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WORD GAMES: SOME IMPLICATIONS FOR ANALYSIS OF TONE AND OTHER PHONOLOGICAL PROCESSES

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1. Introduction

Word games have become very popular among linguists and, in fact, have a current literature of their own. Bamgbose (1970) with Yoruba, Chao (1931) with Chinese dialects, Conklin (1956, 1959) with Tagalog and Hanunóo, Haas (1957, 1969) with Thai and Burmese, Hombert (1973) with Bakwiri, and Sherzer (1970) with Cuna give us an idea of the socio-cultural role of word games, the kind of manipulations which can be used, and how they can help us to solve linguistic problems.

In this paper[1], I shall first present some examples where word games can shed light on problems involved in phonological descriptions and then turn to the representation of tone, especially to the segmental vs suprasegmental nature of tone. In order to do this, I will present data from experimental work[2] done with speakers of Asian and African languages. After looking at problems of analysis introduced by these two different representations, I will attempt to define what some of the theoretical implications are. Finally, I will mention the relevance of data from existing word games and also the possibility of inventing word games as a way of gaining insight into phonological systems.

2. Linguistic use of word games

The examples presented in this paper involve a word game which consists of inverting the position of the two syllables in disyllabic words, as in (1).

(1) $C_1V_1C_2V_2 \longrightarrow C_2V_2C_1V_1$

for instance: 'death' kwélí ⟶ líkwé

The first part of this study will be illustrated with examples from Bakwiri[3], a language spoken on the southern slopes of Mount Cameroun.

2.1 Syllable structure

2.1.1. Word games can be used to define the syllable structure. Let us consider the sequence presented in (2). It is not clear to which syllable V_2 and C_2 belong. Examples presented in (2a, b and c) can suggest a solution.

(2) $(C_1)\ V_1\ (V_2)\ C_2\ V_3$

a. 'plantain' mɔ̀kɔ̀ ⟶ kɔ̀mɔ̀ BUT NOT ɔ̀mɔ̀k
b. 'throat' ì ŋɔ̀ ⟶ ŋɔ̀ʔì BUT NOT ɔ̀ʔì ŋ
c. 'wood' wèɔ̀lí ⟶ lìì wéó[4] BUT NOT ɔ̀lí we

Considering these data, the Bakwiri syllable structure should be analyzed as (C) V (V). It is interesting to notice the appearance of a glottal stop in transformation 2b. In Bakwiri glottal stops occur only before a vowel in word initial position as shown in (3).

(3) /ì ŋɔ̀/ ⟶ [ʔì ŋɔ̀]

This glottal stop is preceived with difficulty in initial position but it becomes obvious when the syllables are reversed in the word game as seen in (2b). Since the vowel sequence [ɔi] is not prohibited and, in fact, does exist in certain words in Bakwiri, our example (2b), along with examples such as (4) shows the psychological reality of the initial glottal stop.

(4) a. 'salt' ì kʷá ⟶ kʷàʔí
b. 'sum' ì gʷé ⟶ gʷèʔí

The reason why the glottal stop is transposed with the vowel is to prevent the loss of a syllable. If the vowel were moved to the end without the glottal stop, the resulting unacceptable game form (5) would reduce the word to only one syllable.

(5) ì ŋɔ̀ is not transformed into ŋɔ̀ì

Thus, the glottal stop provides one more piece of evidence that the unit moved by the word game is the syllable.

2.1.2 The only consonant clusters occurring in Bakwiri consist of nasals followed by homorganic voiced stops. This restricted distribution might lead us to suspect that these clusters are phonemic units. Their behavior in the word game confirms this suspicion.

(6) a. 'to take care' kőmbà ⟶ mbákò[5] BUT NOT bákòm
b. 'rice' kőndì ⟶ ndíkò BUT NOT díkòn
c. 'father' zãŋgó ⟶ ŋgózá BUT NOT gózáŋ

2.2 Glides

One of the problems in the analysis of Bakwiri is establishing whether forms as in (7) are to be analyzed with an intervocalic glide or not.

(7) a. 'stone' lìyé OR lìé
b. 'excrement' lówá OR lóá
c. 'small' tèyí OR tèí
d. 'village' mbówà OR mbóà

The word game provides a reliable criterion for setting up underlying forms as seen in the left column of (8) and (9).

(8) a. lìyé ⟶ yèlí
b. lówá ⟶ wáló

On the other hand, some forms are unable to undergo the game transformation, presumably because they have no underlying glide and therefore consist of only one syllable.

(9) a. tèí ⟶ ø
b. mbóà ⟶ ø

It is possible sometimes to be able to check the correctness of the transformations made by the native speaker. In (10) the plural form of the item given in (7a) is presented, we see that the glide is, in fact, present.

(10) 'stones' màyé

2.3 Vowel length

If we look at (11) we can see that when a word has a long vowel, the length is not transposed with the syllable but rather stays in the same place.

(11) a. 'stomach' lùùŋgá ⟶ ŋgààlú
b. 'burn' zééyá ⟶ yáázé

If we call S1 the first syllable and S2 the second syllable, the generalization of this transformation can be written as in (12).

(12) $\begin{bmatrix} \text{S1} \\ +\text{ length} \end{bmatrix} \begin{bmatrix} \text{S2} \\ -\text{ length} \end{bmatrix} \longrightarrow \begin{bmatrix} \text{S2} \\ +\text{ length} \end{bmatrix} \begin{bmatrix} \text{S1} \\ -\text{ length} \end{bmatrix}$

From the examples presented in (11) it could be argued that there is a constraint which does not allow a double vowel in word final position. If we look at (13) we see that all combinations are possible and therefore this argument does not hold.

(13) a. 'earth' ʔèzé ⟶ zèʔé
1 2 2 1

b 'bone' ʔèèzé ⟶ zèèʔé BUT NOT zè ʔéé
1 2 2 1 2 1

c. 'it is not' é zèè ⟶ zé ʔèè BUT NOT zéé ʔè
1 2 2 1 2 1

In both cases (13b) and (13c) the rhythmic pattern does not change when the syllables are reversed by the game. We can now generalize as in (14).

(14) $\begin{bmatrix} S1 \\ \alpha \text{ length} \end{bmatrix} \begin{bmatrix} S2 \\ \beta \text{ length} \end{bmatrix} \longrightarrow \begin{bmatrix} S2 \\ \alpha \text{ length} \end{bmatrix} \begin{bmatrix} S1 \\ \beta \text{ length} \end{bmatrix}$

When the long or more exactly, the double vowel is formed by two different vowels, the native speaker is sometimes unable to apply the word game rules, but in other cases he can give the expected form as in (15).

(15) 'door' lìòβá ⟶ βààlíó

The problem encountered by the native speaker in applying the word game rules in this case can have two origins. Either it can be a difficulty in replacing a sequence of two different vowels V_1V_2 by a sequence of two identical vowels V_3V_3 (in the case of a word having the structure $C_1V_1V_2C_2V_3$) or more probably, the speaker feels he is violating the length pattern by putting a double vowel in a position where there was a single vowel before the transformation. All these data seem to suggest that, in Bakwiri, the length pattern is a property of the whole word and consequently is not dependent on the segment to which it is originally assigned. The same kind of evidence is found in Conklin (1956, 1959) for Tagalog as shown in (16) and for Humanuóo as shown in (17).

(16) dooti ⟶ diito BUT NOT ditoo

(17) buuŋa ⟶ ŋaabu BUT NOT ŋabuu

3. Tone

3.1 As can be seen from the examples presented so far, as well as in (18) below the tone pattern of disyllabic words in Bakwiri is not affected by the word game transformation.

(18) a. Low-low 'plantain' màkà ⟶ kàmà

b. High-high 'death' kʷélíˊ ⟶ líkʷé

c. Low-high 'one person' màkáˊ ⟶ kàmáˊ BUT NOT kámà

d. High-low 'falling' kʷélì ⟶ líkʷè BUT NOT líkʷé

As I suggested earlier for the length pattern, speakers isolate the tone pattern as a property of words, that is, *without a particular tone being attached to a particular segment*, and, in our case, *not even to a particular syllable*. In other words, data from this word game suggest that tone is a *suprasegmental feature in Bakwiri*[6].

It is interesting to note that in Thai and Burmese word games reported in Haas (1969), the reverse is found. These word games consist of interchanging the finals of two successive syllables as shown in (19) for Thai[7] and (20) for Burmese.

(19) 'big bottom' k[ôn] j[àj] ⟶ k[àj] j[ôn]

(20) 'fire place' míˊ bòw ⟶ mòw bíˊ

The tones move with the transposed segments, suggesting that in Thai and Burmese, tones may be best analyzed as a *segmental feature on syllabic segments*.

3.2. In fact, one of the hotly debated issues on the status of tone is whether tone should be represented as a *segmental or a suprasegmental feature*. Schachter and Fromkin (1968) in Akan, Woo (1969), Maddieson (1971) and Fromkin (1972) argue for segmental representation. But Pike (1948), and McCawley (1964, 1970) view the syllable as the domain of the tone feature. Welmers (1962) claims that tone should be regarded as a feature on the morpmeme in Kpelle. Edmonson and Bendor-Samuel (1966) present evidence for regarding the phonological word as the tone bearing unit in Etung. More recent studies by Elimelech (1973) in Kru, by Leben (1973a) in Mende, Bambara, Maninka and Hausa, and by Mazaudon (1971) in Tamang spoken in Nepal, lead to a similar conclusion: that is in these languages tone should be regarded as a *feature on the phonological word*.

3.3. One persuasive argument for tone as a feature on the phonological word in these languages is that the number and shapes of tone patterns are not dependent on the number of vowels or syllables a given word has. This is what is shown in (21) for Kru[8] and (22) for Tamang.

(21)

	Monosyllabic			Disyllabic		
a.	'pepper'	bá	[¯]	'wine'	númó	[¯ ¯]
b.	'rice'	kò	[_]	'cup'	tàpè	[_ _]
c.	'child'	jŭ	[˘]	'inside'	kélĕ	[¯ ˘]
d.	'chicken'	sû	[˥˩]	'coconut'	kʼtâ	[¯ ˥˩]

(22)

	Disyllabic			Trisyllabic		
a.	'he went'	ni-ci	[˥˥]	'if he goes'	ni-sami	[˥˥˧]
b.	'he sat'	ci-ci	[˥˩]	'if he stays'	ci-sami	[˥˥˧]
c.	'he pinched'	cii-ci	[˥˧]	'if he pinches'	cii-sami	[˥˥˧]
d.	'he remembered'	cii-ci	[˩˩]	'if he remembers'	cii-sami	[˩˩˧]

From these data it is clear that the tone patterns on di- or trisyllabic words are just expanded versions of tone patterns on monosyllabic units for Kru and disyllabic units for Tamang, suggesting that tone is mapped over the phonological word without using segmental information.

3.4. Word games can provide important insight into this segmental vs. suprasegmental controversy. I have devised a word game for this purpose and used it with native speakers of African and Asian languages. This word game involves the two manipulations shown in (23).

(23) a. $C_1V_1C_2V_2 \longrightarrow C_1V_2C_2V_1$ (M1)

b. $C_1V_1C_2V_2 \longrightarrow C_2V_2C_1V_1$ (M2)

A disyllabic word $C_1V_1C_2V_2$ was changed into $C_1V_2C_2V_1$ (vowels interchanged) by the first manipulation M1, or into $C_2V_2C_1V_1$ (syllables interchanged) by the second manipulation M2. After Bakwiri, I experimented with speakers of the Dschang and Kru languages of Africa, and Mandarin, Cantonese, Taiwanese and Thai among East Asian languages.

I taught the word game to my informants by using the simple syllable structure CV (and not CVV or CVC) and identical tones on both syllables to illustrate the rules of vowel and syllable interchanging. The output from M2 was quite consistent both in African and Asian languages. As the data in (24) show, the tone pattern was left unchanged by African speakers performing the syllable switching manipulation.

(24)

a.	Bakwiri	'falling'	kʷéìì	M2 →	ìíkʷè	BUT NOT	ììkʷé
b.	Dschang	'bone'	àkʷē	M2 →	kʷèā	BUT NOT	kʷēà
c.	Kru	'axe'	túwê	M2 →	wétû	BUT NOT	wêtú

But apart from very rare exceptions which will be discussed later, the tones were consistently moved with the syllables by the Asian speakers as shown in (25).

(25)

a.	Thai	'woman'	phu˨˩ jiŋ˧˥	→	jiŋ˧˥ phu˨˩	BUT NOT	jiŋ˨˩ phu˧˥
b.	Cantonese	'convenient'	fɔŋ˨˩ pin˥	→	pin˥ fɔŋ˨˩	BUT NOT	pin˨˩ fɔŋ˥
c.	Taiwanese	'meaning'	i˨˩ su˩	→	su˩ i˨˩	BUT NOT	su˨˩ i˩
d.	Mandarin	'at least'	tɕʻi˧˥ ma˩	→	ma˩ tɕʻi˧˥	BUT NOT	ma˧˥ tɕʻi˩

From (26) we can see that the output from M1 is also consistent for the African languages considered. The tones are not moved when the vowels are interchanged.

(26)

a.	kʷéìì	M1 →	kʷíìè	BUT NOT	kʷìíé
b.	àkʷē	M1 →	ēkʷā	BUT NOT	ēkʷà
c.	tawe	M1 →	tewu	BUT NOT	têwú

The data from the Asian languages on M1 are not so straightforward as they were for M2. In Thai, a great majority of items presented (70%) were transformed as shown in (27a), that is, the tones were moved with the segments; but some items were left unchanged as in (27b).

(27)

a.	'woman'	phu˨˩ jiŋ˧˥	M1 →	phiŋ˧˥ ju˨˩	BUT NOT	phiŋ˧˥ ju˨˩
b.	'milk'	nam˥ nom˧	M1 →	nom˥ nam˧	BUT NOT	nom˧ nam˥

The output of M1 is also subject to variation in Cantonese; 50% of responses were of the form presented in (28a), with the tones being moved with the vowels, and approximately 50% were of the form presented in (28b).

(28)

a.	'convenient'	fɔŋ˨˩ pin˧	M1 →	fin˧ pɔŋ˨˩	BUT NOT	fin˨˩ pɔŋ˧
b.	'salted vegetables'	ha:m˩ tʃɔi˧	M1 →	hɔi˩ tʃa:m˧	BUT NOT	hɔi˧ tʃa:m˩

For Taiwanese and Mandarin, forms such as (29a) are very rare, and in fact, the tone pattern is almost always left unchanged after manipulation M1 (vowel interchanging game) as shown in (29b) and (30).

(29) Taiwanese

a.	'meaning'	i˨˩ su˩	→	u˩ si˨˩	BUT NOT	u˨˩ si˩
b.	'below'	e˩ kha˥	→	a˩ khe˥	BUT NOT	a˥ khe˩

(30) Mandarin

	'at least'	tɕʻi˧˥ ma˩	→	tɕʻa˧˥ mi˩	BUT NOT	tɕʻa˩ mi˧˥

3.5. Problems of analysis

3.5.1. Monosyllabicity

While one might be tempted to conclude from the data obtained with M2 that tone is a feature of the word in the African languages presented here, but a feature of a smaller unit in the Asian languages, there is one important problem which must be faced before the data from the syllable switching game can be accepted as conclusive: namely that words in Asian languages tend to be monosyllabic as opposed to the polysyllabic tendency of African languages. In order to be able to have a certain control on the bias introduced by this difference, I tried to have three

different kinds of disyllabic compounds for Asian speakers. One group, exemplified in (31), contained compounds of two clearly distinct words, the second group contained compounds which were 'felt' to be one word as in (32), and the last group contained associations of words which make very little sense together as represented in (33).

(31)	a.	Thai	'not to stay'	mai	˥˩	ju	˨˩
	b.	Cantonese	'cat's tail'	mau	˧	mei	˧˥
	c.	Taiwanese	'red flower'	aŋ	˧˧	hue	˧
	d.	Mandarin	'black dog'	hei	˧	gou	˨˧
(32)	a.	Thai	'woman'	phu	˧˩	jiŋ	˧˥
	b.	Cantonese	'monkey'	ma:	˧˥	lau	˧
	c.	Taiwanese	'lonely'	ko	˧˧	tuã	˧
	d.	Mandarin	'train'	huo	˨˩	tʂʻe	˧
(33)	a.	Cantonese	'cat wind'	ma:u	˧	fuŋ	˥˩
	b.	Mandarin	'fire pig'	huo	˨˩	tʂu	˧

It was assumed that words of this last group should not be felt as one word and unexpectedly these nonsense compounds turned out to be the only exceptions we have to the general tendency for Asian speakers to move the tones with the syllables during manipulation M2.

3.5.2. Different behavior with M1 and M2

In fact, the apparently opposite results we got with M2 lead us to the same conclusion. In both types of languages, the speakers keep the tone pattern attached to the word or morpheme unit. In African languages, the tone pattern of a disyllabic word is maintained when the two syllables change position. In Asian languages, the tone is changed with the syllables precisely because each syllable is a word. These results suggest that *the word should be regarded as the tone bearing unit* in the case of these African languages: but they do not rule out the possibility that tone is a feature on a smaller unit in Thai, Cantonese, Mandarin and Taiwanese. As we mentioned earlier, the tone pattern of the African words is not modified by the vowel switching game. This was a predictable result: if tones are not interchanged when the whole syllable is moved, we should not expect them to be affected when a smaller unit (namely the vowel) is moved. We saw in (28) through (30) that variations are possible from language to language and from informant to informant. Tone is not always moved with the vowel in Thai, Cantonese, Taiwanese and Mandarin. But nevertheless, the fact that such an interchange is not attested at all with African speakers has to be accounted for. That segments can also be tone bearing units seems to be a reasonable working hypothesis. Further investigation can be done

either by using the manipulation M1 (vowel switching game) and looking for consistency across speakers and across languages, or by trying to find tonological evidence showing whether tone behaves like a suprasegmental or a segmental feature. Leben (1973a) has correctly pointed out that if we assume that tone is a feature capable of being associated with units larger than segments, it should behave like other suprasegmental phenomena.

3.5.3. Level of application of word game rules.

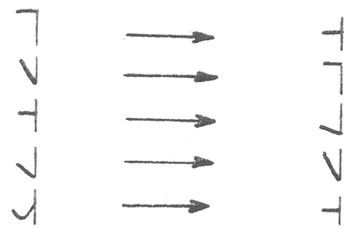
When word games are created by linguists as a method of gaining insight into the native speaker's competence, it is very important to be able to check the level of application of the word game rules. It is obvious that our data will not have the same importance if the word game operates on the surface phonetic form as opposed to a deeper form. It is sometimes easy to know if certain rules have applied before or after the word game. Let us compare the relative ordering of tone sandhi rules and word game rules in Taiwanese. If we consider only the non-checked tones, Taiwanese has five tones as in (35).

(35)

High level	(˥)
High falling	(˩)
Mid	(˧)
Low falling	(˨)
Low falling rising	(˨˧)

When two monosyllabic words are in compound, the first tone of the compound is modified as in (36).

(36)



The tone of the second word is left unchanged. In (37), (38) and (39) three examples, with different ordering of tone sandhi and the word game rules of M2, are shown. The word presented in (37a): i ˩ su ˨ is transformed into su ˨ i ˩ . In fact the original tones are low falling-low falling and the first tone (low falling) has been transformed into high falling by tone sandhi. Then, if we proceed as proposed in (37b), we will get the incorrect output: su ˩ i ˨ (high falling-low falling). But rather, if we consider that the word game rules apply on the surface form only *after the tone sandhi rule* without having

access to the underlying form, then we will get the correct derivation presented in (37c).

(37) a. 'meaning' i ˩su˥from i ˥ su˩
i ˩ su ˥ M2 → su ˥ i˩

b. underlying form --> word game – – tone sandhi → surface form
(U.F.) (W.G.) (T.S.) (S.F.)
i ˥su˩ - - - > su ˥ i ˩ - - - - - - - > su ˩ i ˥

c. U.F. – – T.S. → S.F. - - > W.G.
i ˥ su ˩ – – – – → i ˩ su ˩ – > su ˩ i ˩

This derivation does not explain the output of M2 in (38a). We have to assume that tone sandhi has applied before and after the word game transformation changing the tone sequence from high-high falling to mid-high falling by tone sandhi, then, to high falling-mid by syllable interchanging and finally to high-mid by a new application of the tone sandhi rule.

(38). a. 'flower' hue ˦ lui ˩ from hue ˧ lui ˩
hue ˦ lui ˩ M2 → lui ˧ hue ˦

b. U.F. – – T.S. → S.F. – – – > W.G.
hue ˧ lui ˩ - - - > hue ˦ lui ˩ - - > lui ˩ hue ˦

c. U.F. – – T.S. – – > S.F. – – > W.G. – – T.S. – > S.F.

The transformation presented in (39) can only be explained by considering that word game rules apply before the tone sandhi rule since a sequence low falling-low falling, which is in fact a sequence mid-low falling prior to tone sandhi, is changed to low falling-mid by syllable interchanging and then to high falling-mid by tone sandhi.

(39) 'old house' ku ˩ tshu ˩ from ku ˦ tshu ˩
ku ˩ tshu ˩ M2 → tshu ˩ ku ˦

U.F. – – > W.G. – – T.S. – – > S.F.
ku ˦ tshu ˩ – – > tshu ˩ ku ˦ – – > tshu ˩ ku ˦

3.6. Theoretical implications of suprasegmental representation

While most of the theoretically oriented work has sought to treat tone as a feature on segments, Leben (1973a) proposes that a new matrix containing suprasegmental information should be added to the segmental matrix. Since as I have argued, speakers of some languages at least, strive to maintain a constant tone pattern on words, this proposal appears to have some psychological validity. In addition, Bamgbose (1970)

has shown that Yoruba speakers can invert a tone pattern for poetic purposes, which suggests that they have access to this suprasegmental matrix. Examples of such transformation are given in (40).

(40) a. 'open place' páárápōngbá → pààràpōngbà
b. 'argument' āpérémōpétē → āpèrèmōpètē

4. Conclusion

I have attempted to show that word games can be very useful for gaining insight into phonological systems. We have seen how they can provide information concerning syllable structure, glides and vowel length, as well as providing evidence concerning the underlying representation of tone. Information from such games is valuable when consistency across related languages and across speakers is obtained. This study using only one informant for each language (except for Cantonese and Taiwanese where two informants were used) cannot pretend to lead to indisputable claims but I do think that word games can provide an access to the native speaker's knowledge of his language. It is hoped that both existing and experimentally contrived word games will be further studied from this point of view.

In conclusion, I would like to mention a remark made by Hector Javkin: "Phonology has often consisted of the subject being serious and the linguist playing games. The time has come to reverse the process".

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Footnotes

1. This is an expanded version of a paper presented at the Linguistic Society of America meeting at San Diego, December 1973. The first part of this paper was read at the 1973 Summer Linguistics Conference at Santa Cruz and published in *Studies in African Linguistics* vol. 4, 3, pp. 227-236.

2. The experimental work involved in this study was done at the Phonology Laboratory, University of California, Berkeley and supported by an NSF grant (GS-2286).

3. Bakwiri belongs to the Duala group (Guthrie's A-22). In this study the sign ——→ represents the transformation operated by the word game.

4. The reason why the vowel /i/ is lengthened will be discussed later.

5. The nasalization and denasalization process is explained in greater detail in Hombert (1973).

6. Exactly the same kind of behavior for tone and length patterns is found in a word game played by young Sanga speakers as described by Coupez (1969).

'grandfather' nkàɔ́mbò ——→ mbɔ̀ɔ́nkà

7. According to J. Gandour (personal communication) dialect specific and even speaker specific variations occur with respect to treatment of tone in the Thai word game.

8. This is not the situation found in all Kru dialects (W. Welmers, personal communication).

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Contextual Factors Influencing Tone Discrimination[1]

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Introduction

Tone languages do not exploit the various possibilities of tonal contrasts with equal frequency. For example, falling tones have phonemic status in many tone languages while rising contours are relatively rare. Such disparities in the distribution of tonal patterns may be caused in part by articulatory constraints imposed by the mechanics of laryngeal displacement (Ohala and Ewan, 1973; Sundberg, 1973).

Additional constraints may be imposed by limitations on the auditory system's ability to encode frequency information of a waveform whose periodicity changes constantly.

Detection and recognition of a pure tone is adversely affected upon the introduction of a second tone in temporal proximity to the first. When the interfering tone *precedes* the target, the decrease in performance is significant only if the interval separating the tones is less than 60 msec (Samoilova, 1960; Elliot, 1962). However, the presence of a tone *following* the target can interfere with tonal recognition for inter-stimulus intervals up to 250 msec (Massaro, 1972). A tone *preceding* the target exerts maximal interference when its frequency is slightly below the target's. The situation is a bit more complex when the interfering tone *follows* the target. Identification of temporal order is most severely affected by a tone lying one-sixth to one-third of an octave above the pattern frequency range (Divenyi and Hirsh, 1975). In a tone recognition paradigm, however, the degree of interference appears independent of the direction of frequency change (Massaro, 1972).

In an earlier study Hombert (1975) found that the onset of a falling tone was more accurately perceived than the onset of a rising tone in synthesized vowel stimuli. The data indicated that 1) low tones are more effective at masking higher tones than the converse; and 2) forward masking is more significant than backward masking in the perception of fundamental frequency contours. In the case of a rising tone, each frequency would be masked by the immediately preceding lower frequency. This would not occur in the case of a falling tone since the fundamental frequency descends.