

THE PHONETICS OF REGISTER IN THE FUZHOU DIALECT OF CHINESE

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ABSTRACT - Investigations are made into the phonetic reality of the phonological feature Register, originally defined by Yip as a bifurcation of the pitch range (1990:196). This is discussed in terms of her analysis of Fuzhou tonology, which uses Register to capture the natural class of tones as defined by their participation in vowel alternations. Mean normalised fundamental frequency contours are presented for the citation tones. The degree of abstractness involved in this analysis is assessed in terms of the original definition of Register. Finally, alternative definitions for Register are explored on the basis of the instrumental data.

INTRODUCTION

The relationship between phonetics and phonology has never been straightforward, as phonology describes the relationships between the sounds of a language, and phonetics serves to describe them on the various levels of the speech chain. The extent to which phonological analyses reflect phonetic reality is indeed up to the individual, with varying degrees of abstractness being tolerated by the different phonological theories. Instrumental phonetic data is indispensable, however, for evaluating competing analyses, and its unambiguous nature is ideal input for definitions. It is my aim to explore the possibility of using such data to define the 'Register' feature.

REGISTER

The feature Register was first proposed by Yip (1980), in an extensive study on Chinese tonology, in order to accommodate the contour tones of Chinese dialects within the autosegmental framework which was originally proposed to account the tones found in African languages. From a universal point of view, Register is a desirable feature for a tonological theory as it enables four pitch levels to be specified and restricts the maximum number of any one contour, with only two features, which is less marked than systems employing more features to meet the above criteria (Hyman 1985).

Yip claims that tone is represented by two features bearing a hierarchical relation: [+upper], which is dominant, splitting the pitch range into two registers, and [high] (now called [raised]), which is subservient, and further sub-divides each Register. So a 'tone' while realised phonetically as pitch, is phonologically represented by two features: Register ([±upper]) and Tone or melody ([±high] which is written as H and L). Register and Tone interact to define four pitch levels:

Register	Tone
+ upper	+ high (H)
	- high (L)
- upper	+ high (H)
	- high (L)

Figure 1. Interaction of Register and Tone

Each of the two features forms a separate autosegmental tier, and is therefore subject to the Well-Formedness Condition. However only Tone occurs in sequences underlyingly, Register remains constant over the whole morpheme. As the Register feature is both dominant and binary, the tonal inventory is restricted to no more than two of any given contour.

FUZHOU

Fuzhou is one of the Min dialects, which are found in Southeast China, most of Fujian province and the North-eastern corner of Guangdong.

A reasonable amount of descriptive work has been done on Fuzhou. Chan (1985) produced a list of all the relevant sources and the corresponding values assigned to the seven citation tones. All of these

studies use auditory transcriptions as their observation data. A sample of the differences is shown below in table 1 (underscoring indicates a stopped tone).

Author:		Tone 1	Tone 2	Tone 3	Tone 4	Tone 5	Tone 6	Tone 7
Chan	1985	44	32	213	<u>13</u>	51	131	5
Chen	1967	44	22	242	<u>24</u>	52	312	<u>55</u>
Corbato	1945	44	21	25	<u>24</u>	52	232	5
Ergerod	1956	55	33	13	<u>13</u>	52	242	<u>55</u>
Lan	1953	55	33	11	<u>13</u>	61	242	<u>56</u>
Nakajima	1979	55	33	31	<u>23</u>	52	242	<u>55</u>
Norman	1988	55	22	13	<u>24</u>	41	342	<u>55</u>
Yip	1980	44	22	12	<u>13</u>	52	242	4
Yuan	1960	44	31	213/13	<u>23</u>	52	353	<u>4</u>

Table 1. Differing auditory descriptions for Fuzhou citation tones.

There is obviously not general agreement on the appropriate representations of the tones, even with respect to the other tones in a given system. This could be due to any number of reasons such as sub-dialectal or between-speaker differences. It does also, however, question the reliability and consistency of linguists' pitch transcriptions. All these factors effect the above works as they use the linguist's perception of pitch as their observation data to characterise the tones.

When analysing the tonology of Fuzhou, Yip did not have her own data. Rather she had to rely on data gathered from other sources. The exact values she chose to use have been included in Table 1. One of Yip's major considerations for tonal feature assignment was the morphophonemic natural classes formed under tone sandhi. Table 2 illustrates the changes that occur on the first syllable of a disyllabic expression, as Fuzhou tone sandhi is 'right dominant'. That is, in a disyllabic expression, it is the second or final syllable which remains unchanged, but provides the context for the preceding tone on the first syllable, which changes accordingly.

Second syllable:	44, 52, 4	22	12, 242, 13
First syllable:			
44 - Tone 1	44		52
12 - Tone 3			
242 - Tone 6			
52 - Tone 5			22
4 - Tone 7			
22 - Tone 2	22		35
13 - Tone 4			4

Table 2. Fuzhou disyllabic tone sandhi.

Table 2 shows eg: /52/ followed by /242/ will surface as a sequence of [22], then the unchanged /242/.

Fuzhou's chief claim to fame is its set of alternations in vowel quality under tonal conditioning. These tones divide into two natural classes on the basis of vowel alternation under tone sandhi. In one of the classes, group A (Tones 1,2,5,7), the vowels do not alternate. In group B (Tones 3,4,6), however, the vowels do alternate. That is, when one of these tones changes to any sandhi tone, the vowel will also change to a form like that which occurs on the A group tones. For example (Chao 1934:41):

- 護 [hou ɿ (242)] 'protect'

護兵 [hu ɿ (55) βiŋ ɿ (55)] 'guards' (lit. protecting soldiers)
- 竹 [tøyk ɿ (23)] 'bamboo'

竹節 [ty ɿ (5) 3aik ɿ (23)] 'bamboo section'
- 氣 [khei ɿ (12)] 'air'

氣壓 [khi ɿ (53) ak ɿ (23)] 'air pressure'

When the tone from group B changes under sandhi to a tone like the high level tone of group A, the vowel type also changes to its corresponding form in group A. In the above example, [ou] alternates¹ with [u], [ei] with [i] and [ey] with [y]. In the dialect there are many other such vowel alternations which Yip illustrates as follows:

Group A	Group B
Tones: 1, 2, 5, 7	Tones: 3, 4, 6
i	ei
y	øy
u	ou
ei	ai
œ	øy
ou	ɔu

Table 3. Vowel alternations as presented by Yip.

The contexts for vowel raising are any of the group A tones (1, 2, 5, 7) or ANY sandhi tone. Yip uses the Register feature to capture the natural classes formed by the division in the tonal inventory with respect to the vowel alternations. She assigns [+upper] to the Group A tones and formulates a rule specifying that all tones become [+upper] in sandhi position. Thus, Register determines whether or not the syllable type associated with the tone will participate in the vowel alternations. The Tone features are determined by the natural classes defined by the grouping of context and input for tone sandhi.

This is a very elegant analysis, but when assessing the degree of abstractness from phonetic reality, a problem arises from tone 2. Yip acknowledges that tone 2 has also been represented as falling (cf Table 1), questioning, perhaps, the assignment of [+upper] (LL). Her main justification for this assignment is the vowel alternations. Also if it were [-upper], it would necessarily have to be H to distinguish it from the other [-upper] tones, grouping it wrongly as a context for sandhi. She stresses that a feature like [upper] is a relative one, and that [22] does have a 'higher onset pitch' than the other [-upper] tones. She also points out that (from the data she used), the value of [22] for tone 2 is the same as one of the sandhi tones. Thus the vowel alternations on the citation tones, and the fact that all syllables in sandhi position have the non-alternating vowel types, seem to be connected to the same phenomenon. So an analysis that can account for all this with one feature is obviously desirable.

Whilst firstly defined as a feature bifurcating the pitch range, Register is now used to account for the vowel alternations, requiring the need to justify the assignment of [+upper] to the low level tone 2. So, while Register is clearly a useful and desirable feature to be able to use in tonology, it lacks any strict definition. It would be good for both tonologists and linguistic phoneticians alike to have a solid, working definition of this feature. It is the aim of this paper, then, to investigate the extent to which this phonological feature may be defined phonetically with respect to fundamental frequency, the main acoustic correlate of pitch (Lehiste 1970, Rose 1988).

PROCEDURE

Obviously there needs to be some way of standardising the method of the description of tones in general which can be done by quantifying the linguistically relevant aspects of the physical signal. The results obtained from an instrumental investigation of the acoustic phase are not subject to as many sources of error such as those mentioned above. Ensuring geographical sameness will further narrow the scope of error sources, and by using a multispeaker approach between-speaker differences can be factored out, in order to obtain a tonal configuration representative of the variety as a whole.

Specifically controlling for intrinsic effects between segmentals and tones, I elicited the speech of two males and two females, all from Fuzhou city. About 15 tokens per speaker per tone were analysed spectrographically. Measurements of fundamental frequency (F0) and duration were taken from expanded narrow band, and wideband spectrograms respectively. Measurements of F0 were made at 20% intervals of duration, and also at 5 and 95% in order to satisfactorily resolve details of the time course, entailing about 30 measurement points per second.

Mean F0 contours were plotted against absolute duration for each speaker. Onset and offset perturbations were visible over about the first 5 csecs, and the final 5% of duration. Between speaker differences were factored out by a process of normalisation, using a z-score transform (Rose 1987). The

results of the normalisation were then plotted against the average duration for the given tone, in order to be able to represent these tones as target contours, devoid of effects such as the on- and offset perturbations. Figure 2 is a representation of the resulting mean normalised F0 contours for Fuzhou. The y-axis is expressed in standard deviations away from the mean. The origin is slightly lower than the actual mid-range point as the normalisation parameters consisted only of comparable tones, (tones 1, 3, 4, 6) which lie in the lower half of the range, thus lowering the mean.

RESULTS

The main result arising from this acoustic investigation is that Yip's assumption of tone 2 as [22] is wrong, as this tone is not level, but rather falling. Furthermore, Yip's proposal of a simple bifurcation of the F0 range at 50% to define Register, does not work, because the putative [+upper] tone 2 lies in the lower half of the F0 range. Following is a discussion of the extent to which other methods of division of the F0 range may be useful in capturing the two natural classes as defined by the vowel alternations.

DISCUSSION

This section explores three different ways of defining Register using my instrumental data. The first only takes the point of onset into consideration. The second model involves a variable point of bifurcation, and the final model, overlapping Register features. These models are illustrated in Figure 3.

50% bifurcation of the F0 range at onset points.

This model defines Register a bifurcation of the pitch range at point of onset. That is, halving the range as defined by the onset points, above the line is then [+upper] and below, [-upper]. This accommodates the grouping of tone 2 with tones 1, 5 and 7 in [+upper]. Yip made reference to the fact that the point at which the registers meet could feasibly be designated either \pm upper, pending the assignment of \pm high as a Tone feature. The fact that this tone falls after the onset point would seem to suggest that it should be grouped with the [-upper] tones, thus not capturing the desired natural class. Whilst seeming to be a counter-intuitive assignment of [+upper] to a mid-falling tone 2, this definition of Register can account for the desired natural class in Fuzhou tonology, as the only parameter used to define the feature is the range at onset point. This is mostly counter-intuitive because tones can be conceived of as having targets, and indeed target contours. Another important point against this model is that the onset point could highly sensitive to the manner of articulation of the initial consonant.

Variable point of bifurcation model.

Another parameter within which to define Register is a bifurcation of the F0 range, but not at exactly 50%. Rather at a point which will more comfortably accommodate the data. In order to capture the natural classes in Fuzhou, the point of bifurcation would have to be 30% from the bottom of the F0 range to exclude tone 2 from the lower group. Whilst accommodating tone 2 in the upper register, it has some rather adverse effects on the lower register tones. Two of the [-upper] tones, tones 4 and 6 now rise well into the upper register. More importantly, however, is that the onset points for all of the lower register tones would have to be specified as [+high], (H), at least for tones 3 and 6 in any case, their onset points being located at or above the alleged point of bifurcation. This would necessitate incorrect Tone assignment, so we may conclude that this model cannot be used to define Register in Fuzhou.

Overlapping Register features.

My final suggestion is that the Register features may overlap. This allows tone 2 to be grouped with the other upper register tones, without effecting the lower register Tone feature assignment. From figure 3 we can note that this not only includes all of tone 2 in the upper register, but also the offset of the high falling tone 5. Paralleling the degree of overlap either side of the mid point seems to incorporate unnecessary extension above this point for the lower register, extending beyond the top of the rise in both tones 4 and 6. However, never actually reaching any of the H tones in the upper register, this is insignificant. From this, with lower register H Tones being higher than upper register L Tones, it would seem that the Register and Tone features have swapped positions, though the dominance relationships remain unaffected. This model entails 40%, nearly half, of the range within which tones could be feasibly assigned either [+upper]. This can be likened to a labio-velar consonant grouping with either labials or velars. However, with no constraint on exactly *how* much overlap is allowed, it is basically a vacuous definition, and whilst more explicit, hardly any more rigorous than Yip's original one.

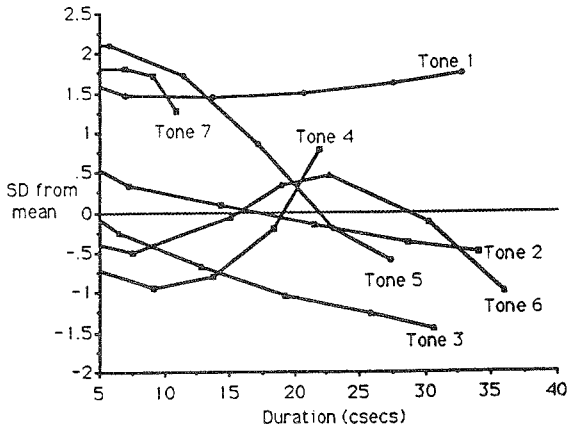


Figure 2. Mean normalised F0 contours for Fuzhou citation tones.

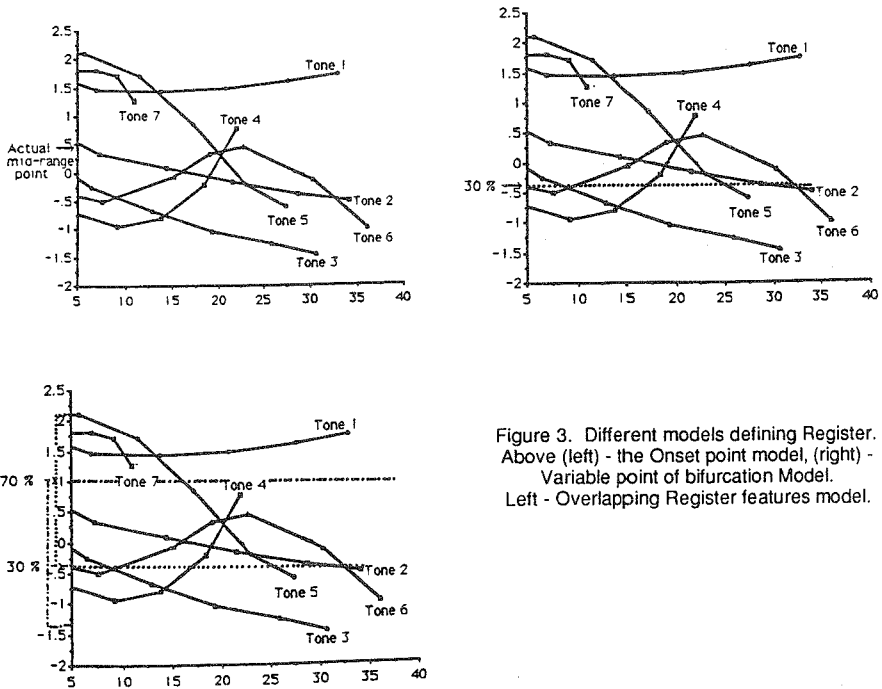


Figure 3. Different models defining Register. Above (left) - the Onset point model, (right) - Variable point of bifurcation Model. Left - Overlapping Register features model.

One concluding remark on a phonetically-based definition of Register. It may be useful to try incorporating other acoustic dimensions, such as radiated amplitude and duration, should these be found to be integral parts of the perception of tone.

SUMMARY & CONCLUSION

Having presented the Register feature, and the natural classes which would desirably be captured by this feature for Fuzhou tonology, an investigation into the phonetic reality of this phonological construct was undertaken. Using acoustic data, a normalised tonal configuration was presented, representative of the whole variety. From this, it was my aim to test Yip's Register feature, as defined as a bifurcation of the pitch range, but which is also manipulated to capture the desired class. The main result is that tone 2 is not level, rather it is falling. From this, Yip's assignment of [+upper] Register to tones 2, is rendered phonetically opaque. However, it has been found that it is possible to use instrumental data to define this phonological feature, maintaining the desired natural class. Specifically, three experimental models were presented, two of which were successful. The bifurcation at onset point model will accommodate the data, but is counter-intuitive to our (limited) knowledge of salient features of tonal perception. The other successful model was that of the overlapping features. Whilst more sophisticated and explicitly defined, it is no more rigorous than 'a bifurcation of the pitch range'. From this, the amount of work needing attention in tonal studies is apparent; particularly we need more work on the phonetics of Register, and also on the perception of tone, and the salient acoustic correlates of linguistic pitch.

ENDNOTE

1. These may be legitimately referred to as vowel alternations. Given two tonal paradigms, one with [i]~[ei] vowel types, and another with [ei]~[ai], the native speaker will perceive those syllables in the first group to be tonal variants of the same rime. My informant didn't think of associating the 'group B' tones with the [ei] vowel type with the 'group A' tones with the same vowel. When this possibility was brought to her attention, she accepted that they were a "bit similar".

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