Stress-meter alignment in French vocal music

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Previous research has shown disagreement regarding the nature of stress in French. Some have maintained that French has lexical stress on the final syllable of each word; others have argued that French has no lexical stress, only phrasal stress. A possible source of evidence on this issue is vocal music. In languages with lexical stress, such as English, it is well known that stressed syllables tend to occur at "strong" positions in the musical meter (some evidence will be presented supporting this view). A corpus analysis was performed to investigate the degree of stress-meter alignment in French songs. The analysis showed that (excluding syllables at the ends of lines) the final syllables of polysyllabic words tend to occur at stronger metrical positions than non-final syllables of those words; it also showed that monosyllabic content words tend to occur at stronger positions than monosyllabic function words. While conflicts between stress and meter are much more common in French than in English vocal music, these results suggest that French poets and composers recognized distinctions of stress between syllables of polysyllabic words and between monosyllabic content and function words. © *2013 Acoustical Society of America*.
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I. INTRODUCTION

The question of stress in the French language has been widely studied and discussed during the last 80 years or more, but there seems to be no consensus on the subject (Verluyten, 1984; Di Cristo, 1999; Lacheret-Dujour and Beaugendre, 1999; Dell and Halle, 2009). In ordinary speech, stressed syllables can be differentiated by several factors, including duration, intensity, fundamental frequency, and spectral content (Sluijter and van Heuven, 1996; Turk and Sawusch, 1996). These dimensions have been measured in corpora of French speech (Galliano *et al.*, 2005), but their interpretation is a matter of dispute. A variety of viewpoints and theoretical frameworks have been put forth with regard to the nature of stress in French. In this study, we explore an empirical approach to the issue based on the association between stress and musical meter.

A central question concerns the existence of *lexical* stress: that is, a fixed stress that is permanently associated with a certain syllable of a polysyllabic word. English has lexical stress: in the word *language*, for example, the first syllable is lexically stressed and therefore generally receives at least some degree of emphasis in any spoken occurrence of the word. The majority of analysts seem to agree that lexical stress does not exist in the French language: For instance Walker writes, "words in nonfinal (i.e., non-phrase-final) position have no word stress independently of that affecting the last syllable of the phrase" (Walker, 2001, p. 31; see also Di Cristo, 1999, p. 160). That this is generally accepted is

shown by the fact that French dictionaries, unlike those of most European languages, do not attempt to mark the stressed syllables of the words they list. However, Peperkamp and Dupoux (2002) suggest that French has lexical stress falling on the last syllable of each word although these stresses may be reduced in certain contexts; and Hirst, Astésano, and Di Cristo (1998) give evidence from speech data for emphasis of both word-final and word-initial syllables.

It is also widely agreed that French possesses *phrasal* stress, that is, stress on the last syllable of a *phrase* (French "groupe": Lacheret-Dujour and Beaugendre, 1999, pp. 41–43); indeed, some have argued that this is the only kind of stress in French (as suggested by Walker's quote in the last paragraph; see also Battye, Hintze, and Rowlett, 1992, p. 105). Most would agree that *les chansons à boire* is a phrase and that the phrasal stress, if any, will fall on the syllable *boi-*. Unfortunately there is no general agreement on what constitutes a phrase. Modern prosodic theories generally assume a hierarchical structure with larger prosodic segments containing smaller ones (for a review, see Shattuck-Hufnagel and Turk, 1996). For example, Selkirk (1986) posits a system with four levels of phrase—intonational phrase, major phrase, minor phrase, and prosodic word; it is not clear which level of this hierarchy corresponds to the phrases at issue here, and in any case, the identification of these kinds of units is frequently subjective. If one chooses the smallest level—the prosodic word, which often consists of a single polysyllabic word—then phrasal stress becomes difficult to distinguish from lexical stress. Without a more specific definition of "phrase," the claim that all stress in French is phrasal is difficult to test directly.

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There is, in addition, the phenomenon of emphatic or contrastive stress ("l'accent d'insistance" in Rossi, 1979; see also Di Cristo, 1999, pp. 162–164), applied on a specific occasion to a syllable that would not normally be stressed and may not end a phrase (Séguinot, 1976; Dahan and Bernard, 1996, pp. 342–343); often it is the first syllable of a polysyllabic word (Di Cristo, 1999, p. 167). Other authors have spoken of secondary lexical stress, which falls on a nonfinal syllable of word (Verluyten, 1984; Di Cristo, 1999, p. 167). These kinds of stress are not our main focus in this article although we will return to them briefly in the discussion section.

Clearly, a major point of disagreement among scholars is the issue of lexical stress: Does French have it or not? All agree that when stress does occur in French (e.g., at the end of a phrase), it normally falls on the last full syllable of a word.[1] The question we consider, then, is whether the final syllables of polysyllabic words are more stressed than non-final syllables in general, even in non-phrase-final contexts. In what follows, we employ an empirical method for resolving this question. We also consider a further hypothesis about stress in monosyllabic words, relating to the distinction between content words (such as nouns, verbs, and adjectives) and function words (such as determiners, pronouns, and prepositions). It has been suggested that only content words in French can take stress (Lacheret-Dujour and Beaugendre, 1999, p. 42; Rossi, 1979, p. 42). [This has some parallels in English, where monosyllabic function words are usually unstressed (Selkirk, 1986); indeed, Hayes (1995, p. 88) argues that this is a general cross-linguistic phenomenon.] This hypothesis, too, will be empirically tested in our study. Putting these two hypotheses together, we might define monosyllabic content words and the final full syllables of polysyllabic words (either function words or content words) as "stressable" and all others as "unstressable"; the question we ask is whether stressable syllables really do receive greater stress than unstressable ones.

One possible way of determining the location of stresses in French is through poetry and music, where—at least in some traditions—there is a regular pattern of stress or accent: that is to say, a poetic meter. For instance, in English verse an iambic pattern is common, with alternating unstressed (u) and stressed (s) syllables:

The boy stood on the burning deck
u s u s u s s
When all but he had fled.
u s u s u s

The actual stresses of the text need not always adhere to that dictated by the meter (for example, the stressed syllable
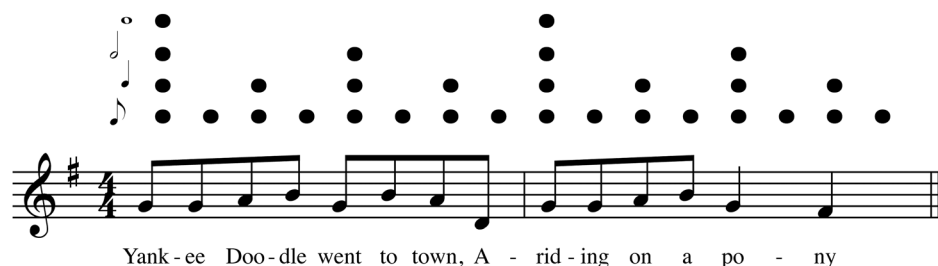
stood falls at an unstressed position in the first line of the quotation), but for the most part they do. It seems to be generally agreed that such regularities are weak or nonexistent in French verse except in the last full syllable of a line. Biggs (1996) examines the distribution of stressable syllables in French poetry using criteria very similar to ours— monosyllabic content words and the final syllables of polysyllabic words. He finds that in one of the three principal meters of Renaissance poetry, the octosyllable, "while within the line there was relatively free deployment of stress, the constraints of syllable count and line-final stress could not be meddled with" (10). In the other two classical meters, the decasyllable and the dodecasyllable (Alexandrine), an additional constraint is the caesura after the fourth or sixth syllable, respectively, which requires a word break and hence favors a stress on the preceding syllable. Biggs finds that among the remaining positions in the line some are more likely to carry stress than others, but this is a tendency rather than an absolute rule.

In this study, we pursue a similar line of reasoning, but focusing on vocal music rather than poetry. Most Western music is built on a meter, a regular pattern of accents similar to that found in poetry. The meter of a piece of music, as conceived in modern music theory (e.g., Lerdahl and Jackendoff, 1983), consists of several levels of (roughly) equally spaced beats: for example, a piece in 4/4 meter might have beats at the eighth-note, quarter-note, half-note, and whole-note levels. Meter is represented in notation by the position of notes in relation to the barline, as shown in Fig. 1. The meter of a piece is conveyed to the listener by events in the music (through the accentuation of certain notes through length and dynamics or by other cues such as changes of harmony), although once established, the music need not constantly reinforce it and indeed may contradict it at times.

In vocal music in languages with lexical stress such as English and German, stressed syllables tend to fall on relatively strong beats of the meter (Palmer and Kelly, 1992; Halle and Lerdahl, 1993). (While there seems to be universal agreement on this point, there is surprisingly little quantitative evidence for it; a small body of evidence will be presented later.) In Fig. 1, for example, in the word *riding*, the first syllable is stressed and is on a stronger beat than the second syllable; the same is true of *pony*. This suggests a possible way of exploring patterns of stress in French. If the hypotheses discussed earlier are true, we should find that stressable syllables (content monosyllables and the last full syllable of polysyllabic words) tend to fall on relatively strong beats. Three prior studies have examined this issue— which we will call "stress-meter alignment"—in French in

FIG. 1. The beginning of "Yankee Doodle," showing the metrical grid.

an informal way. Dell (1989) examines a number of modern French songs and concludes that there is a tendency, but no more than that, for stressed syllables to correspond with strong beats, except at the end of a line, where the correspondence is rigorous. He offers no quantitative data, however. Dell and Halle (2009) reach a similar conclusion comparing French songs with English ones. They find that French songs are much more consistent in syllable count than English ones but much less strict in the allocation of stressed syllables to strong musical beats except for line-final syllables. Like Dell (1989) they make their own selection of songs, limited to a singing idiom which they call "traditional"; again, no quantitative data are offered. Pau (2011) suggests that certain opera composers pay more attention to stress-meter alignment in non-diegetic music (singing as speech) than in diegetic music (singing as song). The present study examines stress-meter alignment in French using quantitative data gathered from a systematically selected corpus of songs.

II. CORPUS ANNOTATION

The songs used in our study are all drawn from a single collection, *Chants de France: Choix de Chants Patriotiques et Populaires* by R. P. Jameson and A. E. Heacox (1922). The book contains a variety of French songs, including patriotic songs, romances, satirical songs, and art songs by named composers, chiefly from the 18th and 19th centuries but including some that are probably of earlier date. All the songs in the collection were analyzed, with the exception of a section of Canadian songs (which we excluded to avoid linguistic or musical influences possibly extraneous to French culture) and two "alternative versions" of songs already processed; this left a total of 54 songs.

Our reasoning is that if French contains the stress distinctions that we hypothesize, creators of songs in the corpus would have been sensitive to this and would have respected it by placing stressable syllables at strong metrical positions. The term "creator" is purposefully vague. In most cases, the lyrics and the music of songs are written by two different people. In some cases, the lyrics are written first (often as a poem, not intended to be set to music); in other cases, the music is written first; in still other cases, the music and lyrics are put together by a third person (such as an editor). For some of the songs in our corpus, little is known about how they were created. But this does not affect our argument. Whether the matching of the tune and the words was done by the poet, the composer, or an editor, any correspondence between metrical strength and stressable syllables in the resulting product would seem to indicate an awareness of the distinction between stressable and unstressable syllables—once alternative explanations are eliminated, as we will discuss.

Every syllable in the corpus was classified in two ways: its prosodic type and the metrical level of the note on which the syllable began. The process of prosodic labeling was carried out independently by two researchers—a native speaker of French and the first author—and the differences were reconciled according to rules summarized in the following paragraph. The metrical labeling was done by the two authors, both professional music scholars. All verses of each song were processed, whether printed under the staff or after the music, but sections with repeated refrains (i.e., with both music and lyrics repeated) were only included once. Any line of text that was repeated with identical metrical strength values was counted only once.

As noted earlier, our assumption is that if French has lexical stress, every polysyllabic word has stress on the last full syllable. The last syllable of a polysyllabic word (either a function word or a content word), or the penultimate syllable if followed by a schwa, was classified as *s*; all preceding syllables in the word were labeled as *u*. (The handling of schwas will be discussed later.) For monosyllabic words, we distinguished between function and content words. A list of monosyllabic function words was compiled, consisting of prepositions, conjunctions, determiners, pronouns, auxiliary verbs, and numerals (see the Appendix); these were all encoded as *f*. Any nonsense syllables were also classified as *f*, as were repeated syllables (e.g., the first two syllables in *l'ag-, l'ag-, l'-ag-ré-ment*). All other monosyllabic words were assumed to be content words and encoded as *c*. Special handling was needed for words ending with an optional schwa, such as *une* or *appelle*; in such cases, the schwa may or may not be syllabified (assigned to its own note). Unsyllabified schwas were ignored; a word consisting of a single syllable followed by an elided schwa was counted as a monosyllable, either *f* or *c* according to its syntactic status. If the schwa was treated as a syllable, it was coded as *x*. But *une, elle, votre*, and *notre* were coded *u-x* rather than *s-x* because it is generally agreed that they are not stressable (Biggs, 1996, pp. 29–30). Thus syllables classified as *c* or *s* are those carrying possible stress; syllables labeled *f*, *u*, and *x* should be unstressed.

The metrical labeling of the syllables was done as follows. The "tactus" level—the level of the main beat, at which one normally taps one's foot and the conductor conducts—was defined as level 2. This is the quarter-note level in 2/4, 3/4, and 4/4 time signatures (see Fig. 1) and the dotted-quarter level in 6/8, 9/8, and 12/8. The level above the tactus (the one-measure level in 3/4, 2/4, 6/8, and 9/8, or the half-measure level in 4/4 and 12/8) was defined as level 3; the one-measure level in 4/4 and 12/8 was defined as level 4. All beats below the tactus level were defined as level 1. Each syllable was then labeled with the highest metrical level present at that point; for example, a syllable on the downbeat of the measure in 2/4 would be labeled 3. Figure 2 shows an excerpt from the corpus along with the prosodic and metrical labels for each syllable.

III. STATISTICAL ANALYSIS

Table I shows the counts for syllables of each metrical level, prosodic category, and combination of the two. Our objective was to determine whether there was a correlation between prosodic type and metrical strength, such that stressable syllables tended to occur at metrically stronger positions than unstressable ones. Figure 3 shows the distribution over metrical levels for syllables of each type. It can be

Metrical level: 1 2   1   4   2   3   2   4   3   1 2   1

Al-lons, en - fants de la Pa - tri - e, Le jour de

Syllable type: *u*   *s*   *u*   *s*   *f*   *f*   *u*   *s*   *x*   *f*   *c*   *f*

4   2   2   1   4

gloire   est   ar - ri - vé.

c   *f*   *u*   *u*   *s*

FIG. 2. The first two lines of "La Marseillaise," showing the encoding of syllables and metrical levels.

seen that, indeed, the stressable categories *s* and *c* show a much stronger tendency to occur at higher metrical levels (4 and 3) than the unstressable categories *f*, *u*, and *x*. Over the entire corpus, the average metrical strength of *s* syllables is 2.69; for *c*, 2.26; for *u*, 1.59; for *f*, 1.91; and for *x*, 2.05. Grouping these categories together yields a mean metrical strength of 2.57 for stressable syllables and 1.80 for unstressable syllables. We can examine the statistical significance of this trend by computing the mean metrical strength of stressable and unstressable syllables for each song and performing a paired-sample *t*-test across songs. The result showed a highly significant difference in metrical strength between stressable and unstressable syllables, $t(53) = 14.7$, $p < 0.0001$. Subtracting the mean metrical strength value of unstressable syllables from the mean value for stressable syllables yields a single number representing the degree of stress-meter alignment in the corpus: 0.77. We will call this the *stress-meter alignment value* or SMAV.

While the data in our corpus clearly show some stress-meter alignment, one might wonder how strong this tendency is in comparison to a language in which lexical stress is unquestioned, such as English. To our knowledge, the degree of stress-meter alignment in English has never been systematically investigated. [Palmer and Kelly (1992) examine the metrical placement of certain syntactic constructions—for example, showing that the first word of a compound noun phrase tends to be on a stronger metrical position than the second—but they provide no general data.] We undertook a small corpus analysis to address this question in an approximate way. We used a collection called *Songs of England*, by J. L. Hannon and Eaton Fanning (1900), a collection similar in character to that used for our French corpus, and analyzed the first ten songs in the book. The songs were analyzed prosodically and metrically in the same way as the French songs. [We used *c* for monosyllabic content words and *f* for monosyllabic function words, using the list of English function words in Temperley (2009); *s* was used for the main

stress of each polysyllabic word; *u* was used for unstressed syllables of polysyllabic words. A new symbol, *w*, was introduced for syllables in polysyllabic words with secondary stress; *w* syllables are treated as stressed in the test described in the following text.] Stressable syllables (*s*, *c*, and *w*) yielded an average metrical strength of 3.08, and unstressable syllables yielded 1.93, creating an SMAV of 1.15. An unpaired two-sample *t*-test across songs showed that the SMAVs of the English songs were significantly higher than those of the French songs, $t(15.01) = 3.63$, $p < 0.01$.

At this point, we must reconsider the issue of phrasal stress. Some have suggested that French has phrasal stress only with a stress on the final syllable of each phrase. While the vagueness of the term "phrase" makes this hypothesis difficult to test directly, it seems clear that, at least, the end of each line of a song is a phrase boundary. The corpus contains 1193 song lines; these usually correspond to major syntactic units such as clauses and would normally be spoken as self-contained intonational units separated by pauses. (Song lines are clearly identified in the notation of vocal music: the first word of each line is capitalized. In addition, lines within a song generally follow a regular repeating pattern with regard to the number of syllables in each line, so that context can be used in the occasional cases of ambiguity.) Lines usually end with stressable syllables (97% of lines do so) and usually at fairly strong metrical positions (the average metrical strength of line-final syllables is 3.14, while the average strength of other syllables is 1.88). One might therefore suspect that the observed association between metrical strength and prosodic category was largely due to the ends of lines. To address this concern, we repeated the above counts with line-final syllables excluded. (In cases where a line ended with a schwa, we excluded both the schwa and the preceding *s*.) The data are summarized in Fig. 4. The greater metrical strength of stressable categories over unstressable ones can still clearly be seen, though the difference between the mean strength of stressable syllables (2.24)

TABLE I. Counts of syllables in the French corpus by prosodic category and metrical strength.

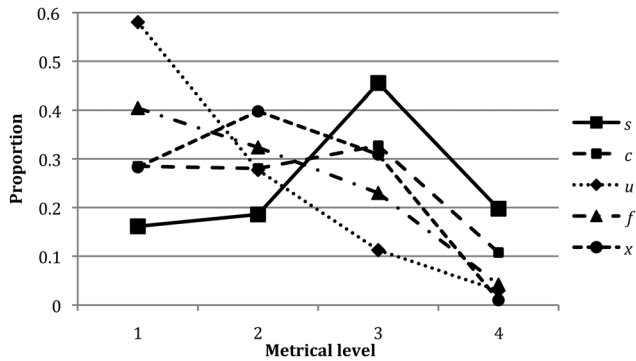|	s	c	f	u	x	Total
1	370 (0.16)	249 (0.28)	1047 (0.40)	1374 (0.58)	249 (0.28)	3289
2	426 (0.19)	245 (0.28)	838 (0.32)	656 (0.28)	350 (0.40)	2515
3	1044 (0.46)	286 (0.33)	595 (0.23)	266 (0.11)	272 (0.31)	2463
4	453 (0.20)	94 (0.11)	109 (0.04)	71 (0.03)	9 (0.01)	736
Total	2293	874	2589	2367	880	9003

FIG. 3. Metrical distribution of prosodic syllable types in the French song corpus.

and unstressable syllables (1.75) is somewhat reduced, yielding an SMAV of 0.49. A paired-sample t-test showed that this difference remained highly significant across songs, $t(53) = 7.4, p < 0.0001$.

It might be argued that the principle of meter-stress alignment is better stated in relative rather than absolute terms. In English vocal music, for example, there is no rule stating that a stressed syllable must be placed at the tactus or any other particular metrical level; rather, the rule appears to be that a stressed syllable must be placed at an equal or stronger beat than neighboring unstressed syllables (although there are certainly exceptions). In Fig. 1, for example, both the stressed syllable *Doo-* and the unstressed syllable *-ny* are placed at level 2, but because *Doo-* is metrically stronger than the unstressed syllables on either side (both level 1) and *-ny* is metrically weaker than the preceding stressed syllable (level 4), the setting is correct. It seemed worth examining the degree to which our French data reflected this pattern. We looked at pairs of adjacent syllables in the pattern *u-s*—a particularly common pattern in our data, with 1031 tokens in the corpus. (Pairs in which the *s* was line-final were excluded.) The view of stress-meter alignment presented in the preceding text predicts that the second syllable of each pair should be metrically stronger. In 32 of the tokens, the two syllables were of equal metrical strength, and these were simply ignored; all remaining pairs were therefore either "weak-strong" or "strong-weak" in relative terms. For each song, we computed the proportion of the total (excluding the "equal-strength" tokens) that were weak-strong. Across songs, the mean of these proportions was 0.64; a
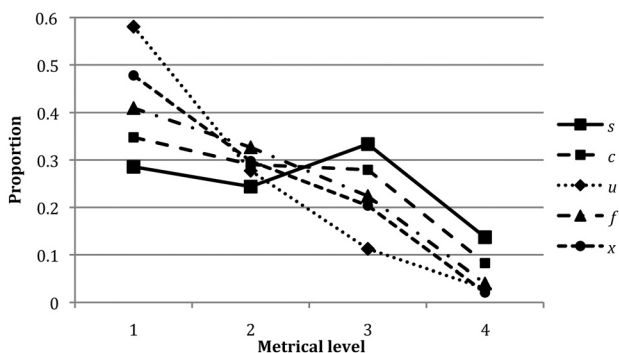

FIG. 4. Metrical distribution of prosodic syllable types in the French song corpus with line-final syllables excluded.

single-sample t-test showed these values to be significantly higher than the value of 0.5 that would be expected by chance, $t(53) = 4.8, p < 0.0001$. (By contrast, in the 94 tokens of the *u-s* pattern in our small English corpus, the second syllable was metrically stronger in all 94 cases, once again reflecting a much higher degree of stress-meter alignment.) We repeated the same test with three other type pairs in which stress-meter alignment made a clear prediction: *s-f* (predicted to be strong-weak), *f-c* (predicted to be weak-strong), and *c-f* (predicted to be strong-weak). (In nine of the 216 tests, there were no tokens of the given type pair in a given song; for these, a value of 0.5 was assigned.) All three syllables types showed a significant tendency toward stress-meter alignment across songs: For *s-f*, $M = 0.63, t(53) = 4.0, p < 0.001$; for *f-c*, $M = 0.56, t(53) = 1.8, p < 0.05$; for *c-f*, $M = 0.61, t(53) = 3.7, p < 0.001$.

A possible confound arises with the tests reported in the preceding text. It may be that French syllables tend toward certain patterns of stressed and unstressed syllables for purely linguistic reasons—for example, a pattern of alternation. [This has been suggested for English (Liberman and Prince, 1977; Kelly and Bock, 1988); to our knowledge, no one has proposed it for French, but it remains a possibility.] And it may also be that musical rhythms tend toward certain patterns of metrical accentuation for purely musical reasons; for example, a series of eighth notes in a 2/4 or 4/4 rhythm will produce a pattern of alternating strong and weak metrical positions. It is possible, therefore, that an alignment between stress and meter might arise quite unintentionally due to coinciding regularities in stress patterning and metrical patterning—perhaps a tendency toward alternating weak and strong elements. We addressed this possibility with a random simulation. We considered only lines with exactly eight syllables; this number was chosen because it is the most common line length, accounting for 21% of the lines in the corpus. From these, we selected only the first eight-syllable line from each song containing any such lines, creating a set of 24 lines. The SMAV of each line was measured. The data were then scrambled so that the sequence of metrical values in each line was paired with the sequence of syllable types in another randomly chosen line. Our reasoning was that if the alignment between stress and meter was due to general patterns in both domains (such as a tendency toward weak-strong alternation), the alignment would be preserved even when the pairing of metrical patterns and stress patterns was random. In fact, the mean SMAV of the original data, 0.99, was higher than that of the scrambled data, 0.24, a statistically significant difference across lines, $t(23) = 2.9, p < 0.01$. While the original SMAV values were significantly above zero, $t(23) = 5.6, p < 0.0001$, the randomly altered values did not significantly differ from zero, $t(23) = 1.1, ns$; this argues against the existence of coinciding regularities in the patterning of stress and metrical strength or at least suggests that their effect on stress-meter alignment is small.

IV. DISCUSSION

The evidence reported in this study shows a significant degree of stress-meter alignment in French vocal music.

Certain types of syllables—specifically, monosyllabic content words and the final syllables of polysyllabic words—tend to occur at stronger metrical positions than other syllables. This is reflected both in the absolute metrical strength of syllable types across the corpus and in the relative metrical strength of syllables within commonly occurring syllable-type pairs. The fact that this pattern persists even when line-final syllables are excluded casts doubt on the possibility that it is only due to the placement of phrase-final syllables. The correspondence between stress and meter in French is considerably weaker than in English vocal music; as stated by Dell and Halle (2009)—whose informal observations about stress-meter alignment in French are confirmed here—it is a "tendency" rather than a rule. There are very many cases in our French corpus where an unstressable syllable is metrically stronger than a neighboring stressable one. Still, the evidence presented here suggests that creators of French songs (composers and lyricists) were inclined to place the final syllables of polysyllabic words on stronger metrical positions than non-final syllables and to place monosyllabic content words on stronger positions than monosyllabic function words. We find it difficult to explain this phenomenon without positing an awareness of stress distinctions between these categories.

As noted in our introduction, the view that French features only phrasal stress is difficult to test directly, due to the vagueness of the term "phrase." While we excluded line-final syllables in the tests in the preceding text, some of the lines in our corpus undoubtedly contain multiple phrases (at least by some definitions of the term), and it is possible that the alignment we observed between stress and meter was partly or even largely due to the metrical placement of phrase-final syllables within lines. We can see no way of excluding this possibility without a more precise definition of what constitutes a phrase. It is interesting to note, however, that in English-language music, the alignment between phrasal stress and metrical strength is quite weak. Indeed, as soon as one moves above the very lowest level of stress distinctions, meter-stress alignment appears to decrease markedly. Returning to Fig. 1, the third syllable *Doo-* would normally be stressed relative to the first syllable *Yank-*, yet is at a metrically weaker position. The same is true for the syllable pair *went* and *town*, and the pair *rid-* and *po-*; in both cases, the stressed syllable of the pair (the second one) is metrically the weaker of the two. Thus there is little correspondence between meter and higher-level stress in English. The situation may not be the same in French, however, and this deserves further study.

Some proponents of lexical stress in French have suggested that "secondary" stress may occur on non-final syllables. There is some disagreement as to where in a word secondary stress occurs: It has been suggested that it occurs on the first syllable (what we will call the "initial" theory of secondary stress: see Di Cristo, 1999, p. 167) or on the antepenultimate syllable (the "antepenultimate" theory: e.g., Verluyten, 1984). The corpus used here provides an opportunity to test these hypotheses. Of particular interest in this regard are words containing three or more *u*'s followed by an *s* because the two theories make different predictions. In

the case of *u-u-u-s*, for example, the initial theory predicts stress on the first syllable, while the antepenultimate theory predicts stress on the second syllable. Our corpus contains 40 words with three *u*'s, 4 with four, and one with five. Across these 45 words, the average metrical strength of the first syllable is 1.53, while that of the antepenultimate syllable is 2.40; this difference is highly significant across tokens, $t(44) = -5.9$, $p < 0.0001$. Thus the small body of data available in our corpus strongly favor the "antepenultimate" view over the "initial" view of secondary stress.

In many of the songs in our corpus, the texts are strophic: That is, they contain clearly defined sections (verses) that each contain the same number of lines and, normally, the same number of syllables within each line. And in many cases, these parallel sections are all set to the same music. This prompts a question regarding the texts themselves: To what extent do the verses within a song reflect similar patterns of stressable and unstressable syllables? To examine this, we compared the first and second verses (V1 and V2) for the 48 songs in the corpus that contain multiple verses. Every syllable in both V1 and V2 must be set to a note; we can therefore associate each syllable in V1 with the syllable in V2 that is assigned to the same note.[2] For each syllable in V1, we can then examine whether the associated syllable in V2 is stressable or not. (As before, the final syllable of each line is disregarded.) The results, shown Table II, reveal a strong pattern. Whereas 54% of the stressable syllables in V1 coincide with stressable syllables in V2, only 21% of the unstressable syllables in V1 coincide with stressable V2 syllables, a highly significant difference, $\chi^2 = 211$, $p < 0.0001$.

While we find this result intriguing, it is somewhat difficult to interpret. It brings us back to an issue raised earlier, the temporal priority of music versus lyrics: for many of the songs in the corpus, we do not know whether the text or the music was written first. (For a number of the songs in the book, either the lyrics or the music, or both, are anonymous. And even when they are not, the order in which they were created would often be difficult to determine.) Let us assume, first of all, that the text of a song was written before the music. In that case, any correspondence in stress between the first two verses would seem to indicate the influence of a schematic pattern of stresses in the mind of the poet—that is to say, a poetic (as opposed to musical) meter. (As noted earlier, the existence of regular stress patterns in French poetry has generally been considered doubtful; "meter" in the context of French poetry usually refers only to the number of syllables in each line.) But now consider the possibility that the music of a song was written first and that words were

TABLE II. Stress levels of associated syllable positions in first (V1) and second (V2) verses.

V1 V2	Stressable	Unstressable	Total
Stressable	331	267	598
Unstressable	282	1019	1301
Total	613	1286	1899

later written for it. While it is possible, even in that case, that the lyricist was influenced by poetic meter and sought to maintain a consistent pattern of stresses across verses, it is also possible that they simply attempted to write a series of verses to the same melody, matching the stresses of the text to the musical meter in each case, and that the parallels in stress structure between verses arose as an indirect result of this process. Thus it is difficult to know whether poetic meter played any role in the regularities of stress patterns that appear in our corpus.

We also examined the relationship between verses in another way. We wondered, do first and second verses differ with regard to the alignment between stress and meter? Computing the SMAV in both cases, we find a significantly higher mean value for first verses than for second verses, $M_1 = 0.51$, $M_2 = 0.33$, $t(47) = 2.2$, $p < 0.05$. We believe this relates to the issue of the priority of music and lyrics, discussed in the previous paragraph. It seems quite natural to us that a composer creating music for a pre-existing text might focus primarily on the first verse, attempting to create a melody that matched the stress (and other aspects) of that verse with less concern for subsequent verses. By contrast, in the case where text was written for a pre-existing tune, it seems less likely that a lyricist would take special care to match the stresses of the text to the meter of the melody for the first verse and then give less attention to this issue for subsequent verses. Thus to the extent that first verses reflect stronger stress-meter alignment than second verses, this seems to suggest that, in general, the text preceded the music for the songs in our corpus. Obviously, the plausibility of this argument would vary from one song to another and, in some cases, would be outweighed by more concrete historical evidence regarding the priority of music versus lyrics.

Connections between music and language have recently become an area of great scholarly interest (for a survey, see Patel, 2008). Topics that have been explored include structural parallels (Lerdahl and Jackendoff, 1983), correlations between music and language across cultures (Patel and Daniele, 2003; Temperley and Temperley, 2011), and the localization of musical and language functions in the brain (Zatorre *et al.*, 2002; Peretz, 2006). We suggest here that music, and particularly vocal music, may also offer useful opportunities for the study of purely linguistic questions—in this case, the issue of stress distinctions in French. We believe that our method might be fruitfully applied to a number of other issues. With regard to French, it could be used to investigate emphatic stress, which Séguinot (1976) claims is becoming increasingly common, sometimes affecting as many as 35% of content words; one wonders if this is reflected in modern French popular music. The study of stress-meter alignment could also be valuable with regard to other languages. An advantage of this approach is that it permits the study of intuitions about stress in historical periods for which there are no longer any living informants; it could be used, for example, to study the historical evolution of stress patterns in English. We have also suggested that stress-meter alignment may shed light on musicological issues, such as the priority of music versus text. Altogether, the alignment between linguistic stress and musical meter

appears to offer a valuable and largely unexplored source of data with relevance to a variety of linguistic and musical questions.

APPENDIX: MONOSYLLABIC FUNCTION WORDS

The following words were labeled as monosyllabic function words in the corpus analysis. (Those ending in a schwa are monosyllables only when followed by a word beginning with a vowel, or when cut off by an apostrophe.)

1. Prepositions, conjunctions, determinants, pronouns, some adverbs

à au autre aux bien bord (in *au bord de*) *ça car ce ces cet cette ceux chez comme dans de des dès donc du elle elles en entre* (=*between*) *et eux fois fort* (in *fort bien*) *guère grâce* (in *à grace*) *il ils je jusque la là le les leur leurs loin* (in *de loin*) *lors lorsque lui ma mais me même mes moi moins mon ne ni nos notre nous on ou où par pas* (=*not*) *peu plus point* (=*not*) *pour près puis* (=*then*) *quand que quel quelle quelles quelque quels qui quoi rien sa sans se ses seul seule si son* (=*his/her*) *sous* (=*under*) *sur ta tant te tes toi ton* (=*your*) *tôt tous tout toute toutes très trop tu un une vers vos votre vous y*

2. Auxiliaries

Forms of *aller, avoir, devoir, être, faire, falloir, pouvoir*, when followed by another verb, but not when used as main verbs

3. Numerals

4. Nonsense syllables

coin dig din don nac nau no

[1]The term "full syllable" will be used throughout this paper to indicate any syllabified schwa that occurs at the end of a word, often called a "feminine ending." This word-final schwa is sometimes referred to as a "mute *e*" and is in fact often silent, but in some songs it is treated as a syllable; that distinction will emerge in the course of our discussion.

[2]Occasionally the note carrying a syllable in V1 does not carry any syllable in V2 or vice versa; this creates a "melisma" in which a note carries no syllable of its own but rather extends a syllable initiated on a previous note. In the current test, melisma notes were simply treated as unstressed syllables. Whether this is the correct approach is a complex question, but less than 1% of the notes (13 of 1899 in V1, 11 of 1899 in V2) were melisma notes, so it makes little practical difference.

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