ON THE INTERACTION OF CLASH, FOCUS AND PHONOLOGICAL PHRASING[1]

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ABSTRACT

This paper examines several phonetic and phonological issues related to the rhythmic form of English sentences. Specifically, we are concerned with the acoustic cues signaling the Rhythm Rule as well as the ways phonological phrasing, clash and focus contribute to the application of this rule. On the basis of acoustic and a TOBI style pitch accent analysis of a relatively large corpus of sentences read by 5 subjects, we show how (Phonological) Phrase Final Lengthening and focus have especially strong effects on the duration of our target words, and in particular on the final (as opposed to the first) rhyme of the words. On the basis of the application and specific manifestation of the Rhythm Rule, we found that narrow focus on a word seems to induce a break immediately following it, as was expected. It also appeared that focus may induce a break before the word, contrary to our expectations, leading to more complex analysis of the acoustic effect of focus in the relevant contexts.

1. INTRODUCTION

A variety of factors contribute to the final prosodic, and in particular, rhythmic, form of an utterance. Three major contributors, phonological phrasing, clash and focus are examined here to determine the relative roles they play and the ways in which they interact. A number of studies have addressed these issues from a theoretical perspective, (e.g. Selkirk 1984, Nespor & Vogel 1986, Nespor & Vogel 1989, Kenesei and Vogel 1996, among others), while others have addressed the acoustic correlates of the phenomena in question (e.g. Beckman et al. 1987, Beckman et al. 1990, Beckman & Edwards 1994, Shattuck-Hufnagel 1991, among others). In both realms, the results are somewhat controversial, and in the latter, in particular, the experiments typically do not involve adequate observations for reliable statistical analysis. Our paper addresses this lacuna by using a sufficiently large corpus of data to systematically examine the acoustic effects of phonological phrasing, clash and focus on the rhythm of sentences. The results of our experiments are, furthermore, used to evaluate several theoretical claims made about the same issues.

2. METHODOLOGY

Eight basic sentences were built around two target words with iambic stress patterns that are susceptible to the Rhythm Rule (RR), <u>Chinese</u> and <u>thirteen</u>, as illustrated in (1). These stimulus sentences varied such that a) they either did or did not contain a stress clash involving the target word, and b) the target word either was or was not in the same Phonological Phrase (PPh) as the following word (PPh as defined in Nespor & Vogel 1986). The target word is underlined.

(1)	Sentence	Clash	Same PPh
	a. The <u>thirteen</u> clients called at noon.	YES	YES
	b. The <u>thirteen</u> cadets called at noon.	NO	YES
	c. The <u>thirteen</u> conned their lawyer.	YES	NO
	d. The <u>thirteen</u> collapsed at noon.	NO	NO

Two additional control sentences were also used to confirm the basic iambic stress pattern of the targets:

(2) a. It takes <u>thirteen</u>. b. They're <u>Chinese</u>.

Each target appeared in three conditions relative to focus in the sentence, with focus a) on the target, b) directly after the target and c) on the last word. The stimulus sentences alternated with filler sentences with different structures, and questions asking about different parts of the sentences.

Five undergraduates were recorded reading a total of 26 randomized target sentences (interspersed with fillers) 10 times each. The recordings were made in a sound dampened booth. Each sentence first appeared on the computer screen and the subject read it. The subjects then heard a question that was intended to induce a focus on one of the three positions of interest in the sentence, as illustrated in (3). They then saw the same sentence, which they read as a response to the question they had just heard. That is, for each target sentence, there were three types of responses, corresponding to the three focus conditions. Only the productions of the sentences that were provided in response to the focus-inducing questions were analyzed.

(3) *Target Sentence:*	*The 13 clients called at noon.*
a. Focus on target (W1):	Which clients called at noon?
b. Focus after target (W2):	The 13 what called at noon?
c. Focus on final word (W3):	When did they call?

The subjects were told that they were participating in an experiment on communication via a noisy intercom, communicating with the experimenter who was in another room, to make the questions seem more plausible. The questions were actually prerecorded and presented by an interactive program. Each subject received a different randomized order of the sentences and questions.

Each sentence/question pair was presented a total of 10 times (=260 sentences per subject). After the first set of responses was discarded, measurements were made of the next six acceptable repetitions, digitized at an 8 kHz sampling rate with appropriate prefiltering. The duration of the first and last rhymes of the target were measured. A TOBI style pitch accent transcription analysis of the sentences has also been carried out. Amplitude, the remaining putative correlate of stress was not investigated, since it was found in previous research not to be statistically reliable (cf. Vogel, Bunnell & Hoskins 1995).

3. RESULTS AND DISCUSSION

A within subjects repeated measures ANOVA was performed only on the duration measurements of the final rhymes of the 5 subjects (cf. Tables 1 and 2), the other factors that are often taken to be manifestations of stress, duration of the first rhyme, pitch and amplitude, having been found not to yield significant results in earlier work (cf. Vogel, Bunnell & Hoskins 1995). For the final rhyme duration analysis, the planned comparisons were orthogonal contrast codes for the phonological phrase (PPH), clash (CLASH) and two codes for focus. The first code (FOCUS1) tested focus on the target (W1) against the average of the other two (W2, W3). The second code (FOCUS2) tested focus after the target (W2) against final focus (W3). As can be seen in Table 1, the results of the ANOVA reveal main effects for CLASH, PPH and FOCUS1. Significant interactions are observed for CLASH x PPH, CLASH x FOCUS1, CLASH x PPH x FOCUS1. Note that there were no main effects for FOCUS2 and only one significant interaction (FOCUS2 X PPH).

Turning now to an examination of the results in relation to the phonological questions we are concerned with, let us consider the actual durations of the final rhymes in the different conditions, shown in Figure 1.[2] The most obvious result is the significant overall increase in duration of the target when this word is focused. While both the final rhyme and the first rhyme (cf. Figure 2) show increased duration in all clash and PPh conditions, as compared with their durations when focus is on either of the other two positions, the extent of lengthening of the first rhyme is relatively small compared to that of the final rhyme. The durations of the target (W1) rhymes are essentially not distinguishable between the conditions with focus on W2 and W3.

The well known effect of (phonological) phrase final lengthening (PFL) is also evident in Figure 1. The most crucial evidence is the comparison of the no clash conditions in 1 vs. 2 PPhs, in particular where focus is on W3, and thus does not directly affect the phonological phrasing of the words in question. The strength of this effect is further confirmed by its presence in the condition in which focus is on W1; it is not observed, however, where focus follows the target, points we return to below. As can be seen in a comparison of Figures 1 & 2, furthermore, PFL lengthens only the final rhyme of the target; the first rhyme actually shows the opposite pattern.

As was expected from previous experiments (cf. Vogel, Bunnell & Hoskins 1995), clash within a single PPh has the effect of shortening the final rhyme of the target word, but not of lengthening the initial rhyme. This is revealed in the condition where focus is on W3, and the clash context itself is essentially free of the influence of particular focus patterns (cf. Figures 1&2). While the clash effect within a single PPh was highly significant in the Vogel et al. study, the present results only show a tendency in the same direction. We, nevertheless, take the results to be consistent with a deletion analysis of the Rhythm Rule (cf. Vogel et al. 1995). One possible explanation for the weaker effect of clash in the present study is that the number of exemplars on which we base our analysis here represents only about 1/3 the number of exemplars analyzed in the previous study. In addition, the weaker effect might be due to the narrow focus on W3, since the presence of such focus on a given word tends to reduce the accents of other words in the same sentence (cf. discussion of pitch accent analysis below). Both possibilities would need to be further evaluated on the basis of additional data.

A more complex pattern emerges when we examine the effect of focus on the target and the immediately following word in the different PPh and clash conditions. As Fig. 1 reveals, focus on W1 results in lengthening of the final rhyme in the clash context, as opposed to the no clash context, in both the 1PPh and 2PPh conditions. Note that this lengthening is precisely what was revealed by the highly significant interaction for CLASH X FOCUS1 seen above in the ANOVA results. Such a lengthening pattern is what is predicted for clashes across PPh boundaries (i.e. 2PPh condition) on the basis of Nespor & Vogel (1989), where focus was not taken into

2. The figures follow on the next page.

Table 1: ANOVA results for final rhyme duration

Main Effects	F(1,4)	Pr>F
CLASH	**133.71**	**0.003**
PPH	**10.25**	**0.033**
FOCUS1	**33.19**	**0.005**
Interactions		
CLASH X PPH	**19.79**	**0.011**
CLASH X FOCUS1	**47.04**	**0.002**
PPH X FOCUS2	**8.13**	**0.046**
CLASH X PPH X FOCUS1	**9.64**	**0.036**

Table 2. Mean Durations of Final Rhyme

	1PPH		**2PPH**	
Focus	**No Clash**	**Clash**	**No Clash**	**Clash**
W1	**253.6**	**259.2**	**269.2.**	**299.4**
W2	**161.2**	**160.7**	**155.3**	**169.1**
W3	**159.2**	**153.6**	**167.6**	**171.4**

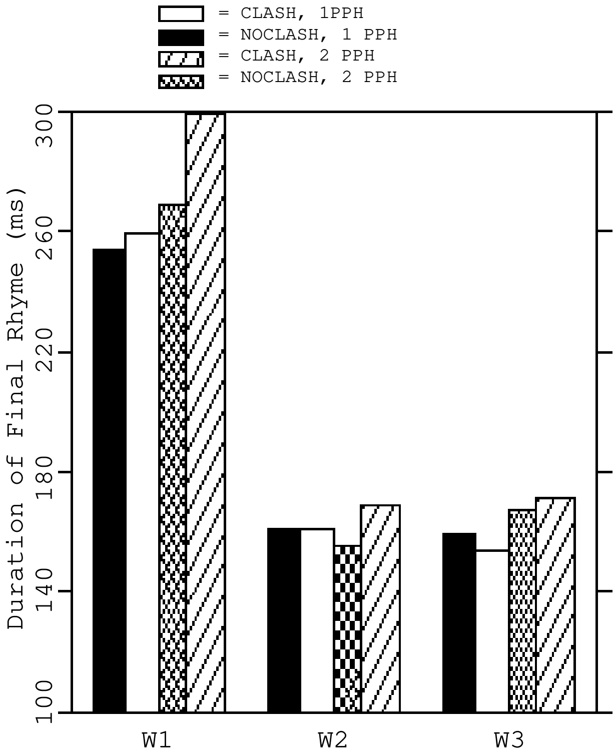

Figure 1 Final Rhyme Duration

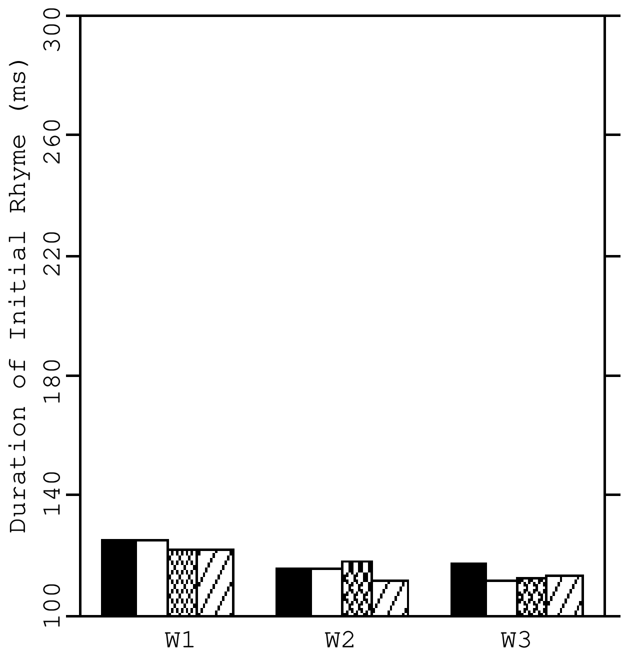

Figure 2 Initial Rhyme Duration

consideration. The fact that even the words originally considered to be in a single PPh show the pattern associated with two PPhs is taken as evidence of the introduction of a PPh boundary to the right of the focused word, as proposed in Kenesei & Vogel (1996). The effect of this PPh boundary is to split W1 off from W2 when these would have otherwise been in the same PPh. As a result, the clash remedy is lengthening of the final rhyme of W1, as if it were a clash across two PPhs, as opposed to the shortening of this rhyme, the pattern found when the two words are, in fact, within a single PPh. The durations in the present study are even longer when the words in question were originally assigned to separate PPhs, as revealed by the highly significant CLASH X FOCUS1 X PPH interaction seen in the ANOVA results. This additional lengthening indicates an effect of PFL beyond that induced by the presence of focus on the target and the resultant phonological phrase break that presumably follows it. Although we do not want to claim that there is a simple additive effect of boundaries, it nevertheless seems that speakers continue to distinguish between those boundaries created solely by the presence of focus and those that also correlate with the location of prosodic domain junctures determined by the syntax-phonology mapping.

It is also proposed in Kenesei and Vogel (1996) that the presence of focus on a word causes it to group phonologically into a unit (i.e. PPh) with the previous material, in essence erasing a PPh boundary between a focused word and what precedes it, if there was originally a boundary in that location. The result we would thus expect is a change in clash behavior, such that the chosen remedy is shortening of the target rhyme, as if it were contained within a single PPh with the following (focused) word. What is observed, however, is that even when the words in question originate in the same PPh, they do not exhibit the usual decreased duration associated with a clash (and the application of the RR) in this context. In fact, what we see in Figure 1 is that the clash and no clash conditions yield essentially the same durations, which might be interpreted as evidence of the presence of a PPh boundary in that position. Similarly, in the cases of clash vs. no clash across original PPh boundaries, we fail to observe the shortening of the final rhyme of the target that we expected as the indicator that the boundary in question was, in fact, removed.

A possible interpretation of these results is that focus on W2 causes it to be prosodically isolated from the material on both the left and right sides. If the PPh is the domain of the Rhythm Rule, this would mean that a focused word forms a PPh on its own, not participating in phonological rules such as the RR with its neighboring words. This would be a somewhat surprising conclusion, given that in a perceptual test (cf. Kenesei & Vogel 1996), it was found that the incidence of the RR increased markedly across PPhs when W2 was focused. One factor that may be relevant here is that this was the only condition in which we observed great variation across the individual subjects, some exhibiting the expected pattern, others exhibiting a variety of different patterns. While the RR is generally a somewhat variable phenomenon, we found much more consistent behavior in the other two focus conditions. The reason for this increased variability may derive from another pattern that emerged with our analysis of the distribution of pitch accents in the data.

A TOBI style prosodic analysis of the data of all 5 subjects revealed several patterns. First, as is to be expected, the focused word in each sentence always contained a final pitch accent (PA) followed by boundary tones (L-L%). 82% of the accents were L+H*; the remaining 18% were H*. As shown in Table 3, we also found a strong tendency to maintain an accent on W1, even when focus is on the following word or on the final word in the sentence. By contrast, there was virtually never a PA on W2 or W3 unless it was focused.

Table 3. Percent Presence of Pitch Accent on each Word in each Focus Condition

Focus	Word1	Word2	Word3
W1	100%	0%	0%
W2	29%	100%	0%
W3	66%	2.5%	100%

The presence of a PA on W1 when it was not focused appears to be an indication of a general tendency to assign prominence at or near the beginning of a sentence, as a signal of the sentential onset. The relatively greater presence of accent on W1 when focus is on W3 as opposed to W2 may, in turn, indicate a type of prosodic conflict when focus is on W2. Such a conflict may be avoided by not placing a PA on W1, as was the case 71% of the time. This conflict may also be the cause of the greater variability in the clash resolution strategies observed when focus is on W2, as mentioned above. The weakening of W1 (i.e. the absence of PA) when focus follows on W2 may result in an already shortened target, and hence one that is not regularly subject to the shortening associated with PPh-internal clashes, the usual manifestation of the RR in this context. The fact that the RR was nevertheless perceived quite regularly when focus is present on W2 (cf. Kenesei & Vogel 1996) must be interpreted as an indication that, at least in the presence of a following focus, duration is not the primary cue to the application of this rule. Instead, the absence of a PA on the expected position in W1 may lead listeners to perceive the pattern as if a shift in stress had taken place. The actual duration effects of the RR may then only be found when both words carry a PA. Our data are only suggestive thus far; analyses specifically designed to test these possibilities are needed to evaluate them adequately.

4. CONCLUSIONS

In this paper, we have analyzed the interactions of clash, focus and phonological phrasing on the basis of a relatively large corpus of data, collected under systematically controlled conditions. We have related the results of our acoustic analyses to a number of theoretical claims about the phonology of these phenomena, and in this way are able to gain insight into some of their physical correlates. Specifically, we found significant lengthening effects of PPh boundaries and of focus on the target. While the former only affected the final rhyme, the latter affected the first rhyme as well, though to a much lesser extent than the effect on the final rhyme. Support was found in several conditions for the claim that clashes across PPhs result in lengthening of the target rhyme, as opposed to the shortening observed within a single PPh. Focus on the target was found to induce a PPh break following this word, as manifested by the clash remedy observed in this context. Contrary to expectations, however, focus on W2 was not found to eliminate the PPh boundary between it and the target, the word immediately to its left, in the sense that it did not result in increased application of the shortening of the final rhyme associate with the RR in this context. The extensive individual variation observed in this condition, however, leads to the conclusion that more clash remedies may be available in the presence of focus, and that the primary cue to the RR in these cases is something other than duration, most likely a pitch-related phenomenon, although at present we have no significant results that indicate this.

5. REFERENCES

1. Beckman, M., de Jong, K. and Edwards, J. “The surface phonology of stress clash in English,” Paper presented at the Annual LSA Meeting, 1987.

2. Beckman, M., Swora, M., Rauschenberg, J. and de Jong, K. “Stress shift, stress clash, and poly-syllabic shortening in a prosodically annotated discourse,” *Proceedings of the International Conference on Spoken Language Processing*, 5-8, 1990.

3. Beckman, M. and Edwards, J. “Articulatory evidence for differentiating stress categories,” In P. A. Keating (ed.)*Phonological Structure and Phonetic Form: Papers in Laboratory Phonology III*., Cambridge University Press, Cambridge, 7-33, 1994.

4. Kenesei, I. and Vogel, I. “Focus and phonological structure,” Ms. University of Szeged and University of Delaware, 1996.

5. Selkirk, E.O. *Phonology and Syntax,* MIT Press, Cambridge, MA, 1984.

6. Shattuck-Hufnagel, S. “Acoustic correlates of stress shift,” *Proceedings of the XIIth International Congress of Phonetic Sciences, Aix-en-Provence*, 4:266-269, 1991.

7. Nespor, M. and Vogel, I. *Prosodic Phonology*, Foris, Dordrecht, 1986.

8. Nespor, M. and Vogel, I. “On clashes and lapses,” *Phonology Yearbook*. 6:69 -116, 1989.

9. Silverman, K. M. Beckman, et al "ToBI: A standard for labeling English prosody" In *Proceedings, Second Intl. Conf. on Spoken Language processing* 2,867-870, 1992.

10. Vogel, I., Bunnell, H.T. and Hoskins, S. “The phonology and phonetics of the Rhythm Rule,” In B. Connell and A. Arvaniti (eds.) *Phonology and Phonetic Evidence: Papers in Laboratory Phonology IV*, Cambridge University Press, Cambridge, 111-127, 1995.