 1985); thus a rest is absorbed into the previous note. However, rests may also indicate phrase boundaries, and it is generally agreed also that durational intervals between phrases (between the last note of one phrase and the first note of the next) are not relevant to rhythmic variability and should not be included in nPVI calculations. Various solutions to this problem have been adopted. Patel and Daniele (2003) exclude any themes containing rests; VanHandel and Song (2010) and London and Jones (2011) exclude or modify intervals crossing phrase boundaries, using phrase analyses by music experts; Lee et al. (2017) treat rests as phrase boundaries but exclude very short sequences surrounded by rests (less than seven notes); Daniele and Patel (2013) absorb all rests into the previous note and do not recognize phrase boundaries. Here we adopt the solution of Daniele and Patel (2013), with one modification: when a rest of one full measure or longer occurs, this is treated as a phrase boundary, and no interval is calculated. An example of the encoding system used here, and the resulting nPVI calculations, is shown in Figure 2.

For each of the six songbooks, the mean nPVI across songs was calculated. The two French books were also

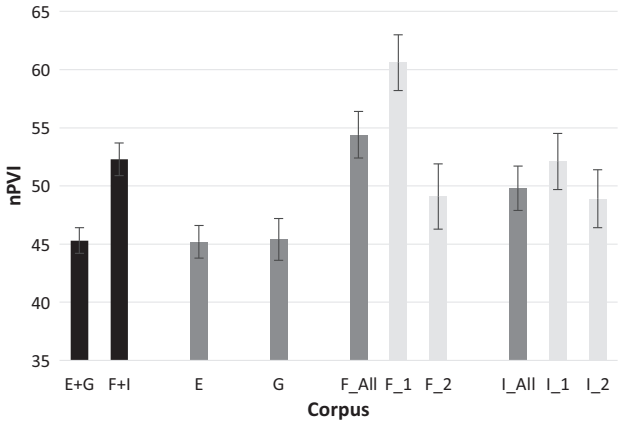

FIGURE 3. Mean nPVI values. E+G = all English and German songs, F+I = all French and Italian songs, E = *Songs of England*, G = *Songs of Germany*, F_All = all French songs, F_1 = *Songs of France*, F_2 = *Chants de France*, I_All = all Italian songs, I_1 = *Songs of Italy* (1880), I_2 = *Songs of Italy* (1904). Error bars represent standard error.

combined to yield a single mean for France; the same was done for Italy. (Eighteen songs appeared in both Italian books, and four songs occurred in both French books; these duplicate songs were only counted once.) The results are shown in Table 1; see also Figure 3. Of particular interest is the comparison between the nations with high speech nPVI, English and German, and those with low speech nPVI, Italy and France. It can be seen that the languages with low speech nPVI consistently have higher melodic nPVI. Overall, for the English and German corpora combined together, the mean nPVI across songs is 45.3, compared to 52.3 for the French and Italian corpora; this difference is highly significant, $t(394) = 3.92$, $p < .0005$ (Welch two-sample t-test). Further t-tests explored the differences between individual nations and songbooks. *Songs of Italy* (1880)

has a significantly higher nPVI than both *Songs of England*, $t(91) = 2.46$, $p < .05$, and *Songs of Germany*, $t(107) = 2.21$, $p < .05$. For *Songs of Italy* (1904), the differences are in the same direction, but not significant. For all Italian songs, the mean nPVI is higher than *Songs of England*, approaching significance, $t(187) = 1.93$, $p < .06$, and also than *Songs of Germany*, again approaching significance, $t(179) = 1.66$, $p < .10$. *Songs of France* has a significantly higher nPVI than both *Songs of England*, $t(100) = 5.52$, $p < .0001$, and *Songs of Germany*, $t(117) = 5.06$, $p < .0001$. For *Chants de France*, the differences are in the same direction, but not significant. For all French songs, the mean nPVI is significantly higher than in both *Songs of England*, $t(205) = 3.79$, $p < .001$, and *Songs of Germany*, $t(194) = 3.37$, $p < .001$.

DISCUSSION

Songs of four nations—England, Germany, Italy, and France—were examined, with the prediction that the two nations with highest speech nPVI, England and Germany, would have higher nPVI in vocal melodies. The results showed no evidence of such a pattern, and indeed some evidence of the opposite pattern. Overall, French and Italian melodies show higher nPVI than English and German ones (though the differences are only marginally significant in the case of Italian melodies). The fact that durational variability in vocal melody does not correlate positively with that in speech across these nations is quite surprising, especially since such correlations *have* been found between speech and instrumental melodies. If the differences in nPVI between French and English instrumental melodies observed by Patel and Daniele (2003) are due to the influence of language, one would expect these effects to be even more pronounced in vocal music. The kind of indirect influence of language on music suggested by Patel and Daniele—in which composers incorporate linguistic rhythms that are "in their ears" (2003, p. B43)—is presumably just as strong in vocal music as in instrumental music, if not stronger; and in vocal music, there is the additional pressure of finding a musical rhythm that fits the natural rhythm of the specific words being sung.[2] It is very difficult to see why speech rhythm would affect only instrumental music and not vocal music. Thus, the fact that the vocal music of the four European nations studied here shows no effect of speech rhythm casts doubt on the linguistic explanation for the nPVI differences observed in instrumental music as well.

It is possible that there are differences between the six songbooks used here, with regard to their content, function, or intended audience, that could explain the unexpected differences in nPVI between them. This seems unlikely, however. The six books are similar in date, and also seem similar in content, all of them featuring a mix of folk songs, popular songs, and art songs. One might argue for a differences in vocal difficulty (level of expertise required) between the six books, though it is not obvious what prediction would follow with regard to nPVI. *Songs of England* contains some songs that are quite virtuosic, including several with elaborate cadenza passages. *Songs of Germany* is at the other end of the spectrum in this regard; nearly all the songs are quite simple and could be easily sung by amateurs. But these two books are the lowest of the six books in nPVI. It is hard to see how level of difficulty could explain why the easiest and most difficult of the six books are lower in nPVI than the other four books.

While the six songbooks are similar in date of publication, each book contain songs composed over a long period—in some cases, several centuries preceding the publication date—including many whose composer and exact date are unknown. This is important, in light of Daniele and Patel's (2013) argument that the degree of national pride and patriotism felt by a composer could affect the degree to which speech rhythm affects their composition. Patel and Daniele use this reasoning to explain the fact that the nPVI of German instrumental themes increased from the 17th century to the 20th, a period during which national pride in Germany was increasing as well. Possibly, if the current study were confined to songs *composed* in the late 19th and early 20th centuries, different results would be obtained. The difficulty of dating many of the songs in the six songbooks prevents further exploration of this issue. Presumably, though, all the songs in the six collections were at least *popular* at the time that the books were published (not only in the English-speaking world but in their home countries as well). If national pride augments the effect of speech rhythm on composition, we might expect it to affect listening preferences as well; that is, during the highly nationalistic period around 1900, we would expect listeners of each nation to be especially drawn towards music that reflects their speech rhythm.

One way in which the four national data sets differ is in the proportion of songs for which the composers are identified—we will call these "attributed" songs. Songs without known composers ("unattributed") are generally regarded as folk songs. The proportion of attributed

[2] Notes and syllables in vocal music need not follow exactly the same rhythm; there is the possibility of a melisma, in which multiple notes are placed under a single syllable. (An example is seen in the last measure of Figure 2.) This gives composers some flexibility in setting words to music.

TABLE 2. *Attributed (With Composer Specified) and Unattributed Songs in Each National Data Set*

	Percentage attributed	nPVI of attributed songs	nPVI of unattributed songs
England	77 / 102 = 75.5	45.4	44.6
France	78 / 117 = 66.7	59.2	44.8
Germany	32 / 81 = 39.5	52.5	40.9
Italy (*Songs of Italy* [1880] only)	10 / 54 = 18.5	54.3	51.6

songs ranges from 18.5% in the Italian set to 75.5% in the English one (see Table 2).[3] We should bear in mind that every song is composed by someone (or by multiple people), but unattributed songs may differ in historical origin from attributed ones (generally they are likely to be earlier) and in musical features as well. Indeed, further analysis shows that attributed songs have much higher nPVI than unattributed ones in the German and French sets, though, curiously, not in the Italian and English ones (see Table 2). This is an interesting finding worth further exploration. Importantly, though, it does not explain the nPVI differences between nations in any simple way: it is not the case that national data sets with more attributed songs tend to have higher nPVI. In particular, the English set has the highest proportion of attributed songs, but has lower nPVI than the French and Italian sets.

The original intent of this study was to try to explain the expected nPVI advantage of English and German vocal music over French and Italian in terms of specific musical features. Instead, the opposite challenge arises: to explain why French and Italian songs are higher in nPVI. I will not explore this issue in depth, but will offer a few observations. First, the four national data sets differ somewhat in the proportion of the songs in simple meter (with the main beat divided in two) versus compound meter (with the beat divided in three); in particular, the Italian set has a much higher incidence of compound meter than the other three sets. Table 3 shows the percentage of compound meter songs in each national corpus, as well as the nPVIs for simple and compound meter songs. Many songs in compound meter are based on an uneven long-short pattern (like Figure 1B), which tends to yield a relatively high nPVI; Figure 4A shows an example. VanHandel and Song (2010) found that French and German songs in compound meter had a higher nPVI than those in simple meter, and that is the case in the current corpus as well, though the difference is small: across all four nations, the average nPVI is 49.8 for compound meter songs and 48.2 for simple meter songs, $t(326) = -0.85$, *n.s.* Within the Italian corpus, though, the nPVI for compound meter songs is *lower* than that for simple meter songs, so it is difficult to argue that the preference for compound meter in Italian songs explains their high nPVI. London and Jones (2011) also found a difference in nPVI between duple meter (with beats grouped in two) and triple meter (grouped in three), with French (but not English) instrumental themes having higher nPVI in triple meter. This information is also shown in Table 3, and yields a complex picture; for the German and Italian songs, nPVI is higher in triple meter, but for English and French songs there is virtually no difference. The overall difference in nPVI between duple and triple meter songs is, again, small: 48.4 for duple, 50.2 for triple, $t(125) = 0.80$, *n.s.*

One might wonder if other differences between these nations' languages might explain the musical differences between them. Traditionally, a distinction has been made between syllable-timed languages, in which syllables are roughly equal in length, and stress-timed languages, in which stresses are roughly equally spaced and syllable length is highly variable; French and Italian are thought to belong to the former category, and English and German to the latter. This distinction has not held up to empirical scrutiny, however (Dauer, 1983; Roach, 1982); the nPVI measure was initially proposed as an alternative to it (Grabe & Low, 2002). One might also distinguish between languages that have lexical stress, such as English, German, and Italian, and those that do not, such as French. This affects musical rhythm, since there is generally a strong preference to align lexical stresses with strong beats (Halle & Lerdahl, 1993; Palmer & Kelly, 1992). Temperley and Temperley (2013) show that, indeed, French is less consistent than English regarding the alignment of words with musical meter. This suggests that French melody might be less constrained by linguistic rhythm than English, and thus governed more by purely musical considerations; but it is unclear what prediction follows from this with regard to nPVI.

The current study invites comparison with VanHandel and Song's (2010) study of 19th-century German and French art songs. Those authors also found a higher nPVI for French than for German songs, but the difference was small and not significant; they found a higher nPVI for German songs than was found here (48.8

[3] One songbook, *Songs of Italy* (1904), does not identify composers. (Comments on the songs indicate the origins of some of them, but this is not done systematically.) So the figure for Italy quoted here and in Table 2 is based only on *Songs of Italy* (1880).

TABLE 3. *Songs in Simple/Compound Meter and Duple/Triple Meter and Double-dotted Rhythms in Each Each National Data Set**

	% of songs in compound meter	nPVI of simple meter songs	nPVI of compound meter songs	% of songs in triple meter	nPVI of duple meter songs	nPVI of triple meter songs	Double-dotted rhythms per measure
England	24.5	43.7	49.7	14.3	45.3	44.2	.008
France	29.6	52.3	56.8	13.9	53.8	52.1	.027
Germany	22.1	47.5	42.1	46.8	43.3	49.4	0
Italy	62.5	50.2	48.5	15.6	47.9	55.8	.012

* A small number of songs (22 out of 401 total) had changing meters and were excluded from the meter statistics shown here.

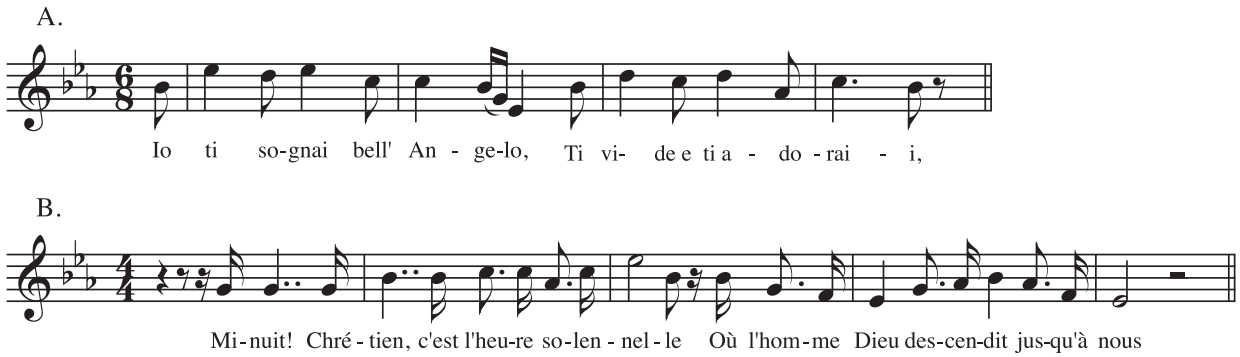

FIGURE 4. (A) "Io ti sognai bell' angelo" (unattributed), from *Songs of Italy* (1880), mm. 5-8; (B) Adolphe Adam, "Cantique pour Noël" ("O Holy Night"), from *Songs of France*, mm. 2-6.

versus 45.4 in the current study) and a lower nPVI for French ones (49.4 versus 54.4 in the current study). Of particular interest in this regard is the book *Songs of France* (1904), used in the current study; this book consists almost entirely of attributed songs (58 out of 60 are attributed), mostly from the 19th century, and it has the highest nPVI of any of the six books used in the study (60.6). VanHandel and Song's corpus appears to include mainly "art song" composers (as their article title suggests), including French composers such as Bizet, Debussy, and Fauré, whereas *Songs of France* contains mostly "popular" songs by little-remembered composers such as Masini, Wekerlin, and Boieldieu. Inspection of the French songs in the current corpus shows that many of them feature double-dotted or even triple-dotted rhythmic patterns, which create high nPVIs; Figure 4B shows one famous example from *Songs of France*. (The rightmost column of Table 3 shows data as to the frequency of double-dotted rhythms in each corpus.) Such rhythms seem to have been a stylistic feature of 19th-century French song—perhaps more so in popular songs than art songs. It should be emphasized, though, that even VanHandel and Song's study finds no evidence that nPVI in German songs is higher than in French songs, as the speech-rhythm perspective would predict.

As Daniele and Patel (2013) rightly observe, the rhythmic character of a musical style may be affected by many factors, linguistic rhythm being just one of them. To convincingly establish a link between speech rhythm and musical rhythm—instrumental or vocal—would require data from many different musical/linguistic cultures. In this sense, a study such as Patel and Daniele's (2003) study of French and English instrumental themes only really provides two data points, albeit highly suggestive ones. Other studies add additional data points (Huron & Ollen, 2003; Jekiel, 2014; McGowan & Levitt, 2011). It is possible that further data from other musical styles would confirm the connection between speech rhythm and instrumental musical rhythm. As argued earlier, the data here regarding rhythm in vocal music cast some doubt as to whether such a pattern will be found. But—by the same logic—the data presented here really only constitute four data points, and is not a sufficient basis for strong general conclusions about connections between musical and linguistic rhythm. Here, too, other studies of nPVI in vocal music provide additional evidence, both

positive (Jekiel, 2014; Lee et al., 2017) and negative (VanHandel & Song, 2010). In any event, Patel and Daniele's pioneering application of the nPVI measure to music has opened a whole new area of inquiry, and raises many interesting questions and possibilities for future research.

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