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STRESS IN HAUSA: AN EXPERIMENTAL STUDY[1]

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Hausa has been described as having stress on High toned syllables which shifts to Low toned syllables under certain conditions, notably when the first word of a Noun + Noun or Verb + Noun construction is LH and the second word is stressed on the first syllable. This paper examines those constructions to determine what phonetic feature causes the observed change in pronunciation and whether or not that feature can be called stress. The results of the experiment lead to the conclusions that while there are contextually conditioned pronunciation changes which occur in certain grammatical constructions in Hausa, these changes cannot appropriately be described in terms of stress but rather must be considered tonal changes.

1. Introduction

1.1. Stress in Hausa. The feature *stress* has not received nearly the attention in writings on Hausa that the features *tone* and *vowel length* have received. Nonetheless, for over 50 years many grammars and articles on Hausa have included some statement on stress. Taylor [1923] is probably the first to actually mention stress and distinguish it from tone and vowel length.[2] He says:

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[1]Work for this paper was begun while working as a Research Fellow at the Centre for the Study of Nigerian Languages, Bayero University, Kano during 1974-1976. It was completed as part of my Ph.D. dissertation [Dresel 1977], and I am particularly grateful for the help given to me by Robert Port.

[2]Some of the earlier writings on Hausa such as the grammars of Seidel [1906], Migeod [1914], and Robinson [1917] contain the words *accent* and *emphasis*. Since the terms are not clearly defined it is difficult to know if they refer to what we would call *stress* or *tone*. It is most probable that they refer to tone, although the section in Migeod on the movement of accent is quite a bit like Abraham's later descriptions of the movement of stress.

> "apart from the natural emphasis which seems to be inherent in a long vowel—and generally speaking long vowels predominate in Hausa, especially at the end of a word—nouns have ordinarily no stress accent except when a vowel is final and precedes the enclitics ne and ce or the negative particle ba . With words of more than one syllable the stress is normally leveled out" (p. xi).

Abraham [1934, 1959] has the most complete account of stress in Hausa. He does not define stress itself but claims there is an intimate connection between stress and tone such that High tones are stressed and Low tones are unstressed [1959:185]. For example:[3]

ˈdokì	'horse'	HL, stress on first syllable
àlˈkawą̀ˈri	'promise'	LHLH, stress on second and last syllables

Pilszczikowa [1968] also claims that stress usually falls on High tone syllables. She finds that in words of all High or all Low tones, all the syllables are stressed, and that in words of various tones, the first syllable with High tone carries the main stress and other High tone syllables have secondary stress. Wängler [1963] does not discuss stress at great length but mentions that most High tone syllables are stressed while Low toned ones are unstressed and that Falling tone is always stressed. He does, however, indicate stress in all his diagrams by circling the stressed syllables. Kraft and Kraft [1973] and the similar Kraft and Kirk-Greene [1973] represent the most recent accounts of stress:

> "(i) Differences in stress alone do not account for differences in meaning between words. (ii) Stress generally, though by no means always, falls on syllables possessing High tone. (iii) When a series of High tone syllables is followed by a Low tone, the High tone syllable immediately preceding the Low syllable carries greater stress

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[3]The Hausa examples in this paper are written in standard Hausa orthography with the following modifications:

ˌ	is used to indicate a short vowel
ˋ	is used to indicate a Low tone
ˈ	is used to indicate stress on the syllable following it

Long vowels and High tones are not marked, and stress is only marked where it is relevant to the discussion.

than the preceding High syllable unless such a syllable is both word final and short" (p. 37).

1.2. Stress movement. Abraham [1934] describes several types of stress movement. The most interesting ones deal with Noun + Noun and Verb + Noun constructions. He also discusses nouns followed by the stablizer ne/ce and by the possessive pronouns, and verbs followed by the negative particle ba . According to Abraham, LH nouns are stressed on the second syllable. He finds, however, that the stress shifts to the first syllable when these words are followed by nouns which are stressed on the first syllable. This means, in most cases, nouns whose first syllable has High tone. So, for example, kà're is stressed on the second syllable, but in the construction 'kàren 'Audù , it is stressed on the first syllable. His observations about LH verbs are that the stress shifts to the first syllable when followed by

a) a noun stressed on the first syllable,
b) a noun whose stress has shifted to the first syllable,
c) a noun with even stress (HH),
d) a Low toned noun (LL).[4]

Abraham's claims about Noun + Noun and Verb + Noun constructions can be summarized as follows:

$$L'H \rightarrow {}'LH \;/\; \_\_ \;[\text{stress}]$$

Pilszczikowa [1968] has a similar account of stress movement rules which she acknowledges to be based mainly on Abraham [1934], with additional information from the diagrams in Wängler [1963]. She concludes that there cannot be two consecutive stressed syllables across word boundaries. If that should happen the stress on the first word moves back one syllable.

Yet another observation on the shifting of stress in Hausa is to be found in Parsons [1961:119]. He notices as Abraham does that the stress of some words shifts to the final syllable before ne/ce , but claims that stress is interrelated with both tone and vowel length. He gives the following exam-

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[4]While Abraham describes LL nouns as being unstressed he finds that they behave as having stress on the first syllable for stress movement. Pilszczikowa says LL nouns are stressed on both syllables. Because of this discrepancy I have used LL words in all of my test environments.

ples:

haskin ra'na nè 'it is sunlight'
barcin 'ranạ nè 'it is daytime sleep'

1.3. Experimental investigation of stress movement. It has been noticed by several investigators, then, that there are variations in the pronunciations of certain Hausa words which seem to be environmentally conditioned. The words so affected seem to be nouns and verbs in close construction with following nouns or enclitic particles. The change in pronunciation has been attributed to a shift of stress. Two experiments were designed and conducted, therefore, to try to determine what phonetic (phonological) feature causes the observed change in pronunciation. Furthermore, an attempt was made to clarify the question of whether or not there is in fact something we can call stress in Hausa. Both experiments deal with *shifts* of stress, not stress alone. It is difficult to try to investigate stress alone in Hausa since both tone and vowel length are phonemic. It is not clear how to distinguish between pitch effects, or duration effects, and stress. In dealing with shifts of stress, however, we are dealing with exact minimal pairs. If the *same word* is pronounced one way in one environment and another way in another, then there is reason to believe that some feature, possibly stress, has shifted, causing the difference in pronunciation.

In discussing the phonetic realization of stress, Hyman [1977:40] describes a stressed syllable as being frequently characterized by a pitch change, by greater duration, and by greater intensity. The work of Fry [1955], Bolinger [1958], Lehiste [1970], and others indicates that pitch or changing pitch followed by duration are the most important perceptual cues to stress, at least for English. In the experimental study of Abraham's claims about stress in Hausa measurements were made of fundamental frequency and duration. The hypothesis was that if the change in pronunciation noticed by Abraham is to be called stress it should show up phonetically as a change in *both* fundamental frequency and duration. Lea [1977] has reported that combinations of cues work better for stress determination than individual ones. This should be especially true in a language like Hausa where fundamental frequency and duration have their own phonological roles in the

language. Thus, if the change in pronunciation showed up as a change in only fundamental frequency or only duration it could probably be accounted for by phonological rules concerning these features. If, however, differences in *both* fundamental frequency and duration were detected than a case could be made for saying that the difference was one of stress.

2. Experiment 1

2.1. Noun + Noun

2.1.1. Introduction. This experiment was designed to examine the claims made by Abraham about stress movement in Noun + Noun constructions as described above. Abraham made his claim about constructions in which the first noun has a LH tone pattern. We were interested to see if the pronunciation of that noun could be affected by the first tone of the following noun. The hypothesis was that the Low tone first syllable would have different fundamental frequency and duration measurements depending on whether the following word had initial High tone or initial Low tone. The experiment examined Noun + Noun constructions in which the first noun had the four possible tone patterns: HH, HL, LH, and LL. The same four tone patterns were used for the second noun although only the effect of the first tone was under investigation.

2.1.2. Methods. The Noun + Noun constructions were investigated in the following frame:

wannàn N_1 + linker N_2 ne/ce 'this is N_1 of N_2'

For the test word N_1 8 words were used, two words with each of the above tone patterns, one having a short first vowel, and one a long first vowel. Vowel length was controlled since the hypothesis predicted systematic lengthening. The context word N_2 was one of four words with the same tone patterns as the test words. The 32 utterances were read five times each by three Hausa speakers[5] and were recorded in a sound treated room on a Sony tape recorder. In addition the sentences which Abraham used as illustrations

[5]Adam Sheik Abdullahi, Mohammed Sabo Nanono, Nicholas Pweddon

Table 1: Materials for Experiment 1 - Noun + Noun

N_1	dạga	'bracelet'	gara	'wedding present'
	kạdà	'crocodile'	tasà	'dish'
	gạ̀da	'duiker'	kàza	'chicken'
	gwạ̀dǫ̀	'blanket'	kèkè*	'bicycle'
N_2	Musa			
	Bellǫ̀			
	Bà̀la			
	mạ̀cè	'woman'		

1. Wannàn dạgar Musa cè.
2. Wannàn dạgar Bellǫ̀ ce.
3. Wannàn dạgar Bà̀la cè.
4. Wannàn dạgar mà̀cè ce.
5. Wannàn garan Musa nè.
6. Wannàn garan Bellǫ̀ ne.
7. Wannàn garan Bà̀la nè.
8. Wannàn garan mà̀cè ne.
9. Wannàn kạdàr Musa cè.
10. Wannàn kạdàr Bellǫ̀ ce.
11. Wannàn kạdàr Bà̀la cè.
12. Wannàn kạdàr mà̀cè ce.
13. Wannàn tasàr Musa cè.
14. Wannàn tasàr Bellǫ̀ ce.
15. Wannàn tasàr Bà̀la cè.
16. Wannàn tasàr mà̀cè ce.
17. Wannàn gà̀dar Musa cè.
18. Wannàn gà̀dar Bellǫ̀ ce.
19. Wannàn gà̀dar Bà̀la cè.
20. Wannàn gà̀dar mà̀cè ce.
21. Wannàn kàzar Musa cè.
22. Wannàn kàzar Bellǫ̀ ce.
23. Wannàn kàzar Bà̀la cè.
24. Wannàn kàzar màcè ce.
25. Wannàn gwà̀dòn Musa nè.
26. Wannàn gwà̀dòn Bellǫ̀ ne.
27. Wannàn gwà̀dòn Bà̀la nè.
28. Wannàn gwà̀dòn mà̀cè ne.
29. Wannàn kè(ken) Musa nè.
30. Wannàn kè(ken) Bellǫ̀ ne.
31. Wannàn kè(ken) Bà̀la nè.
32. Wannàn kè(ken) mà̀cè ne.
33. Wannàn kà̀ren Audù ne.
34. Wannàn kà̀ren À̀li nè.
35. Wannàn goran ruwa nè.

* kèkè has two pronunciations: LL and LH, which are in free variation. The second syllable is therefore shown in parentheses. This word was only analyzed when it was pronounced as LL.

of his claims were also recorded. All the test sentences are shown in Table 1. As none of the five readings were judged to be better or worse than the rest, the first and third reading were arbitrarily chosen and the recordings were played through a Trans-pitch meter into a Siemens Oscillomink multi-channel graphic recorder. A fundamental frequency curve was obtained as well as a duplex oscillogram for segmentation and length measurements.[6] Measurements to the nearest 5 Hz were made of the fundamental frequency of the two vowels of the test word N_1. Each vowel was measured twice, once 20 msec after onset and once 20 msec before the end. This was done to reduce consonantal influence, such as the sudden increase in fundamental frequency following unvoiced consonants [Lea 1977]. An investigation of the two fundamental frequency measurements of each vowel showed that while the fundamental frequency was unchanging in some cases and changing in others the contour was consistent for any given syllable and not affected by environment. This was confirmed by statistical analysis of the results using a *t*-test. Therefore the means of the two measurements were the values used in the experiment. The duration of each vowel of the test word was measured to the nearest 10 msec on the duplex oscillogram tracing.

2.1.3. Results. Table 2 shows the mean values for fundamental frequency for the first vowel (V_1) and the second vowel (V_2) of the test word (N_1) in the two contexts, before initial High tone nouns and before initial Low tone nouns. These values are plotted in Figure 1. The slope of the lines indicates the overall pitch contour across the two syllables of the test word. A left to right upward slope indicates that the first vowel has a lower fundamental frequency than the second; a downward slope that the second vowel is lower.

Looking first at the tone contour of the LH word, statistical analysis of the results using a *t*-test shows that the difference between mean fundamental frequencies before a following High tone and before a following Low tone in the context word is significant ($p < .02$). It is marginally significant ($p < .10$) for HL words. For HH and LL words the difference is not sig-

[6]Described by Fant [1958].

Table 2: Fundamental Frequency (Hz), Experiment 1 - Noun + Noun

Test Word (N_1) tone patterns

H	H	H	L	L	H	L	L		
$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$		
108 (2.9)	111 (2.7)	115 (2.0)	113 (0.7)	102 (0.0)	109 (0.7)	103 (1.7)	97 (3.7)	H	Initial tone of Context Word (N_2)
109 (1.0)	113 (1.1)	117 (1.0)	111 (1.6)	99 (1.0)	111 (1.6)	105 (1.9)	101 (1.9)	L	

Mean fundamental frequencies (to nearest Hz) of V_1 and V_2 of test words (columns) in environments of words with initial High tone and initial Low tone (rows). Standard deviations shown in parentheses below each fundamental frequency value. (Six tokens: 3 speakers x 2 readings).

Table 3: Duration (msec), Experiment 1 - Noun + Noun

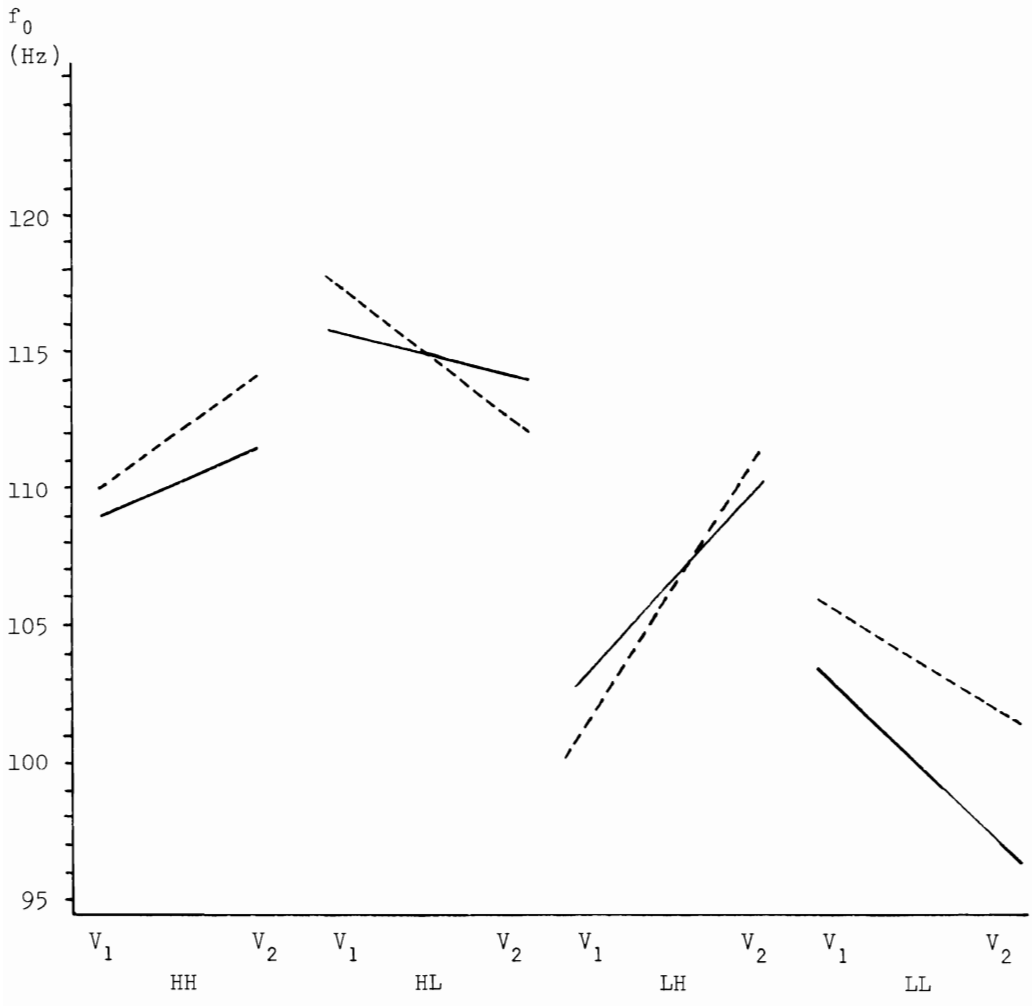
Test Word (N_1) tone patterns

H	H	H	L	L	H	L	L		
$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$		
198	147	218	77	201	110	127	131	H	Initial Tone of Context Word (N_2)
195	141	227	82	203	118	129	125	L	

Mean values for duration (to nearest msec) of V_1 and V_2 of test words (columns) in environments of words with initial High tone and initial Low tone (rows).

nificant. Thus the tone of the first syllable of the context word seems to influence the tone contour of the preceding test word when the word is HL or LH but not if it is HH or LL. The overall tone levels of the various tone patterns are different depending on the tones of the following words, but

Figure 1: Mean Fundamental Frequencies of V_1 and V_2 of Test Words (Nouns)



Key: ———— environment of following High tone
---------- environment of following Low tone

this difference is not significant in any of the cases as determined by *t*-tests.

The durations of V_1 and V_2 in msec for the four test noun tone patterns in

the two general contexts of following High and Low tones are shown in Table 3. It is clear that the tone of the context noun has no effect on the duration of the vowels of the test words.[7]

2.1.4. Discussion of results

2.1.4.1. LH nouns. The design of this experiment was based on a claim which predicted a change, which might be a change in stress, in the pronunciation of LH words depending on the initial tone of the following word. The aim of the experiment was to find out if there was any measureable difference in fundamental frequency or duration depending on environment. The results for LH words show that the pitch of the Low tone is slightly higher when the word occurs before a High tone than when it occurs before a Low tone, as can be seen in Figure 1. The data also show that the difference in pitch between the two syllables is smaller before a following High tone than before a Low tone. There was no effect on the duration of the test word due to the tone of the context word. In the examples that were taken directly from Abraham the values for fundamental frequency and duration showed the same trends, although the difference in pitch between V_1 and V_2 was not significant due to a small data sample.

Thus, although there is evidence that the pitch of LH words is affected by the initial tone of the following word, the absence of any effect on duration makes the use of the term *stress* inappropriate. While certain aspects of Abraham's observations have been validated, it seems preferable to account for them in terms of tonal context rules rather than introducing a new feature called stress.

2.1.4.2. HL nouns. The results for HL words show, of course, that the High tone is on a higher pitch than the Low. One interesting result is that the difference in pitch between the two tones is smaller when the following word begins with a High tone than when it begins with a Low tone. This was also the case with LH nouns and both can be seen in Figure 1, where the solid line is shorter than the dotted one. Thus the basic observation made by Abraham

[7]According to Klatt [1976] a just-noticeable change in duration is 25 msec. Changes of 20% or more may serve as primary perceptual cues.

can be expanded to say that the pronunciation of both LH and HL nouns is affected by the initial tone of a following noun. Another interesting result for the HL nouns is that the High tone has the highest overall pitch, and the Low tone is itself within the fundamental frequency range for High tone. The Low tone is on a lower pitch before a following Low tone than a High tone, however.

2.1.4.3. HH and LL nouns. The pitch of both syllables of HH and LL words was higher before a following Low tone than before a following High tone, although not significantly so.

2.1.5. Conclusions. Abraham made the observation that the stress of LH nouns could shift from the second to the first syllable depending on the grammatical construction they were in and the phonological features, tone in particular, of the following word. This observation was investigated experimentally with additional tone patterns included as controls. The results of the experiment showed that the initial tone of the second noun had an effect on the fundamental frequency of the first noun when it was LH or HL. Overall pitch level changes were also observed for the HH and LL nouns, but they were not statistically significant. The initial tone of the context noun had no effect whatever on the duration of any of the test words. It was concluded, therefore, that while there is indeed a change in pronunciation in LH words depending on the features of the following word, as noticed by Abraham; the change is not, as he claimed, one of stress. Although the fundamental frequency changes, the duration does not, and changes in *both* would be expected in order to consider the difference stress. Furthermore, it was not only LH words which exhibited a change in fundamental frequency but HL words as well. Thus Abraham simply observed one case of a more general process. The changes observed were changes in fundamental frequency and occurred in all the nouns. They appeared to be cases of general tone rules and pitch realization rules in the language.[8] Thus the phonological context

[8]Meyers [1976] has a good account of pitch realization rules in Hausa. The phonetic realization of various tonal contours is also treated in Wängler [1963]. Both are discussed in Dresel [1977].

is important in that the sequence LH H, for example, will have a different phonetic realization than LH L. The grammatical context is important in that two nouns in the genitive construction form a close unit, the tones becoming a sequence subject as a whole to pitch realization rules.

3. Experiment 2

3.1. Verb + Noun

3.1.1. Introduction. This experiment was designed to examine the claims made by Abraham about stress movement in Verb + Noun constructions as described in section 1.2. As in the previous experiment, Abraham's claims deal only with LH verbs. HH and HL verbs were added here, however, both as controls and because the results of the previous experiment showed an effect on both LH and HL nouns. There are no LL verbs in Hausa. For Verb + Noun constructions, Abraham's hypothesis about stress movement is slightly different. He claims that the stress should shift from the second to the first syllable when LH verbs are followed by HH, HL, or *LL* words. That is, although LL words are said to have no stress, they supposedly function like nouns stressed on the first syllable. Experimental validation of Abraham's observation should show a change in fundamental frequency and duration on the first syllable of LH verbs before HH, HL, or LL nouns but not before LH nouns. Based on the results of the previous experiment, however, we expect that there will be no effect on duration but that there will be a contextually determined change in the fundamental frequency of LH and HL verbs.

3.1.2. Methods. Six verbs were chosen, expanding on the claim and conditions stated by Abraham, two each with the tone patterns HH, HL, and LH. Four nouns were chosen with the tone patterns HH, HL, LH, and LL. The 24 sentences were read in the following frame and were recorded under the same conditions as the previous experiment:

ta V N 'she V N'

An additional six sentences were read, taken from the examples used by Abraham, to illustrate his claim. The materials recorded are shown in Table 4. The measurement conventions and statistical analysis are the same as in the

Table 4: Materials for Experiment 2 - Verb + Noun

Verbs:			Nouns:		
	sato	'steal'		gara	'wedding presents'
	debo	'draw out'		tasà	'dish'
	dubà*	'look at'		kàza	'chicken'
	bʏgà*	'beat'		kèkę̀***	'bicycle'
	sàta**	'steal'			
	dùba**	'look at'			

1. Ta sato gara·
2. Ta sato tasà.
3. Ta sato kàza.
4. Ta sato kè(ke).
5. Ta debo gara.
6. Ta debo tasà.
7. Ta debo kàza.
8. Ta debo kè(ke).
9. Ta dubą̀ gara.
10. Ta dubą̀ tasà.
11. Ta dubą̀ kàza.
12. Ta dubą̀ kè(ke).
13. Ta bʏgą̀ gara.
14. Ta bʏgą̀ tasà.
15. Ta bʏgą̀ kàza.
16. Ta bʏgą̀ kè(ke).
17. Ta sàcį gara.
18. Ta sàcį tasà.
19. Ta sàcį kàza.
20. Ta sàcį kè(ke).
21. Ta dùbį gara.
22. Ta dùbį tasà.
23. Ta dùbį kàza.
24. Ta dùbį kè(ke).
25. Bài shìgą̀ ba.
26. Ya shìgą̀ ɗakì.
27. Ya shìgą̀ kògi.
28. Ya tą̀fi gįda.
29. Ya nèmį gįda.
30. Ya nèmį mą̀cę̀.

*The final vowel of these verbs shortens before noun objects.

**The final vowel of these verbs (Parsons Grade II) changes to -į before noun objects.

***See Table 1.

Noun + Noun experiment.

3.1.3. Results. Figure 2 shows the mean fundamental frequencies of LH verbs before the four noun tone patterns. As can be seen, contrary to Abraham's claim, LL context nouns do not pattern with HH and HL in terms of their effect on the preceding verb but rather have the same effect as LH nouns.

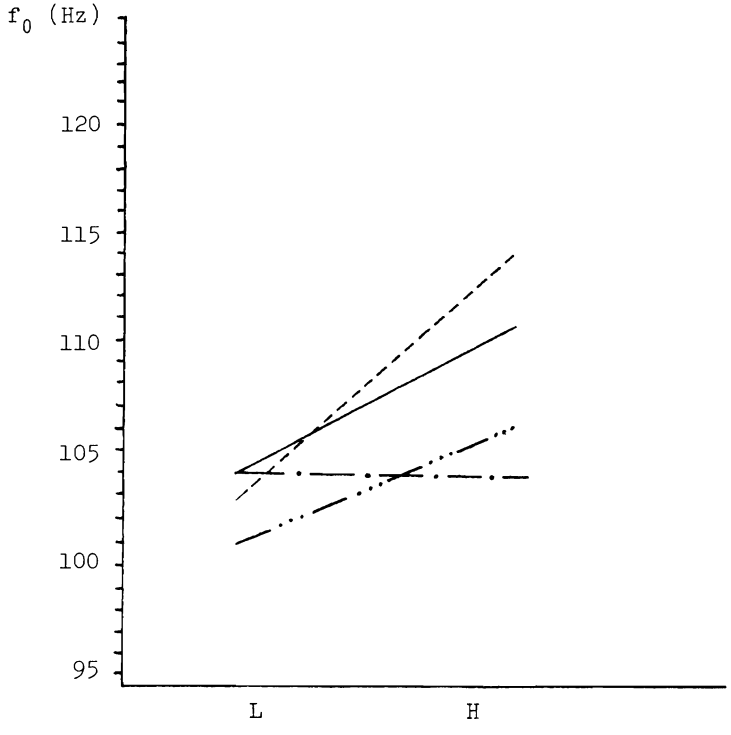
Table 5: Fundamental Frequency (Hz), Experiment 2 - Verb + Noun

Verb tone patterns (test words)						
H	H	H	L	L	H	
$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	Initial Tone of Nouns (Context Words)
113 (1.9)	112 (1.8)	125 (1.6)	109 (1.5)	102 (2.1)	105 (1.2)	H
118 (2.4)	119 (1.5)	121 (3.2)	106 (2.1)	104 (1.8)	113 (4.2)	L

Mean fundamental frequencies (to nearest Hz) of V_1 and V_2 of verbs (columns) in collapsed environments of nouns with initial High and initial Low tones (rows). Standard deviations shown under each fundamental frequency value. (Six tokens: 3 speakers x 2 readings).

Table 5 shows the mean fundamental frequencies of the verbs in the contexts of a following initial High tone and a following Low tone. These values are plotted on Figure 3. The differences in tone contours within the word are significant for LH verbs as indicated by a *t*-test ($p < .02$). For HH verbs the difference is only of marginal significance ($p < .10$) and for HL verbs there is no difference. It seems, therefore, that the initial tone of the context noun only has an effect on the tone contour of preceding verbs whose tone pattern is LH. There are also significant differences in the overall pitch levels of the verbs depending on the tone of the following noun. The overall tone level of HH and LH verbs is significantly higher ($p < .02$) before following Low tones. While there is also a difference in absolute level for HL verbs, the difference is not significant.

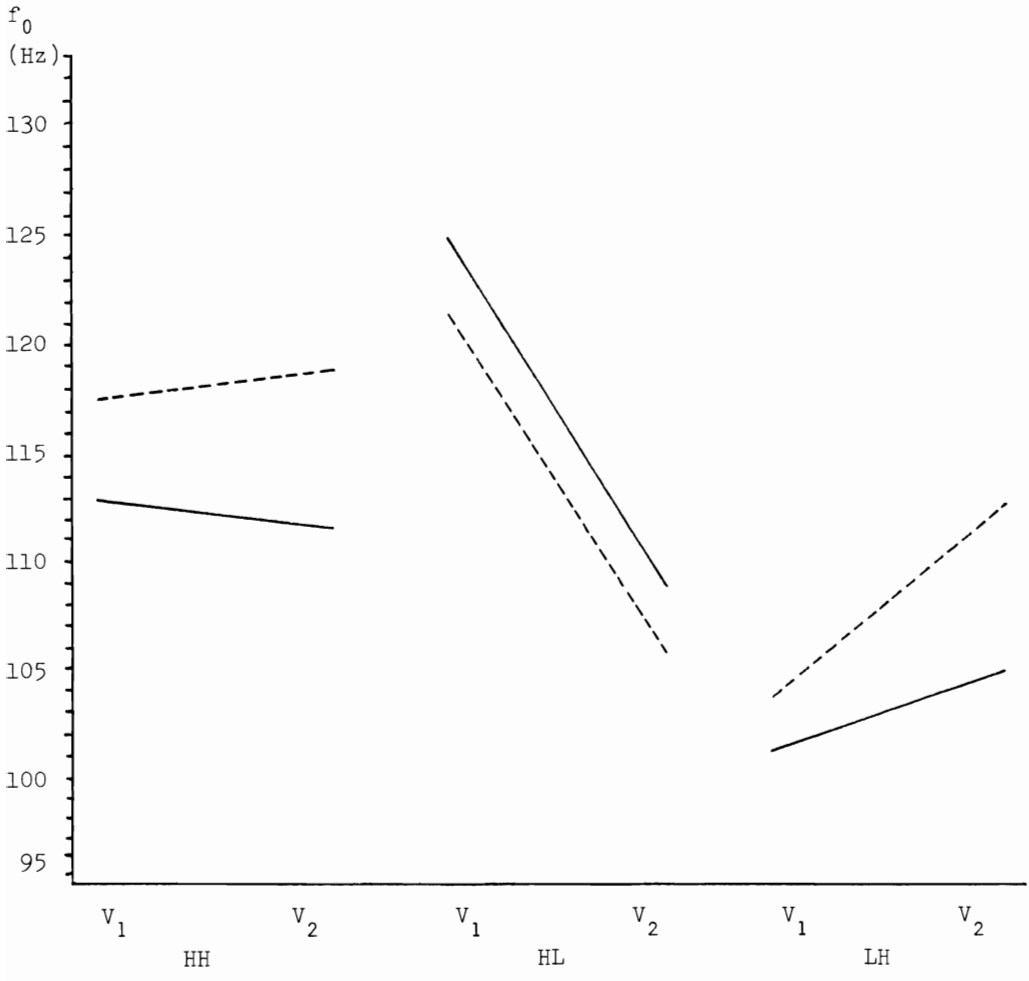
Figure 2: Mean Fundamental Frequencies of LH Verbs



Key: —•—•— environment of HH
—•••—••• environment of HL
———————— environment of LH
---------- environment of LL

The durations (in msec) for the two vowels of each of the three types of verb in the two contexts are shown in Table 6. While the duration of both vowels is consistently a bit longer before following High tones than Low tones, the difference is not significant ($p < .20$). Even for V_1 of the HH verbs, which has the biggest difference, it is only marginally significant ($p < .10$). We can conclude, therefore, that the initial tone of the context noun has no significant effect on the duration of the verb.

Figure 3: Mean Fundamental Frequencies of V_1 and V_2 of Test Words (Verbs)



Key: ———— environment of following High tone

---------- environment of following Low tone

Table 6: Duration (msec), Experiment 2 - Verb + Noun

Verb tone patterns (test words)

H	H	H	L	L	H		
$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1$	$\bar{V}_2$		
234	203	138	152	196	75	H	Initial Tone of Noun (Context)
215	196	132	151	183	72	L	

Mean durations (to nearest msec) of V_1 and V_2 of the three verb tone patterns (columns) in the environment of nouns with initial High and initial Low tones (rows).

3.1.4. Discussion of results

3.1.4.1. LH verbs. Abraham claimed that LH verbs would be pronounced with stress on the first syllable before HH, HL, or LL nouns, and with stress on the second syllable before LH nouns. The results of this experiment indicate that there is a difference in pronunciation in LH verbs depending on the context they are in, but that the difference is only in pitch. Since there is no difference in duration as well, the difference cannot be considered one of stress. There is less pitch difference between the two vowels of LH verbs when they are before a High tone than when they are before a Low tone. Furthermore, the pitch of LH verbs in the environment before a High tone is such that the pitch of the High tone is in the fundamental frequency range of Low tones. The difference between V_1 and V_2 is not only less, but the absolute values are also significantly lower. Thus, LL nouns pattern with LH nouns contrary to Abraham's claim that HH, HL, or LL nouns should all trigger a stress shift.

3.1.4.2. HH verbs. The HH verbs showed a tendency to have slightly higher pitch on the first syllable before Low tone words. While this difference is only marginally significant, there is a difference in the overall pitch such that the fundamental frequency of both syllables is much lower before a High tone than before a Low tone.

3.1.4.3. HL verbs. For HL verbs the difference between the mean fundamental frequency values before High and Low tones was not great enough to be considered the result of contextual influence. There was a difference in absolute values however, such that the fundamental frequencies of both vowels were higher before a following High tone than before a Low tone. In HH and LH verbs the opposite was found, that is, the absolute values were higher before following Low tones. Thus it seems there is assimilation of a Low tone in one word to a following Low tone, but dissimilation of a High tone to a following Low.

3.1.5. Conclusions. Based on a claim made by Abraham about the pronunciation of LH verbs when followed by nouns of various phonological qualities, an experiment was designed to try to determine what phonetic feature was influencing the pronunciation of these verbs. LH verbs were investigated in four environments, and HH and HL verbs were added as controls. The hypothesis was that if the change in pronunciation was a change in stress, it would be measurable as an increase or change in fundamental frequency and increased duration. The overall pitch was higher for LH and HH verbs before Low tones, and higher for HL verbs before High tones. Furthermore there was a significant change in the difference between V_1 and V_2 for LH verbs, and a marginally significant one for HH verbs. The tone of the context nouns had no effect, however, on the duration of the test verb. There are, then, as Abraham noticed, some environmentally conditioned phonetic changes in some Hausa verbs. These changes cannot be described, however, as the result of stress but rather as the result of tonal rules.

There are some similarities and some differences in the results for the two experiments. In both cases it was found that the difference in pitch between the vowels of LH words was greater before a following Low tone than a High tone. The difference in pitch contour between the vowels of level toned words was not significant in either experiment. The main difference is that the contour effects (difference between V_1 and V_2) are more noticeable in the Noun + Noun experiment, while the effect on absolute values (pitch level) is greater in the Verb + Noun experiment.

4. General Conclusions

Any discussion of stress in Hausa must look at two questions. One is the definition of stress as a feature different from tone, and the other is the necessity of both features for the description of the language.

Addressing himself to the first question Meussen [1970] writes that distinctions in stress are less stable and more likely to be affected by changes in intonation or tempo than are distinctions in tone. It has also been noticed that one difference between tone and stress is that while they are both characterized by relative high pitch, they function differently in relation to surrounding syllables. High toned syllables tend to cause surrounding syllables to raise their pitch, while stressed syllables tend to cause surrounding syllables to lose their stress (Pike [1974:169] and Hyman and Schuh [1974:81]).

Several authors have addressed themselves to the question of the need of features both of stress and of tone. Meussen [1970] lists several African languages, investigated by other linguists, which are described as having both stress (either predictable of unpredictable) and tone. Lea [1973] entertains an interesting speculation about the problem in relation to historical linguistics. He surmises that tone and stress contrasts might both exist in a language at some point in its development. However, he predicts changes which would make the interpretation of one type of contrast become a perceived contrast of the other type. Woo [1969] reviews data from several languages, Bambara (Mande) among them. She classifies Bambara as a tone harmony language since each lexical item has one of two pitch patterns. She claims, however, that in addition, Bambara has rules of stress assignment. In a word with HH tone, the second syllable will be stressed and will therefore be higher in pitch, longer, and of increased intensity. She concludes that although stress is related to pitch it can exist independently of it. Stress is related to pitch in that stress often has the effect of raising pitch and lack of stress of lowering pitch. A similar relationship exists between stress and vowels and vowel quality. Woo concludes therefore, that pitch and stress are different phonological features. Lehiste [1970] tries to evaluate the evidence regarding the possible independence of fundamental fre-

quency and intensity on the one hand, and stress and pitch on the other. She concludes that although there are two physiological mechanisms, subglottal pressure and the tension of the vocal folds, that can produce increases in fundamental frequency independently of each other, speakers tend neither to do so systematically nor use them for different linguistic purposes nor perceive any distinction between them.

The results of the experiment on stress in Hausa lead to the conclusions that while there are contextually conditioned pronunciation changes which occur in certain grammatical constructions in Hausa, these changes cannot appropriately be described in terms of *stress* but rather must be considered *tonal* changes. There is no need therefore for both *tone* and *stress* to describe Hausa. Furthermore, the "prominence" which occurs behaves linguistically like tone and not like stress.

There are, however, reasons why the term stress has persisted in descriptions of Hausa. The major investigators of Hausa have been Europeans whose languages were stress languages. Lea [1977] reports that there is experimental evidence that listeners judge foreign languages in terms of what they know to be the correlates of stress in their own languages and what they hear as prominence in the foreign language. People working on Hausa could easily, then, interpret fundamental frequency or duration changes as stress. Even when this was not the case, investigators like Abraham, who described the tone and vowel length systems very accurately, occasionally found what they considered variations from the normal tone patterns. It was very convenient, therefore, to use a different feature, stress, to describe them. As seen by the results of the experiment, there is instrumental evidence that the observations made by Abraham were in fact correct. But whereas he accounted for the observation by calling it stress, we have found that wider reaching tone rules, already functioning in Hausa, can account for the observed change. The experiments were conducted to look at shifts of stress which were determined to be experimentally more suitable than an investigation of stress on individual words. The results of the stress shift experiments however, indicate that there is no justification for introducing a feature of stress.

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