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Dimensions of Rhythm: the multi-layered nature of rhythmic style

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Abstract

The paper motivates a new, musical, view on rhythmic variation that focuses on accent and pause distributions on the intonational phrase level and views accenthood broadly as an interplay between relative duration, relative intensity and pitch accentuation. The *musical approach to rhythmic variation* integrates the study of rhythm into the study of the rest of the prosodic landscape and aims to emphasize the importance of syntagmatic rhythmic variables: *rhythmic patterns*. The musical approach highlights dramatic contrasts in the use of rhythmic and prosodic resources on the part of Melody, a jock, and Judy, a burnout (Eckert 1989, 2000), two stylistic opposites and the stars of our investigation. Melody's IPs are characterized by a single accented syllable which often corresponds to the focal accent, while Judy's IPs contain multiple accented syllables and IP-internal pauses which together comprise a rhythmic pattern. In addition, 'disfluencies' in Judy's speech perform a rhythmic function. Judy's use of rhythmic patterns and the diversity in the phonetic realization of her accents suggest that she is more expressive in her use of prosodic resources, while Melody's rhythmic strategies reflect information structure.

Dimensions of Rhythm: the multi-layered nature of rhythmic style

Jeremy Calder and Daria Popova*

1 Introduction

Rhythm is a multidimensional phenomenon with exceptional stylistic potential. Rhythmic variation can be relativized to different domains: individual segments, individual words, expressions, intonational phrases, episodes. Rhythmic variables are very diverse as well: length of utterances in words, durational characteristics of sounds and sound segments, rhythmic make-up of particular words and expressions etc. Yet, the sociolinguistic studies of rhythm have usually focused on a single gradient contrast between stress-timing and syllable-timing phrased in terms of purely durational contrasts.

This paper analyzes 5 minutes of speech from each of two interviews that are part of a larger linguistic and ethnographic study conducted by Eckert (1989, 2000) at Belten High in the Detroit suburbs. The study identified two salient social groups: the burnouts, who were bound for the local work force, were urban-oriented, and rejected the school institution as the basis of social life, and the jocks, who were college-bound, school-oriented, involved in extracurricular activities. The two selected interviews represent two speakers who are stylistic extremes: Melody is the most squeaky-clean of the jocks, whereas Judy prides herself in being the most burned-out of the burnouts. Melody and Judy make radically different use of the elements of the Northern Cities Chain Shift (Eckert 2000) and, as we'll show, also differ in their use of rhythmic resources. The main goal of the paper is to highlight the rhythmic contrasts between the two speakers and to trace the contrasts to the differences in their styles.

We first approach rhythmic contrasts between Melody and Judy through the lens of the traditional approaches that aim to reveal durational contrasts between stressed and unstressed syllables. We show that although these approaches yield slightly different results for Melody and Judy, those results are neither statistically significant nor stylistically informative. Instead, we propose a new approach that looks at the accent distributions on the IP-level and treats accenthood as a combination of relative duration, relative intensity, and pitch accentuation. Since the new approach mimics the view on rhythm in music, we call it *the musical view on rhythm*. Overall, the new approach aims to promote *an integrated view on rhythm* that does not completely separate rhythmic and other prosodic resources. It also allows us to study syntagmatic variables, namely, *rhythmic patterns*, on par with paradigmatic variables.

The musical approach to rhythmic variation highlights dramatic contrasts in Melody's and Judy's use of rhythmic and prosodic resources. Melody's IPs turn out to be characterized by a single accented syllable in 71% of cases. The accent in those IPs is a focal accent that guarantees discourse congruence by signaling an explicit or implicit question under discussion. Even the IPs with multiple accents in Melody's speech reflect the same accentuation strategy that is geared towards information structuring concerns. On the contrary, Judy exploits a broader variety of accentuation strategies. In 24% of cases, her IPs resemble Melody's IPs in that they bear a single focal accent. In the majority of cases, Judy's IPs with multiple accents represent a particular rhythmic pattern that consists of a small IP followed by a short pause and a larger IP with multiple accents. Interestingly, the first element of the pattern, a small IP, is often realized by a 'disfluency', e.g. filled pauses, hesitations, repetitions, etc. This suggests that in Judy's speech, elements that may be characterized as 'disfluencies' perform a rhythmic function.

The use of rhythmic patterns, greater diversity in the phonetic realization of the accents, and the use of 'disfluencies' as rhythmic figures suggest that Judy uses rhythmic and prosodic resources more robustly, more emphatically and more unexpectedly that Melody does. This observa-

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tion aligns with Judy's overall more expressive persona. The use of the new methodology is thus necessary to provide a window into stylistic use of rhythmic resources.

2 The Musical View on Rhythm

The present paper aims to provide a stylistically informative study of rhythmic variation. Socio-phonetic studies of rhythm have usually focused on a single gradient contrast between *stress-timing* and *syllable-timing* (Pike 1945, Abercrombie 1967). Stress-timing describes a situation when the length of time from one stressed syllable to the next is approximately the same. In contrast, syllable-timing labels the cases when the length of time from one syllable to the next is relatively uniform, regardless of stress. The contrast between stress- and syllable-timing has been used to capture dialectal differences (e.g. Thomas and Carter 2006, White and Mattys 2007) and has been shown to be stylistically informative (e.g. Vaughn 2008, Callier 2011). Yet by its nature, stress- vs. syllable-timing is imposing a view on rhythm that is restricted to the study of purely durational contrasts between stressed/unstressed vowels and is only successful as long as the stylistic differences in the use of rhythmic resources can be attributed to these durational contrasts. Below we will mention a couple of limitations of the stress- vs. syllable-timing view on rhythm and, in particular, a number of potential rhythmic contrasts that this approach to rhythmic variation will fail to capture. The enumeration below does not aim to discard the stress- vs. syllable-timing view on rhythm, but rather to provide some preliminary illustrations of the idea that rhythmic variation can be far more diverse than the stress- vs. syllable-timing view alone would lead us to believe.

A number of measures have been proposed to capture the contrast between stress- and syllable-timing. Below we will focus on one of them, the normalized Pairwise Variability Index (nPVI) (Low and Grabe 1995, Low et al. 2000), but our remarks can be extended to the other measures as well.

(1) $nPVI = 100 \times \left[\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1) \right]$, where m is the number of vowels in the utterance and d_k is the duration of the kth vowel.

The first problem arises when one uses the nPVI formula as defined in (1). The formula appeals to the mean as a measure of variation. The mean, however, is one of the measures that are most sensitive to statistical outliers. Moreover, the substitution of the mean with a measure less sensitive to extremes, for example, the median, as attempted in Thomas and Carter 2006, would not completely solve the outlier problem. As Thomas and Carter (2006) point out, one would still need to exclude from the analysis 'predictable outliers', pauses and vowels in all prepausal feet that demonstrate phrase-final lengthening effects. It has been established, however, that precisely the elements that have to be excluded from the analysis to avoid the outlier problem, pauses and phrase-final lengthening, are stylistically loaded (e.g. Callier 2011).

Another problem related to the use of the mean as a measure of variation is that it does not allow us to see individual rhythmic moves that might be stylistically marked. Further problems occur when one considers the distribution of vowel durations on the IP-level. It is not hard to see that the mirror-distributions of vowel durations (e.g. 2,2,2,4 in the example below) receive the same nPVI-scores:

(2) $[2,2,2,4]_{nPVI} = [4,2,2,2]_{nPVI}$

A similar distributional problem arises when the contrast between stressed and unstressed vowels is realized not by the durational resources, but by some other means, for example, the intensity of the vowels. Again, nPVI would obscure dramatic rhythmic differences between the two IPs in (3) below.

(3) $[\mathbf{2},2,\mathbf{2},2]_{nPVI} = [2,\mathbf{2},2,\mathbf{2}]_{nPVI}$, where the durations of the stressed vowels are in bold.

The example above is suggestive of a bigger problem for the stress- vs. syllable-timing view on rhythm: rhythmic contrasts can be realized through a variety of means, with duration being only one of them, on par with, for example, intensity or pitch accentuation.

The list of the problems mentioned above is hardly exhaustive, but it highlights some limitations of the stress- vs. syllable-timing view on rhythm. In sum, rhythmic variation cannot be boiled down entirely to durational contrasts captured in the stress- vs. syllable-timing terms.

In what follows, we will show that nPVI does not seem to be successful in capturing the rhythmic contrasts between Melody and Judy. We will instead propose to look at rhythmic variation from a musical point of view. In particular, we will propose to look at accent distributions on the IP-level and to broaden the notion of accenthood so that it encompasses durational prominence, intensity, and pitch accentuation.

The musical approach to rhythm has a number of advantages for the study of rhythm as a stylistic resource. First, it aims to provide a clear-cut contrast in the number of accents per IP that might reflect different accentuation strategies that, in turn, might align with different styles. Second, the new approach does not isolate rhythm from other prosodic resources, for example intonational resources. Since styles are constellations of stylistic variables (Eckert 2008), an integrated view on rhythm is a clear advantage. Moreover, the musical approach allows us to study syntagmatic variables, rhythmic patterns. The notion of a rhythmic pattern turns out to be central for Judy's rhythmic style.

3 Methods

The data come from two sociolinguistic interviews conducted by Penelope Eckert at Belten High in the Detroit suburbs in the 1980s. One interview was conducted with Melody, the most squeaky-clean of the jocks, and the other with Judy, identified by herself and her peers as the most burned-out of the burnouts. The speakers were chosen based on their position in the social network at Belten High; each is representative of their social category, not because they are typical members, but because they are iconic in their extremity.

Five minutes of each interview were selected for analysis. The selections of the interview we analyzed exemplify Melody's and Judy's social positions as jock and burnout respectively. The assumption is that the linguistic styles corresponding to jock- and burnoutness would be most evident when the girls are talking about friends, activities, and practices: all things that define their positions as a jock and a burnout.

The five-minute sections from each of the two interviews were transcribed and aligned using the Penn FAVE (Force Align and Vowel Extraction) Aligner (Rosenfelder et al. 2011). A Praat script was written to group phone intervals into syllables in the aligned textgrid, based on the Maximum Onset Principle (Pulgram 1970, Selkirk 1981).

In order to characterize the specific rhythmic patterns at the level of the Intonational Phrase, it is necessary to first define an Intonational Phrase (IP) and what its boundaries are. This can be a subjective and impressionistic enterprise, and boundary identification isn't always straightforward. IP boundaries "seem to take on a bewildering variety of manifestations, from a clear pause accompanied by a local F0 fall or rise, to a subtle local slowing or pitch change that defies unambiguous definition" (Ladd 1996). In other words, IP breaks can be signaled by pauses, pitch falls, or any number of other phenomena, which may not always align. Previous studies employing IPs use pauses to delimit them; however, we find that not every pause corresponds to a division between IPs, but some pauses may be hesitations within an IP. Rather than using pauses, we use intonational contours as our main parameter in identifying IPs. An intonational contour whose shape is continuous comprises a single IP, whether or not pauses break up the stream of speech within that contour. In other words, we placed boundaries between IPs where there was a disruption in the shape of an intonational contour on the Praat pitch-tracker, i.e. the location where one contour ends and a new one begins. In order to combat the impressionistic nature of placing the boundaries between contours, the two of us each annotated IP boundaries. The results of the annotation process were compared and a case-by-case agreement was reached. Each IP was finally characterized for whether its intonational contour was rising or falling. Ultimately, 109 IPs for Melody and 84 IPs for Judy were analyzed.

In characterizing rhythmic patterns, we focused on two features: accents and pauses. Each annotator impressionistically marked each accented syllable in each IP on a tier in a Praat textgrid. Any accent that was not agreed upon by both annotators was discarded. Each accent that both annotators agreed upon was verified based on a number of instrumental parameters: pitch, duration, and intensity. A syllable was defined as durationally accented if its duration in milliseconds was greater than the durations of the surrounding syllables. Pitch accent was defined based on the Praat pitch tracker; if the syllable's pitch was higher than the pitches of the surrounding syllables, it was considered to have a pitch accent. Finally, intensity was checked based on the Praat intensity tracker. Any impressionistically accented syllable that was not accented based on one of these three instrumental parameters was not coded as accented in the final analysis.

Each annotator marked pauses on a separate tier in the Praat textgrid, and any pause that was not agreed upon by both annotators was discarded. Pauses were checked instrumentally in the spectrogram for whether there was a break in the speech stream of at least 45 ms. Any pause shorter than 45 ms was discarded. Finally, pauses were characterized for whether they were IP-internal or -external. Pauses that occurred under the scope of a single intonational contour were considered IP-internal. Pauses that fell between separate intonational contours were considered IP-external.

Finally, a number of measures were calculated for each speaker. A nPVI score was calculated for each speaker using a Python script, based on the durations of the syllable intervals in the Praat textgrid. For each IP, the following were calculated: number of syllables, IP duration, speech rate (in syllables per second), pitch standard deviation, and number of accented syllables. For each speaker's pauses, we calculated the percentage of pauses that were IP-internal.

4 Results

A number of characteristics were coded for each IP. The averages are shown in Table 1 below. For many of the characteristics, IPs behaved in the same way for both Judy and Melody. Both speakers uttered about 6 syllables per IP, had an average duration of about 1 second per IP, uttered about 5 syllables per second, had a pitch deviation of about 31-32 Hz per IP, and had similar nPVI scores, well within reported ranges for stressed-timed languages in previous studies. Despite these similarities, Judy was much more likely to have a rising pitch contour than Melody, with 25 percent of her IPs having a rising intonation, as compared with only 8 percent for Melody.

	Judy	Melody
Average # sylls / IP	5.583	5.983
Average IP duration	1089.046	1087.87
Average speech rate	5.046 sylls/s	5.384 sylls/s
% Rising IPs	25% (21 of 84)	8.257% (9 of 109)
Avg Pitch St Dev	32.224	31.367
Avg nPVI	0.626	0.583

Table 1: Average IP data for Judy and Melody.

	Estimate	Significance
Speaker (Melody)	-0.043	n.s.
IP Duration	-0.009	n.s.
# sylls	0.001	n.s.

Table 2: Factors conditioning nPVI for each IP.

As both Judy and Melody's average nPVI scores seemed similar, a fixed-effects linear regression was performed, with IP nPVI as the dependent variable, and speaker, IP duration, and number of syllables as independent variables. The results are displayed in Table 2 above. None of the factors emerged as significant predictors of nPVI, including speaker. In other words, Judy and Melody do not pattern significantly differently with respect to nPVI. Collapsing a speaker's rhythmic

performance into a single measure like nPVI does not capture any significant rhythmic difference between the two speakers.

In addition, the percentage of IP-internal vs. IP-external pauses was calculated for each speaker, and a chi square test was performed to test whether the difference between Judy's and Melody's use of pauses was significant. Judy was much more likely to use IP-internal pauses than Melody (p < 0.001), with 23 percent of her pauses being IP-internal, as opposed to Melody's 8 percent.
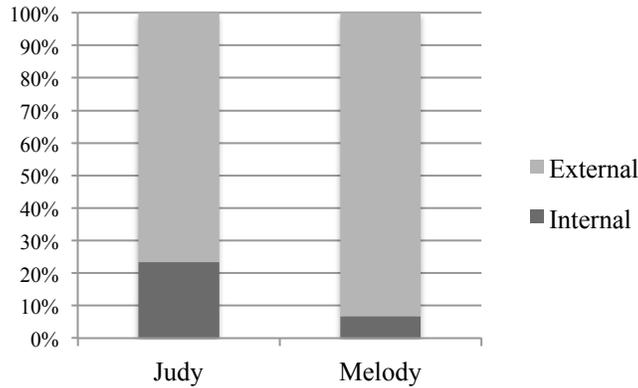

Figure 1: Internal vs. External Pauses

Finally, we examined the use of accented syllables in each IP. Number of accents per IP ranged from 1 to 4. As shown in Figure 2, almost 80 of Melody's IPs (71%) contained only a single accent, while only 20 of Judy's (24%) contained a single accent. On the other hand, Judy was much more likely to have 3 or 4 accents in a single IP than Melody.
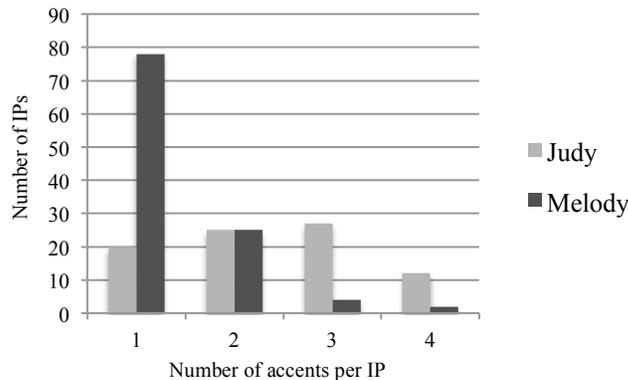

Figure 2: Accents per IP

In order to test whether the way the two speakers use accents in IPs was significantly different, a fixed-effects linear regression was performed with number of accents per IP as the dependent variable, and speaker, IP duration, and whether the IP was rising or falling as independent variables[2].

Both speaker and IP duration emerged as highly significant predictors of how many accented syllables an IP contains. Judy is much more likely to have a greater number of accented syllables in an IP (p < 0.001) than Melody, and longer IPs contain more accented syllables (p < 0.001).

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[2] A statistical model containing number of syllables per IP as an additional independent variable was run, but since it was not significant, it was not included as a factor in the final model.

	Estimate
Speaker (Melody)	-0.869***
IP Duration	0.001***
Rising/Falling (R)	0.122 (N.S)

***Significant at the p < 0.001 level

Table 3: Factors conditioning accents per IP.

5 Discussion

In the previous section we saw that the difference between Melody's and Judy's nPVI scores is not significant. In contrast, Judy and Melody show highly significant differences in their use of accents and pauses. Judy demonstrates a great variation in phonetic realization of accents. Her speech is characterized by a significant amount of IP-internal pauses. The majority of her IPs have multiple accents. Melody shows less variation in duration and pitch and sounds more monotone. Her speech contains less IP-internal pauses and less IPs with multiple accents than Judy's speech does. Given that IPs usually have a single focal accent, and that pauses often align with IP boundaries, we assume that IPs with one prominent accent and no IP-internal pauses are unmarked. Therefore, Judy's IPs tend to be marked, whereas Melody's IPs tend to be unmarked. In what follows we argue that the statistical facts are not unrelated; they reflect two different rhythmic strategies that Judy and Melody use.

5.1 Judy's rhythmic strategy

Judy's speech demonstrates rhythmic regularities that are not characteristic of Melody's speech. These regularities lead to a quantitative dominance of IPs with multiple accents and to the presence of IP-internal pauses. In what follows we propose to capture these regularities in terms of rhythmic patterns, or distributions of accents and pauses on the IP-level. The definition of a pattern crucially depends on the view on accents adopted in this paper that regards relative intensity, pitch and relative duration as potential sources of accenthood.

   The prevalent pattern in Judy's speech is presented below.

(4) **The pattern:**
   [(x _)$_{IP}$ ∨ (x_x_x)$_{IP}$]$_{clause}$,
   where **x** is a stressed syllable, _ is a sequence of unstressed syllables, and ∨ is an optional short pause.

   The pattern in (4) consists of a short IP with a single accented syllable, a short pause, and a second IP that contains multiple accented syllables (usually three), each separated by one or two unstressed syllables. It is important to note that the first IP (or its elements on the right edge) is often pronounced in a creaky or breathy voice, and the following short pause is often glottalized.
   Examples (5) and (6) illustrate the typical realization of the pattern; accented syllables are in bold, elements that are pronounced in breathy or creaky voice are italicized.

(5) [(**All** sixth)$_{IP}$ ∨ (**we** had **so** much **fun**)$_{IP}$]$_{clause}$
(6) [(***Damn***)$_{IP}$ ∨ (**we** did some **cra**zy **shit**)$_{IP}$]$_{clause}$
(7) [(**Oh** my **God**)$_{IP}$]$_{clause}$

   It should be noted that the pattern is not always fully realized. In (7), the initial short IP is absent, and the longer IP contains only two accents.

5.2 Disfluencies?

As shown in (4), the first part of the pattern is a short IP. In (5) and (6) above, we saw that it can be filled with words that contribute new propositional or expressive information. Another source of the material in this slot is what one might otherwise consider to be disfluencies.

(8) [(**We** *uh*)$_{IP}$ ∨ (**dressed** up as sar**dines** you **know**)$_{IP}$]$_{clause}$

(9) [(**We**)$_{IP}$ ∨ (**we** got ar**res**ted be**fore**)$_{IP}$]$_{clause}$

In (8), the first slot is filled with the subject material and a filled pause. Note that the filled pause at the end of the first IP in (8) is pronounced in a creaky voice, a trait that is characteristic of the pattern in (4). The utterance in (9) contains *we* in its first slot, which is reduplicated in the following IP.

Examples (8) and (9), which contain possible 'disfluencies', are rhythmically parallel to examples (5) and (6), which are typical instantiations of Judy's rhythmic pattern. Therefore, 'disfluencies' in Judy's speech might not be real disfluencies, but rather they have a rhythmic function. They are rhythmic figures that fill the initial slot of the pattern in (4). Specifically, Judy often inserts a duplicated word and filled pause into this initial slot when it is not already occupied by other lexical material.

5.3 Melody's rhythmic strategy

Melody does not use patterns like the one shown in (4), but rather employs a different rhythmic strategy. Her IPs are characterized by a single accent in 71% of cases. Close examination of these accents shows that they are focal accents that signal an explicit or implicit question Melody engages with.

(10) (She was my **first**$_{FOC}$ friend)$_{IP}$

Example (10) is uttered in a context when Melody is talking about her group of friends. The focal accent of *first* differentiates her *first friend* from other friends she is discussing.

(11) PENNY: Do you think uh you'll keep a lot of your high school friends after you graduate?
MELODY: (Not a **lot**$_{FOC}$)$_{IP}$ (I'm pretty **sure**$_{FOC}$ I'll keep **Karen**$_{FOC}$)$_{IP}$ (In **fact**$_{FOC}$)$_{IP}$ (I'm almost **positive**$_{FOC}$ I **will**$_{FOC}$)$_{IP}$ (Um probably **Bessie**$_{FOC}$ too)$_{IP}$

Even in Melody's IPs with multiple accents the accents correspond to focal accents. In (11), the focal accents signal that Melody engages with a question that posits both her belief state and the friends she would like to keep as alternatives.

Judy also uses the focal accentuation strategy on par with the pattern we discussed above.

(12) PENNY: And that was like, in seventh grade? Sixth grade?
JUDY: (No uh in **eighth**$_{FOC}$ grade.)$_{IP}$

Her use of the focal accentuation strategy is, however, non-prevalent and is restricted to the IPs with a single accent (24% of cases).

5.4 Rhythmic variation feeding styles

The musical view on rhythm that focuses on the accent distributions on the intonational phrase level and views accenthood broadly as an interplay between relative duration, relative intensity and pitch accentuation allows us to arrive at dramatic contrasts in Melody's and Judy's uses of rhythmic and prosodic resources.

Melody's rhythmic strategy is geared towards expressing focal accents. The accents in her IPs are placed to guarantee discourse congruence. They signal which explicit or implicit question is under discussion. This suggests that Melody's use of rhythm can be viewed as more 'interactive': her accents reflect information structure, and her use of pauses reflects IP/clause structure. Melody's use of rhythmic resources is also unmarked if one assumes that by default, an IP has a single accent and no internal pauses.

Judy is a stylistic opposite of Melody. Her use of rhythmic strategies that are not employed by Melody reinforces the stylistic opposition. Judy's IPs are characterized by multiple accents in 76%

of cases and by IP-internal pauses in 23% of cases. On the assumption that an IP, by default, has a single accent and no internal pauses, Judy's IPs are more rhythmically marked than Melody's. The use of a pattern with multiple accented syllables aligns with Judy's more expressive persona. It also suggests Judy is using accents, pauses, even elements that one might otherwise describe as 'disfluencies' for rhythmic purposes. Diversity in the phonetic realization of accents enhances the drama of Judy's narratives.

Thus, the musical view on rhythmic variation proves vital for the stylistically informative study of rhythm.

6 Conclusion

The paper motivates a new, musical, view on rhythmic variation that focuses on accent distributions on the intonational phrase level and views accenthood broadly as an interplay between relative duration, relative intensity and pitch accentuation. The musical approach to rhythmic variation integrates the study of rhythm into the study of the rest of the prosodic landscape and aims to emphasize the importance of syntagmatic rhythmic variables: rhythmic patterns.

The musical approach highlights dramatic contrasts in the use of rhythmic and prosodic resources on the part of Melody and Judy, two stylistic opposites and the stars of our investigation. Melody's IPs are characterized by a single accent in 71% of cases. The accent in those IPs is a focal accent that guarantees discourse congruence by signaling an explicit or implicit question under discussion. Even the IPs with multiple accents in Melody's speech reflect the same accentuation strategy that is geared towards the information structuring concerns.

Judy exploits a broader variety of accentuation strategies. In 24% of cases, her IPs resemble Melody's IPs in that they bear a single focal accent. The tendency for Judy's IPs to have multiple accents and to contain IP-internal pauses can be traced back to the fact that Judy uses a rhythmic pattern that consists of a short IP with one accent followed by a short pause and a longer IP with multiple accents. The initial short IP is often realized by elements that one might describe as 'disfluencies', suggesting that these so-called 'disfluencies' are performing a rhythmic function in Judy's speech.

Judy's use of rhythmic patterns and the diversity in her phonetic realization of accents suggest that she is more creative in her use of prosodic resources. She uses them more emphatically than Melody does. This observation aligns with Judy's overall more expressive persona.

References

Abercrombie, David. 1967. *Elements of General Phonetics*. Edinburgh: Edinburgh University Press.

Callier, Patrick. 2011. Social Meaning in Prosodic Variability. In *U. Penn Working Papers in Linguistics*, 17:41–50.

Eckert, Penelope. 1989. *Jocks and Burnouts: Social Identity in the High School*. New York: Teachers College Press.

Eckert, Penelope. 2000. *Linguistic Variation as Social Practice*. Oxford: Blackwell.

Eckert, Penelope. 2008. Variation and the indexical field. *Journal of Sociolinguistics* 12:453–476.

Ladd, D. Robert. 1996. *Intonational Phonology*. Cambridge: Cambridge University Press.

Low, Ee Ling and Esther Grabe. 1995. Prosodic patterns in Singapore English. In *Proceedings of the 13th International Congress of Phonetic Sciences*, ed. K. Elenius and P. Branderud, 636–639. Stockholm: KTM and Stockholm University.

Low, Ee Ling, Esther Grabe, and Francis Nolan. 2000. Quantitative characterizations of speech rhythm: Syllable-timing in Singapore English. *Language and Speech* 43:377–401.

Pike, Kenneth L. 1945. *The Intonation of American English*. Ann Arbor: University of Michigan Press.

Pulgram, Ernst 1970. *Syllable, word, nexus, and cursus.* Mouton: The Hague.

Rosenfelder, Ingrid, Josef Fruehwald, Keelan Evanini, and Jiahong Yuan. 2011. FAVE (Forced Alignment and Vowel Extraction) Program Suite. http://fave.ling.upenn.edu.

Selkirk, E.O. 1981. English Compounding and the Theory of Word-structure. In *The Scope of Lexical Rules*, ed. M. Moortgat, H. Van der Hulst, and T. Hoestra. Dordrecht: Foris.

Thomas, Erik R. and Phillip M. Carter. 2006. Prosodic rhythm and African American English. *English World-Wide* 27:331–355.

Vaughn, Charlotte. 2008. Effects of discourse factors on prosodic rhythm: Evidence from inter- and intra-speaker variation in Hispanic English. Paper presented at NWAV 37, Rice University.

White, Laurences and Sven L. Mattys. 2007. Calibrating rhythm: First language and second language studies. *Journal of Phonetics* 35:501–522.

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