

## Pitch and duration of yes-no questions in Nchufie

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### 1. Introduction

This paper will present a preliminary phonetic description of yes-no questions in Nchufie (also known as Bafanji), a Grassfields Bantoid language of the Nun group in the Mbam-Nkam family spoken in Northwestern Cameroon by approximately 8,500 people (Grimes 1988). As there is no published description of this language, a very brief review of the Nchufie segment inventory will be in order. Following this, an instrumental description of the yes-no questions in the language will be presented, focusing on the prosodic cues of duration and pitch. Of special interest will be the interaction of intonation with lexical tone and the representation and cross-linguistic significance of Nchufie yes-no question formation. Below is a brief description of the phonetic segment inventory of Nchufie. Due to the complexities of Nchufie phonology and tonology, the following description should be considered preliminary only; the details are not well understood.

#### *Consonants*

The surface consonants are shown in the chart below. Aspiration is contrastive in stops, except at the velar place. The dental stops are articulated laminally. The voiced velar fricative shown alternates with [g], and a palato-alveolar fricative alternates with the alveolar fricative before high vowels. The velar nasal is the *only* coda consonant permitted. Onset clusters of nasal plus voiceless stop also occur. Because of complications with creaky voice—treated as a property of vowels here—the status of ʔ, if present at all, is unclear.

	labial	labio-dental	dental	post-alveolar	palatal	velar	labialized velar	labial-velar
plosives	p <sup>h</sup> p		t <sup>h</sup> t			k <sup>h</sup>	k <sup>w</sup>	
affricates				tʃ dʒ				
nasals	m	ɱ	n		ɲ	ŋ	ŋ <sup>w</sup>	
prenasalized	mb		nd	ndʒ		ŋg	ŋg <sup>w</sup>	
fricatives		f v	s z			ɣ	ɣ <sup>w</sup>	
approximants			l		j			w

#### *Vowels*

The language has three vowel heights and front, central, and back places of articulation. The back vowels are rounded and the front and central unrounded. These

vowels will be transcribed: i, e, a; u, ə, ɑ; u, o, ɔ ([i] alternates with [ɪ] in closed syllables). Vowels may be contrastively nasal and oral, long and short, and, if long, have creaky and modal phonation types. Only short vowels may occur in closed syllables. The diphthongs [uɔ], [ɑi], [uə], and [ie] also occur.

### *Tones*

Four tonal patterns occur on monosyllabic lexical items. These are a level high tone (represented here as H), a level low tone (represented as L), a falling pattern (represented as HL), and a rising pattern (represented as LH). The nasal portions of prenasalized consonants always occur with a low pitch in lexical items. This low pitch plays no role in the tonology. Mid and superhigh occur in particular syntactic constructions, for example, superhigh occurs in the past tense construction. Downstepped highs also occur, for example in some cases of adjacent highs. No claims as to the phonological units involved are intended in the following phonetic study of yes-no questions.

### *Question marking*

A language's yes-no questions may be marked morphologically, syntactically, intonationally, or by some combination of these mechanisms. When marked intonationally, this kind of question generally has either a terminal rise or a higher overall fundamental frequency. In a sample of 53 languages, Ultan (1978, cited in Shen 1991) found that 71.7% had a rising intonation and 34% had an overall higher F<sub>0</sub> in yes-no questions. Only 5.7% had a falling contour (Ultan 1978). In Nchufie, yes-no questions are not marked segmentally but rather marked by intonation and localized lengthening. I will suggest that Nchufie presents a case of question marking which is very unusual in the world's languages. First, final lengthening is the most salient feature marking a yes-no question; the final rhyme in the question domain is lengthened almost 70% compared to the declarative statement. Secondly, Nchufie shows two intonational mechanisms at work. In the question, a higher pitch range occurs which is distinct from a final rise or high raising (upstep), and from an overall higher F<sub>0</sub>, as phrase final lexical low tones are not affected. Most interestingly, in the question we see an optional final lowering of phrase final high tones. While this is a preliminary study on a language never previously examined, the data suggest that Nchufie is an important language in the investigation of universals of the formation of yes-no questions. Finally a brief discussion of apparently similar data in Hausa and problems for future research will be presented.

## **2. Method**

### *Data Collection*

Monosyllabic, modal voice nouns were selected as target words and inserted in the carrier phrase [ā ɣé \_\_\_\_], meaning either "He has a \_\_\_\_" or "Does he have \_\_\_\_?" depending on whether it is spoken with statement intonation or question intonation. The nouns included all four tonal patterns: H, L, HL, and LH, and all possible rhyme types: CV, CV<sub>1</sub>V<sub>2</sub>, CVN, and CV<sub>1</sub>V<sub>1</sub>. The target words used in this experiment are shown in Table 1. A fully balanced set could not be obtained with the lexical data collected thus far within the constraints of monosyllabicity and modal voice. These constraints were applied in order to minimize variation in the interaction of lexical and intonational tone and to simplify automatic pitch tracking.

Table 1. Target words used, arranged by rhyme type and tone pattern.

	CV		CV <sub>1</sub> V <sub>2</sub>		CVN		CVV	
H	t <sup>h</sup> w ndzwi ma	'tree' 'cloth' 'mother'	muɔ	'fire'	kuŋ kɔŋ sɔŋ ŋ <sup>w</sup> ŋ	'ant' 'bed' 'friend' 'machete'	laa	'lamp'
L	ntʃɔ ŋgɔ̃ ŋkɔ	'mouth' 'stranger' 'box'	fuɔ fuɔ̃	'chief' 'key'	puŋ niŋ	'stomach' 'animal'	kɔɔ kuwu pɛɛ	'foot' 'barn' 'bag'
LH	ŋki ku ŋkū	'water' 'pot' 'back'	fuɔ fuɔ	'leaf' 'medicine'	ŋgwaŋ ndzɪŋ zɪŋ	'corn' 'brother' 'brothers'	ŋg <sup>w</sup> ɔ̃ɔ̃	'plaintain'
HL	ndzə li p <sup>h</sup> u ŋk <sup>w</sup> e	'egg' 'name' 'ashes' 'firewood'	p <sup>h</sup> uɔ ŋkuə ndie	'arm' 'bush' 'neck'	puŋ mbuŋ luŋ	'breast' 'money' 'tongue'	mee lii pɔ̃ɔ̃ kuwu too	'child' 'eye' 'thing' 'dish' 'ear'

The resulting 43 sentences were randomized and recorded in blocks first as declarative statements and then as yes-no questions, with the speaker being prompted by a written English translation of each sentence. The sentences were recorded in blocks of statements and questions so that no overt contrast effects were produced by the speaker. A female speaker raised speaking Nchufie in Cameroon was recorded in a sound insulated booth. Each target word was recorded only once in each condition as the intended independent variables in evaluating F0 and duration were lexical tone and rhyme type.

#### *Acoustic Analysis*

Pitch tracking was done on the digitized sentences using the Kay Computer Speech Lab (CSL) package. Pitch synchronous pitch tracking was used by first employing the automatic peak picking capabilities of CSL which marks the division between each voicing impulse in the waveform immediately following positive-going zero crossings that precede the first positive-going amplitude peak of the voicing impulses. The process separates the voiced signal into its periodic components, the inverse of each period being the fundamental frequency (F0) of the signal. Peak picking was done with a 25 ms window and a 20 ms frame advance with a specified range of 50 - 300 Hz. The minimum peak threshold was lowered for target rhymes ending in a coda nasal or a nasalized vowel due to the decreased amplitude. However, the same threshold was always used for a word for both statement and question. Impulse marks were checked by hand and missing divisions added. The pitch tracking function of CSL extracts the fundamental frequency values by computing the inverse of the time between each marked peak. Sample pitch tracks of the statement condition for four CV target words, one from each of the tonal patterns, are shown below.

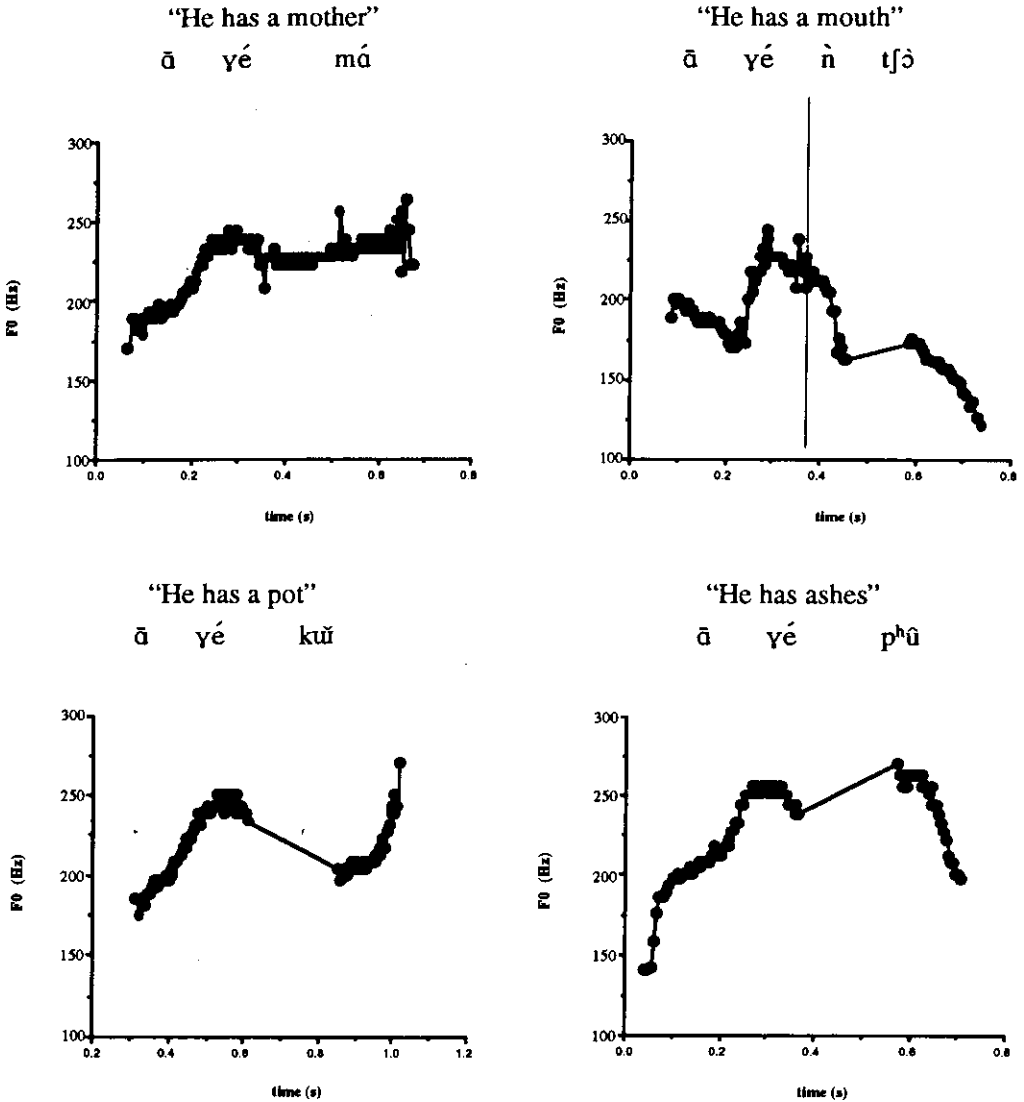


Figure 1.  $F_0$  tracks of sample words from each tone pattern, in statements. Measured values, represented by dots, are connected by interpolation lines.

In the experiments below, the pitch track of the entire rhyme of the target word was recorded and smoothed using three point smoothing. A single measure for  $F_0$  in each word of the carrier phrase at the point of highest amplitude was also obtained using a simultaneously displayed energy plot. This procedure provides measurements relatively independent of the effects of adjacent consonants.

The duration of the rhyme of the target word was measured in both sentences from the onset to the end of vocalic voicing. The duration of the carrier phrase [ā yé] “he has” was also recorded as a control across the statement and question conditions. This

measure was made from the onset of voicing up to but not including the onset consonant of the target word. Segmentation was done by waveform examination.

### 3.0 Results

#### *Lengthening in questions.*

In order to test the anecdotally observed final lengthening in questions, it was first necessary to determine that the speaker maintained the same carrier phrase rate in both conditions. The mean carrier phrase durations were 311.1ms for statements and 312.4ms for questions. A (two-tailed) paired t-test showed there to be no effect of statement vs. question on the rate at which the sentence was spoken,  $t(42) = -.219, p = .8281$ . A paired test was used in order to control for possible effects of the onset consonant of the target word on the preceding vowel of the carrier phrase.

There being no effect of statement vs. question on rate, the rhyme durations could be compared directly for each condition. A paired one-tail t-test showed there to be a significant main effect of statement vs. question on the duration of the final rhyme in the sentence,  $t(42) = -156.767, p = .0001$ . The difference between the mean final rhyme duration in statements and in questions is 156.8ms; questions being 72.7% longer than statements. This main effect is shown graphically in Figure 2.

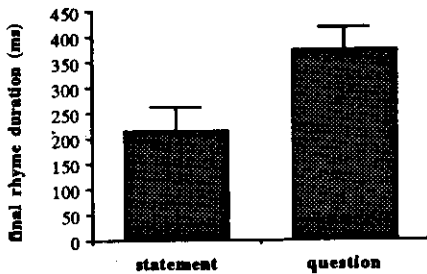


Figure 2. Duration of final rhymes in statements and questions. Standard deviation shown by error bars.

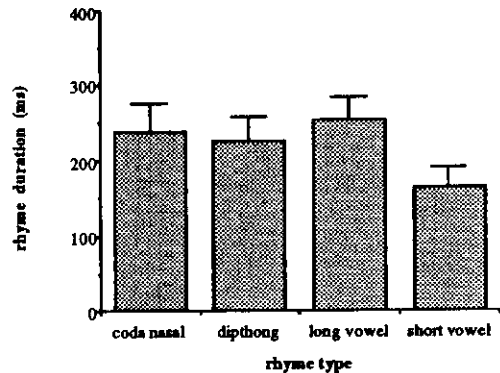


Figure 3. Final rhyme duration as a function of syllable type in statements. Standard deviation shown by error bars.

Next, we need to ask what effect, if any, the four rhyme types have on lengthening. In order to do this, we need first to find if rhyme types are significantly different from one another in rhyme duration in the *statement* condition. A one factor ANOVA showed there to be a significant effect of rhyme type on rhyme duration in statements,  $F(3, 42) = 17.838, p = .0001$ . Post-hoc pairwise comparisons using the Scheffe F-test showed there to be no significant difference at the 95% level in rhyme duration between the diphthong, closed syllable, and long vowel rhyme types. The CV type was significantly different at the 95% level from the other three rhyme types. The mean rhyme duration in statements for each rhyme type can be seen graphically in Figure 3.

These results suggest that the four rhyme types can be collapsed into just long and short categories. Subsequent analyses involving the categorical variable of rhyme type

will be made using these categories. As expected, long versus short rhyme has a significant effect on rhyme duration in statements,  $F(1, 42) = 48.81, p = .0001$ . In the statements long rhymes have a mean duration of 240.7ms and short rhymes 164.8ms.

While all final rhymes are lengthened in a question as compared to a statement, there is a significant interaction of duration with rhyme type in questions as shown by a two-factor ANOVA,  $F(1, 82) = 4.6113, p = .0347$ . Short rhymes lengthen by 109.4%, and long rhymes by 59.2%. This lengthening is shown in Figure 4. Although short rhymes lengthen by a considerably larger percentage than long rhymes, the underlyingly long and short rhymes are still significantly different in length. It appears rather that the long rhymes are displaying a ceiling effect which prevents them from lengthening by the same amount as the short rhymes. A one-factor ANOVA shows a significant effect of rhyme type on rhyme duration in questions,  $F(1, 42) = 7.544, p = .0089$ . Long rhymes exhibit a mean duration of 383.2ms (s.d. = 43.5) in questions, and short rhymes a mean duration of 345.1ms (s.d. = 37.2).

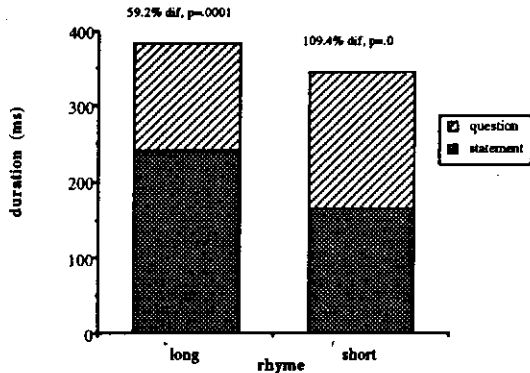


Figure 4. Final rhyme duration in statements and questions as a function of long vs short rhyme type. Darker shaded areas represent duration in statements. Lighter area represents lengthening in questions.

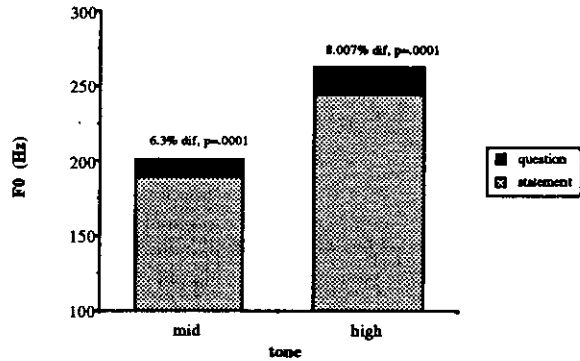


Figure 5. Pitch raising in statements and questions for the mid and high tones in the carrier phrase.

### Pitch Range

Two F0 measures were made of the carrier phrase in both the statement and question condition: one of the mid tone on the first word and one of the high tone on the second. A one factor ANOVA shows there to be a significant effect of statement vs. question on the mid tone,  $F(1, 85) = 16.685, p = .0001$ . The questions have a significantly higher F0 for the mid tone in the carrier phrase than statements: 201Hz (s.d. = 18) vs. 189Hz (s.d. = 6). This is a difference of 6.3%. Likewise, the carrier phrase high tone is significantly higher in the questions than in the statements ( $F(1, 85) = 67.361, p = .0001$ ). The question high has a mean F0 of 263Hz (s.d. = 13) and the statement a mean F0 of 243Hz (s.d. = 9); a difference of 8%. This question raising is shown graphically in Figure 5.

The H tone on target nouns occurring at the end of the phrase were raised by a like amount compared to the highs in the carrier phrase. The mean maximum F0 value for these words is 276Hz (s.d. = 9) in questions vs. 258Hz in statements (s.d. = 13), a difference of 7%. The overall mean F0 value for H target words (which also averages in

tokens where optional final lowering took place as will be discussed below) was 261Hz (s.d. = 15) in questions vs. 246Hz (s.d. = 10) in statements; a difference of 6%. While there was no low tone word in the carrier phrase, the low tone target nouns were examined to determine if low tones were realized differently in statements than in questions. Four measures were considered for all low tone target nouns—overall mean F0, minimum F0, endpoint F0, and maximum F0. One-factor ANOVAs showed that the statement vs. question condition had no effect on mean F0, minimum F0, and endpoint F0,  $F(1, 19) p = .3342$ ,  $p = .94$ ,  $p = .8357$  respectively. Maximum F0 was significantly higher in questions  $F(1, 19)$ ,  $p = .0107$ , but this can probably be explained by the fact that the target noun was falling from a preceding high tone which was raised significantly in the questions. All of these pitch tracks show a downward fall from this preceding high. In summary, this experiment suggests that raising in the questions occurs over the entire clausal domain and affects highs more than mids, and lows not at all.

This raising of mids and highs in the question phrase, and of highs more than mids, suggests that pitch range expansion rather than upstep or overall register shift is at work here. Lows are not raised, and highs are raised by a greater percent than mids. Upstep generally refers to the raising of highs only, and an overall register shift or key raising would produce an equal raising of all lexical tones.

Before we can firmly assert that pitch range expansion is at work, we need to determine if for some reason the lexical low tones on the final target word are not undergoing raising whereas a low tone earlier in the sentence would be raised. There is evidence to suggest that the final pitch of a declarative phrase is less variable than other peaks in the phrase (Boyce & Menn 1979). This suggests that last syllables may be under-informative when examining F0 scaling. For this reason, a second experiment was conducted in which a low tone occurred at the beginning of the carrier phrase.

In experiment two, the carrier phrase [ŋgò yé \_\_\_\_]; “The stranger has \_\_\_\_” or “Does the stranger have \_\_\_\_?” was used. The high and low tone nouns from Table 1 were used as the target words, yielding a total of 19 statements and 19 yes-no questions, 8 with high final nouns and 9 with low final nouns. The pitch of each word in the carrier phrase was tracked according to the methods outlined in section two. The pitch of the final noun was recorded at its endpoint.

Two-tailed paired t-tests were conducted to test a difference in pitch between statement and question for the low and high tones in the carrier phrase and for the lexical tone of the target word. The high tone of the carrier phrase is significantly higher in questions than in statements,  $t(18) = -13.078$ ,  $p = .0001$ . The mean high tone is 205Hz (s.d. = 7) in the statements and 228Hz (s.d. = 7) in the questions. Importantly, the low tone in the carrier phrase also differs significantly between the two conditions,  $t(18) = -13.459$ ,  $p = .0001$ , the mean low tone being 168Hz (s.d. = 3) in the declarative carrier phrase but 182Hz (s.d. = 4) in the question phrase.

The results show the lexical highs in the target words to be raised significantly in the questions,  $t(8) = -6.872$ ,  $p = .0001$ , and the lows *not* to be significantly different,  $t(9) = 1.118$ ,  $p = .2923$ . This result is in accordance with experiment one in which low toned target words were not raised in questions. However, the change in the low tone of the carrier phrase suggests that in general an overall higher pitch range is used in the yes-no questions than is used in the segmentally identical statements. However, lexical low

tones occurring phrase finally appear not to undergo this raising.

### *Optional Final Lowering*

Certain individual tokens of the LH and H, i.e. lexically high-final, target nouns in the questions have a final fall or a lowering throughout the rhyme which causes the F0 contour in the question rhyme to fall even with or below that of the statement. No statements ending in LH or H nouns showed this final lowering.

We have seen in experiment one that the endpoint, minimum, and overall mean for low target words does not differ between statement and question. However, the HL nouns do show a significant difference in both endpoint,  $F(1, 29) = 12.344, p = .0015$ , and in minimum,  $F(1, 29) = 12.824, p = .0013$ , as a function of statement vs. question with questions being significantly lower on both measures. It is unclear however whether this difference is due to final lowering operating in these questions or is merely a by-product of the question rhyme being longer in duration than the statement thereby allowing it more time to reach a lower target value in the fall from the initial H of the contour. Because these alternatives cannot be evaluated in this dataset, the discussion of final lowering in questions will focus on the LH and H nouns where final lowering in questions can be clearly distinguished due to the presence of a final lexical high.

The two patterns found in the LH case can be seen by comparing Figures 6 and 7. In pattern one, in Figure 6, the final H in the question condition ends higher than in the statements. In pattern two, in Figure 7, the entire contour in the question is lower than that of the parallel statement. This is counter to the general pattern of raising in questions. In pattern two, all the questions end lower than all the statements. Other tokens show fairly identical LH contours for the statements and questions.

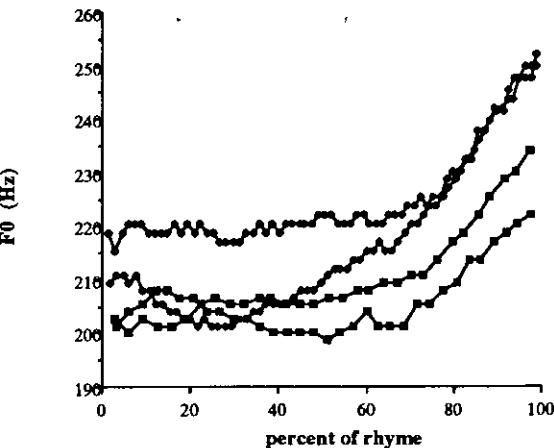


Figure 6 Pattern one pitch contours for LH final rhymes. Questions are shown by filled symbols, statements by open ones.

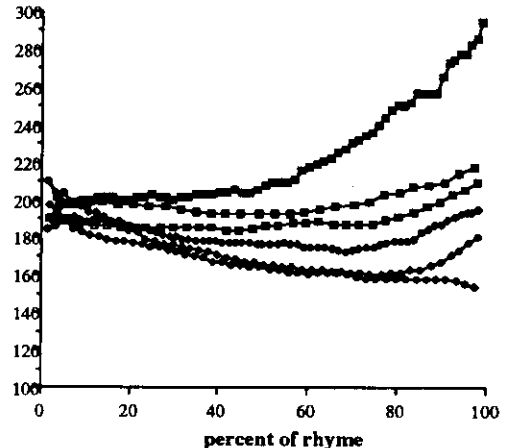


Figure 7. Pattern two pitch contours for LH final rhymes. Questions are shown by filled symbols, statements by open ones.

In the word [ŋdʒiŋ] 'brother', the statement contour shows a LH pattern while the question contour shows a LHL pattern. This can be seen in Figure 8. The final fall in the question is aligned precisely to occur where the final high ends in the statement. This suggests that a final L is optionally added along with the extra length in the question. If



not added, the endpoint of a phrase final lexical LH in a question is raised above that of the statement level as is expected due to the higher pitch range used in questions. If the final L is added, it may act to lower the entire preceding contour, or it may simply cause a final lowering, i.e. a fall, after the predictably raised contour.

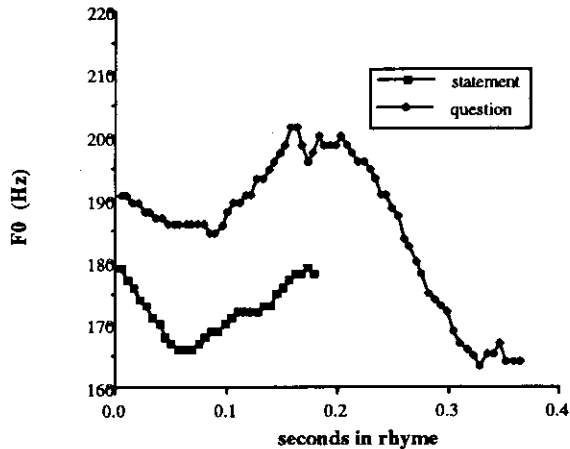


Figure 8. Pitch contours for the word [ɲdʒĩŋ] 'brother'. Questions are shown by filled symbols, statements by open symbols.

It can be shown that the addition of the final low is optional by comparing the pronunciations of [fũɔ], recorded as both 'leaf' and 'medicine'. The token for 'medicine' showed no final lowering while the token for 'leaf' showed a pattern two output. These two English words are translated by the same word in Nchufie; identical segmentally, tonally, and in noun class. However, this word was elicited twice, once using each English meaning, yet the word conformed to different patterns for each elicitation. Likewise, 'brother' and 'brothers' which differ in only the onset consonant showed final lowering in the case of 'brother' and no final lowering in the case of 'brothers'. This suggests that the addition of the final low in questions is optional and not determined by segmental, tonal, or class qualities of the noun. The appearance of final lowering was also not predictable from the token's location in the recording list.

High final nouns show a similar duality in patterning. In pattern one, as seen in Figure 9, each statement/question pair shows the question condition to have a higher pitch contour throughout the final rhyme than that found in the statement. Figure 10 shows the second pattern where the normally raised high of the question falls to the same level as the statement, or the end of the rhyme falls below its level in the statement. In experiment two, one of the 8 high target words, [tʰuí] 'tree' showed no raising in the questions, ending in the same pitch as in the statement condition. This word did undergo raising in experiment one, again suggesting an irregular process.

To determine if speaking rate (i.e. carrier phrase duration) or rhyme duration were correlated with the appearance of the optional final low, the pattern one and two groups for the H and LH nouns were recoded as integer values and correlations of these categories with carrier phrase duration and rhyme duration were calculated. Neither rate nor rhyme duration were correlated with the appearance of a final low ( $R^2 = .0001$  and  $R^2 = .022$  respectively).

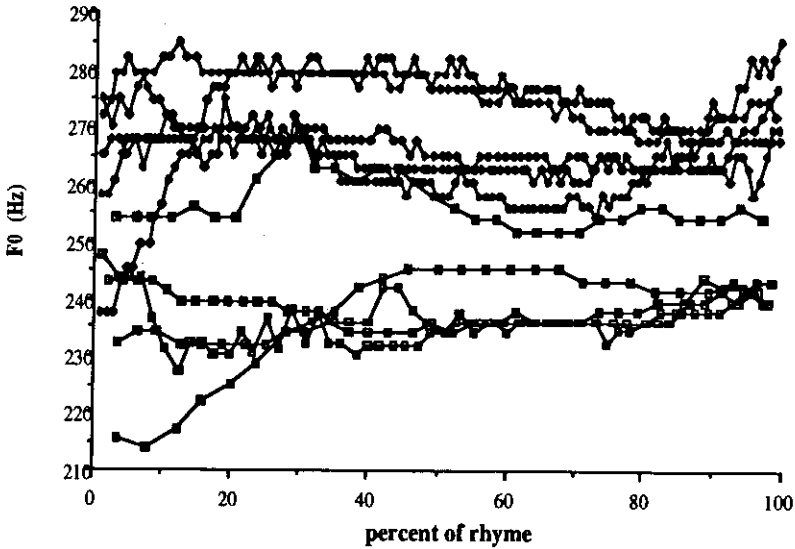


Figure 9. Pattern one pitch contours for H final rhymes. Questions are shown by filled symbols, statements by open symbols.

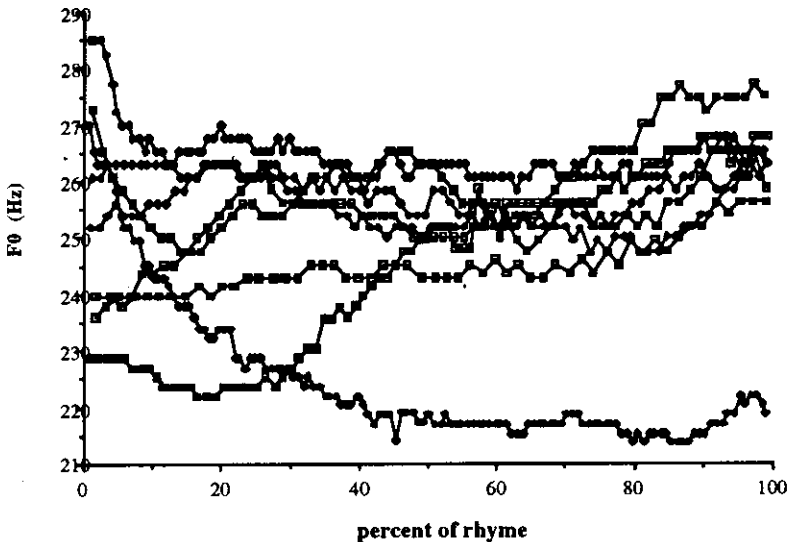


Figure 10. Pattern two pitch contours for H final rhymes. Questions are shown by filled symbols, statements by open symbols.

### *Summary of Results*

In summary, it has been shown that yes-no questions in Nchufie are marked by several cues. First, question prosody is characterized by a specific duration cue. The final rhyme of the phrase is lengthened substantially, more than doubled in the case of CV syllables. The amount of lengthening is dependent on whether the rhyme is underlyingly long or short, with long rhymes showing a ceiling effect causing them to

lengthen by 59% as compared to 109% for short rhymes. Secondly, a higher pitch range is used in questions, causing high, mid, and low tones to be raised in the phrasal domain but not affecting phrase-final lexical low tones. Finally, we have seen that the lengthening of the final rhyme in yes-no questions may optionally be accompanied by a final lowering. If present, this low tone may have the effect of lowering the entire contour of the final rhyme or adding a final fall in F0 at the end of the rhyme. Whether this low tone appears or not is not predictable in this dataset from the melodic, tonal, or morphological nature of the word nor from the rate of speaking or length of the rhyme.

#### 4. Discussion

The facts of Nchufie yes-no question formation appear to set it apart from most other languages, including others, such as Hausa, that form yes-no questions solely by prosodic means. First, there are no *non-local* durational differences between Nchufie questions and statements. Lindau (1986) found that in Hausa questions were an *overall 10% shorter* than statements. Lindau notes that consideration of durational differences in questions and statements is not part of the general literature on the topic of question formation; however, Bannert's (1983) study of German found no significant differences in the duration of statements and questions. *Final* lengthening in questions may be more common in West African languages. Dagbani combines lengthening with a final lowering (Hyman, to appear), and Gokana has an utterance final glottal stop in the declarative which is lost in the corresponding negative, leaving a somewhat longer vowel (Hyman 1985a). Ngangoum (1970) describes different question particles in Bamileke-Fe'fe' which, with or without segmental and/or tonal content, may result in lengthening of the final vowel.

Second, local lengthening in questions appears to affect both final short and long vowels in Nchufie. In contrast, Newman and Newman (1981) have claimed that in Hausa questions lengthening takes place on final short syllables only.

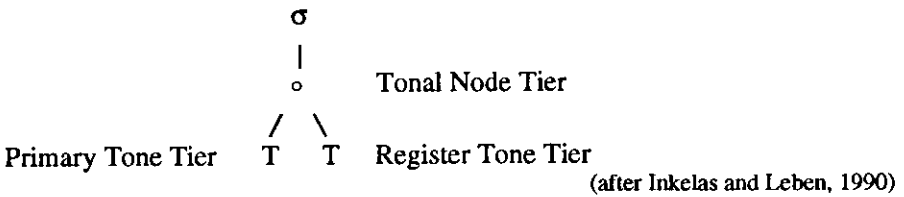
Third, a higher register is used in Nchufie questions. While an overall higher register is not the most common type of yes-no question intonation, 34% of Ultan's (1978) sampled languages used some form of raised pitch other than a final rise. Some of the languages using this type of yes-no question intonation include Swedish (Hadding-Koch 1961, Gårding 1979, Bredvad-Jensen 1980), Mandarin (Shen 1990), and Sango (Samarin 1967). Hausa has been shown to have a locally raised final high tone in yes-no questions (Hoffman & Schachter 1969, Kraft & Kraft 1973, Cowan & Schuh 1976, Miller & Tench 1980, Lindau 1986). Newman and Newman (1981) have used the term 'key raising' to refer to the systematic upward shift of final H and L tones which occurs in questions in Hausa (also Hodge & Umaru 1963). Hoffman and Schachter (1969), Newman and Newman (1981), Schuh (1978), Lindau (1986), and Inkelas and Leben (1990) have claimed that downdrift is suspended in Hausa questions. Inkelas and Leben (1990) suggested that the reason for this is that downdrift is incompatible with key raising. They analyze key raising as the attachment of a H tone to the register tone tier, which raises the tone attached to the primary tone tier. Since downdrift is the insertion of a register low tone, the incompatibility is predicted. Lindau's (1986) showed that Hausa yes-no questions are not marked by a raised register but by the global suspension of the statement downward slope in favor of zero slope, and a local feature of a considerably raised F0 for the last high tone. The slopes of the F0 grids for the statement and question pivot around the same starting F0. The width (range) of the grid is no different in

statements and questions, and the grid is in no sense raised for questions. However, for the Nchufie data presented here, a zero slope F0 contour, i.e. the suspension of downdrift, cannot entirely explain the higher F0 in questions in Nchufie, as the *starting* fundamental frequency in question and statement phrases is significantly different.

A comparison of raised question highs with the syntactic superhigh which marks the past tense in Nchufie has not been undertaken. Work on Hausa by Inkelas and Leben (1990) and Hyman (1985b, 1986) suggest that the raised highs in Nchufie questions might be represented by a phonological structure linking a high register tone and a high primary tone. As this system of representation offers no obvious way of distinguishing the syntactic superhigh from the raised intonational high, it is important whether or not these tones are empirically different. This representation for Nchufie would additionally predict that superhighs in a yes-no question would not undergo any raising and that downdrift would not occur within the the intonational phrase of the question.

Fourth, an optional final low tone was found to occur in Nchufie questions. Newman and Newman (1981) suggested that the final raised high in Hausa questions may optionally be followed by a low tone question morpheme which includes length. The addition of this final low tone neutralizes the distinction between H and HL lexical tones in final position (Inkelas & Leben 1990). Kraft and Kraft (1973) similarly report that a final high becomes falling in a Hausa yes-no question. This observation is similar to some of the Nchufie data described above. Lindau (1986) found, however, that the final fall observed by Newman and Newman (1981) in Hausa yes-no questions is actually an optional rule of ending low which is not specific to questions but also occurs in statements. In her data, the same speakers who fell finally in questions also fell in statements. She claims therefore that the optional low is not part of the question morpheme. In the data presented here, the optional low tone seen in questions was *never* seen in statements, suggesting that this is a process which is part of yes-no question formation in Nchufie, not a general characteristic of the language or this speaker. One would like to find some explanation for the irregular appearance of the optional final low tone in these questions. It has been suggested that a difference in meaning could affect which type of question formation is used (Hayes, personal communication). The connotation signaled by this low tone would have to be one that doesn't occur in statements, as we never saw the final lowering in statements. The optional final low tone may also be a survival from an interrogative particle such as that occurring in Bamileke-Fe'fe', another Grassfields language. Ngangoum (1970) describes two question particles in this language, [í] which can assimilate to a preceding vowel resulting in lengthening and [à]. He also notes that final vowels may simply be lengthened, even in CVC syllables.

Speculation as to how the yes-no question intonation of Nchufie can be represented phonologically is presented below as a means of introducing some of the relevant representational questions raised by this data. The possibilities described are not intended to be exhaustive, but rather, thought-provoking. The representation of key raising and downstep outlined by Inkelas and Leben (1990) and Hyman (1985b, 1986) provides for a Primary Tone Tier and a Register Tone Tier. These are linked to the syllables via an intermediate Tonal Node Tier. This structure is shown below.



A high Register Tone will raise a Primary Tone and a low Register Tone will lower or downstep a Primary tone. I will assume for the sake of this discussion that a Tonal Node may be attached to only one Primary Tone and that falling and rising contours are created by adjacent Tonal Nodes which differ in their Primary Tone specification. This implies by extension that a syllable may be attached to more than one Tonal Node.

In considering the Nchufie yes-no questions, a H register tone could be added to all tonal nodes within the relevant intonational phrase. This will be realized as a globally higher pitch during phonetic implementation. The final lengthening could be represented as the addition of a mora to the final rhyme of the phrase. The phonetic implementation of this additional mora will result in final lengthening. Note that this level of the phonology couldn't have restrictions on the number of moras in a syllable. The straightforward interpretation of this procedure however makes the prediction that a short vowel which gets another mora should be realized with the same length as a long (two mora) vowel in the declarative condition. However, this was found not to be the case. One resolution would be to allow phonetic implementation to have access to the source of the length/weight. Finally, recall that in questions the optional final low sometimes produces an abrupt final fall and sometimes has the effect of lowering the final H Primary Tone, neutralizing the pitch range expansion in that rhyme. The final abrupt fall could be represented as the case in which a low tone attaches as a *Primary* Tone dependent on the rightmost Tonal Node of the phrase. This leaves open the question of whether it attaches to a tonal node created by lengthening or whether it projects its own tonal node. The lowering of the final Primary high tone could be captured in a representation in which the low tone attaches as a *Register* Tone dependent on the rightmost Tonal Node of the phrase. In the process, it would displace the high register tone otherwise present in question intonation. Crucially, this approach does not explain why final lexical low tones do not undergo raising. The description outlined above is only one of several ways in which the prosodic aspects of Nchufie yes-no questions could be represented. It is offered not as a definitive approach but rather as a means of suggesting some of the relevant representational questions engendered by this and other similar data.

## 5. Conclusion

The results described above extend our typology of prosodic marking in questions. This research is an instrumental study of the use of duration and intonation in question formation. Being a tonal language, Nchufie provided the opportunity to explore the interaction of lexical and intonational F0 specification. Both duration and pitch behave unusually in Nchufie questions with respect to patterns familiar from the rest of the world's languages. Substantial lengthening was found to occur in questions, and the intonational patterns employed in questions, i.e. overall raising and optional final lowering, are types rarely attested in other literature.

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