Aspects of the Rhythmical Structure of Cocopa

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Introduction

This is a report on preliminary findings from a study of the rhythmical structure of Cocopa in spontaneous narratives (1). The data is drawn from a narrative related by Sam Miller to Professor James Crawford in 1967. Crawford's published syntactic and morphological analysis (Crawford, 1976) is preserved (although a slightly different notational system is used). In addition, a phonetic transcription (in IPA) was made marking pause and syllable boundaries.

Crawford has claimed (1966, p.28-29) that Cocopa is 'stress timed', i.e., that sentences having the same number of stresses have approximately the same duration. (2) As an example, he cites the following sentences: (Hyphens in the Cocopa sentences indicate syllable boundaries.)

1. nyá:c c-nyár la-ká:ym á:c yuṣ
   I=s yesterday town 1-go-c 1-exist-evid
   "I went to town yesterday"

2. a-yá:-piny ṣáy c-cšá:-cm ṣ-nya:yá:m̊
   tree-dem there 1-pl-plant-sr dem-then-happen-m
   "We planted the trees over there.'

3. nyá:c wáły mán spác
   I=s house-in 1-get-up 1-go-out-prf
   "I went out of the house"

Each of the above sentences contains four stressed syllables, and, hence, by the stress timing principle, they have approximately the same duration. As Crawford notes, the sentences differ in the number of unstressed syllables they contain. Sentence 1 has three unstressed syllables, 2 has six unstressed syllables, and 3 has no unstressed syllables. The presence of unstressed syllables , thus, should not affect sentence duration.

Crawford's stress timing claim describes the rhythmical structure of Cocopa in terms of the number of stresses in a 'sentence'. It is difficult to isolate 'sentences' in spontaneous Cocopa narratives -- partially because of the narrative speech style which links phrases with connectives; and also because the concept 'phrase', a verb phrase or a noun phrase, is a more easily identifiable structure in Cocopa syntax.

In this analysis, the sentence boundaries noted by Crawford are presented in the phonemic transcription. In the discussion of the rhythmical structure, the term 'sentence' will be avoided in favor of the more general concept of 'semantic topic' comprising one or more phrases which express a unitary semantic concept, e.g., a paragraph.

Stress timing, in its more general usage, describes listener perception of a special type of speech rhythm -- listeners hear stress as occurring at regular intervals. The isochronous interval between stresses remains at present a perceptual judgement, one that has not been verified by acoustic analysis. The present analysis of Cocopa narratives seeks to define some phonetic and phonological bases for the perception of stress timing.

The Basis of Speech Rhythm

Stress timing is one type of rhythmic structure. What is rhythm? 'Rhythm' refers to the temporal structure of speech utterances. It deals with the relative durations of units at many levels: the segment, the syllable, the word, the sentence and the paragraph. Phonology has traditionally acknowledged the distinctiveness of duration at the level of the segment, i.e., the phoneme. Poetic meter is based on duration of syllables. Speech production views syllables as the minimal articulatory programs used in temporally (and articulatorily) structuring an utterance.

How is an utterance temporally structured? The question of speech rhythm has been studied in the field of speech production by Kozhevnikov and Chistovich (1965) and Fowler (1977). Their description of speech production follows.

The abstract string generated by the grammar is a linear concatenation of abstract segments (i.e., phonemes) which still must be translated into motor commands for articulation. The abstract string is stored in Short Term Memory (STM) while it is parsed into articulatory programs. (A 'program' is the set of instructions which are sent to individual muscle fibers in the speech apparatus to initiate the articulation of a given speech unit.) The Central Nervous System does not have rapid enough control of muscle activity to permit segmental control of speech. The articulatory programs comprise integrated motor commands for syllable production. Each articulatory program also contains one stress. The stress is the organizational focus around which the motor commands for the syllable are organized.

The motor commands within each articulatory program do not follow the linear sequence of segments in a syllable. Differences in the length of the cranial nerves innervating the speech muscles, and the different inertias of the speech articulators themselves, i.e., how much effort is involved in moving them, require that the neural command be of a rather different linear order than that of the segments of the word. This requires that the abstract string produced by the grammar undergo a restructuring before articulation. Thus, at the time of temporal structuring, the linear sequence of phonemes in the abstract string is 'lost'.

The articulatory programs that are created in the Central Nervous System result ultimately in the production of syllables. These articulatory programs must be sequentially ordered to follow the intended sequence of syllables in the word and utterance. The articulatory programs are sequentially sent out to the vocal tract musculature for production. The rate at which the programs are sent out corresponds to the <u>rate of speech</u>, i.e., speech rhythm.

As was noted above, the temporal structuring of an utterance occurs while it is stored in Short Term Memory. STM has a limited storage capacity, it can hold approximately seven (stressed or unstressed) syllables at a time. An abstract string that is too long to be stored in STM as a unit must be entered into STM in seven syllable chunks. 'Left-over' material in the abstract string is loaded into STM after the preceding seven syllable portion has been sent out to the vocal tract.

Stress is the organizational focus around which motor commands are structured within the articulatory program. On the speech production level, i.e., outside the grammar, the stress internal to each articulatory program is synchronized with the beats of a 'neural rhythm generator'. (The neural rhythm generator emits pulses at regular intervals. All rhythmic motor activity, tapping a finger or speaking, is temporally coordinated with these rhythmic beats.) On the level of speech perception, linguists assign stress to syllable peaks, usually vowels. The implicit claim of the above speech production model is that stressed vowels are synchronized with the rhythmic beats of the neural rhythm generator. An unstressed vowel will not constitute an independent articulatory program because it has no stress. Remember that all articulatory programs require stress so that they may be rhythmically coordinated with the neural rhythm generator. Unstressed syllables, then, are appended to a preceding or following stressed syllable's articulatory program.

According to Fowler (1977), the phonetic reduction observed in unstressed syllables derives from their 'second class' status in speech production. Articulation is targeted from stress to stress. Unstressed syllables are 'deflections' from the major articulatory path. Similarly, pre-tonic consonants should have more precise articulation than post-tonic consonants because they are directly en route to a stressed vowel. Post-tonic consonants are more reduced because they occur after the goal ,i.e., the stressed vowel, of the articulatory program has been achieved.

What are the implications of the speech production model for the surface phonetic form of an utterance?

I. Co-articulatory phenomena (assimilation, simplification, etc.) are viewed as artifacts of the changes brought about when an abstract string is restructured for speech production in STM. The articulatory programs will integrate the motor commands associated with each syllable into those of neighboring syllables. Successive articulatory programs will similarly be integrated into one another. Maximum efficiency will cause the greatest simplification to occur in unstressed syllables or post-tonic consonants. These predictions are borne out in the Cocopa data. (See Nasal Merger, Nasal Deletion, and Consonant Cluster Simplification below.)

II. The theory outlined above divides speech production of a linguistic utterance into the seven syllable 'chunks' that can be stored in STM at a given moment. As seven syllables are stored together for restructuring into articulatory programs, co-articulation phenomena will obtain within these seven syllables. An utterance containing more than seven syllables will be restructured in successive seven syllable chunks. The speech production model predicts that no co-articulation phenomena will occur at the juncture between successive seven syllable chunks. The possibility of pauses separating each group from the next is left open. This is the norm in the Cocopa data.

III. The speech production model describes stress timed languages when it synchronizes stresses with the impulses of a neural rhythm generator. The synchronization of stresses with rhythm impulses explicitly attempts to account for isochrony between stresses. Note that this explanation of stress timing does not consider rhythmic structure to be specified in the grammar. (Segmental length and the location of stress are, of course, permitted.) Stress timing is not linguistic because it is created outside the grammar while the utterance is stored in STM. The rhythmic structure of language is assigned in the same fashion as other rhythmic behavior -- by coordinating it with rhythmic beats from a neural impulse generator.

Phonological and Phonetic Aspects of Stress Timing

In the introduction Crawford's description of stress timing was summarized. The second part of the paper described a proposed model describing the physiological basis for stress timing in language. In this last section, I would like to return to Cocopa and examine Cocopa stress timing.

The speech production model explains the rhythmic aspects of stress timing as deriving ultimately from the rhythmic impulses of the neural impulse generator. Yet, as I noted in the introduction, 'stress timing' remains a perception on the part of listeners that has not been verified by acoustic analysis. I would like to suggest that listeners 'reconstruct' the intended speech rhythm. They are able to interpret the acoustically varying intervals between stresses as isochronous with the aid of accompanying phonological and phonetic cues. These cues are the overt co-articulation phenomena accompanying stress timed speech production and the location of pauses within the larger utterance. The idea of a speaker 'reconstructing' a speech rhythm parallels the familiar 'analysis by synthesis' model of speech perception wherein a listener can comprehend an utterance despite speech errors, false starts, or extraneous external interference.

Pauses

Three types of pauses occurred in the data: major pauses, minor pauses and syllable-internal pauses. Generally, a pause separated each 'chunk' of speech temporally structured in STM. This does not mean that a pause occurred at seven-syllable intervals, but rather that the amount of material between pauses was in fact surprisingly regular, occurring at 4- to 7-syllable intervals. The documentation for this observation is included in the discussion of the semantic function of the individual pause types.

Major and minor pauses are intervals of silence separating two successive speech utterances. A major pause is at least twice as long as a minor pause. The absolute duration of major and minor pauses varies across speakers, but their relative durations remains constant.

Major pauses occur at the boundaries between semantic topics. Major semantic junctures occur at the beginnings and endings of direct quotes, or between direct quotes from different persona in the narrative. Major pauses usually occurred at these points throughout the narrative. For example: (3) ("//" marks a major pause boundary, "/" marks a minor pause boundary.)

4. [/ p^{ə}-kʌt pa-wí:-l^{yI}t // mõ: n^{y}-xó:l /]
ppukát pa:wí:c 'ac "mu: nyxu:l
p-p-u-kat pa:-wi:-c 'a-c mu: nyxu:l
3o-*-3-meet 3o=3-see-c 3=say-c well younger=brother
(Coyote) met up with him, looked at him, and said, "Well, you

[m^{ə}ká-mà:x myú:-w^{ə} // hĩ: / n^{y}á:dʐ-]
makám ma:x myu 'a "ə̨ə̨, nya:c
makam m-a:-x m-yu 'a nya:-c
where 2-go-irr 2-exist 3=say uh=huh I-s
where are you going," he says "Uh huh,

[mã́m / n^{y}adʐ-ma:m-^{m}p^{I}l^{y} mám-p^{ə}-'á:m-pn^{y}:]
ma:m nya:c ma:m mapíly ma:m pa'á:mpiny
ma:m nya:-c ma:m mapily ma:m pa-'a:-m-piny
now I-s now now now dem-1=go-from-dem=o
[as for] my going along now,

[-ve-rá:r n^{y}é: p^{ə}-'á:mʃ]
nyawí: 'ará:r nyay pa'á:mṣ, :::
nyawi: 'ara:r nyay pa-'a:-m-ṣ
thing work 1=look=for dem-1=go-m̄-adv
I am on my way to look for a job, ..."

Major pauses also occur at boundaries between semantic topics. In 5, a major pause precedes the introduction of a new persona, Coyote:

5. [// n^{y}a:dʐ-ma:m / pn^{y}a:dʐ-ma:m /]
nya'ác ma:m pnya:c ma:m.
nya-'a-c ma:m p-ny-a:-c ma:m
then-3=say-prf now *-then-3=come-c now
When he said it, he then went on his way.

[n^{yI}-ve-rá:r u-n^{y}é:-pá:m // xç-p^{ə}-p^{I}c]
nyawí: 'ará:r unyáy pa:m xṭpa pi:c
nyawi: 'ara:r u-nyay pa:-m xṭpa pi:-c
thing work 3-look=for 3=go=along-m coyote dem-s
As he was on his way looking for work, this Coyote

[bi-n^{y}a-wé: / p^{ə}-kʌt pa-wí:-l^{yI}t //]
pnya:yí:c ppukát pa:wí:c 'ac
p-nya-:-yi:-c p-p-u-kat pa:-wi:-c 'a-c
dem-then-3-come-c 3o-*-3-meet 3o=3-see-prf 3=say-c
was coming, met up with him, looked at him, and said,

[mõ: n^{yɪ}-xó:l /]
"mu: nyxu:l, ...
mu: nyxu:l
well   younger=brother
"Well, younger brother, ..."

Minor pauses, '/', usually separate phrases. Minor pauses are <u>not</u> phrase boundary markers. Almost any word in Cocopa can constitute a phrase. This is especially true in narratives where long strings of concatenated verbs tend to appear with few intervening nouns. (Note that the Cocopa verb is inflected for pronominal subject and object.) A minor pause occurring after a 'chunk' of (STM-structured speech is very likely to occur at a phrase boundary. Minor pauses, '/', occur at phrase boundaries. Not every phrase is bounded by minor pauses. In long semantic topics, minor pauses occur frequently in the initial portion of the topic. They gradually include more and more phrases, reaching a maximum (of about 10-11 syllables) at the end of the topic. This gradual increase in the number of syllables per 'chunk' in long semantic topics is called 'accelerative timing'.

An example of the 'accelerative timing' found in long semantic topics is presented below:

6. [// n^{y}o-w^{ɪ}-má:m / n̥-n^{yɪ}-kǽ:r / mæ:l /]
pnyawám   ma:m, nya nyakú:r   Mu:l
p-nya-wa-m   ma:m   nya nyaku:r   mu:l
dem-then-l=sit-sr now   day long=ago Mule
I'm here now, so one day long ago, Mule,

[mæ:l vas-t^{r}í:t⌝   k^{r}i-yu-mí:k⌝ // pn^{y}a:c]
Mu:l pa:'ás,   pi:c   xyumí:k   pnya:c
mu:l pa:-'a-s   pi:-c xy-u-mi:k p-ny-a:-c
Mule 3o=3-call-pl   dem-s *-3-grow=up then-3=go-c
they called him, he kept on growing

[mam mǽ:r^{ɪ}-v^{ɪ}t / p^{ɪ}-n^{y}u-á:dz <u>ma:</u> -n^{yə}-vé-rá:r]
ma:m Mú:lpic   pnypu'á:c   ma:m nyawí: 'ará:r
ma:m mu:l-pic   p-ny-p-u-'a:-c   ma:m nyawi: 'ara:r
now   Mule-dem   dem-then-*-3-stand-c now thing   work
and then he stood -- a [full grown] mule. "I'm going to look for

[<u>n^{y}e:</u>-mə-ʃɛt //]
nyayxm   yuş "   'ac.
nyay-x-m   yu-ş   'a-c
1=look=for-irr-sr exist-evid 3=say-c
a job," he said.

A second example of 'accelerative timing' is presented below. Perceptually, the rate of speech appears to increase, and a greater degree of phonetic compression (i.e., phonological simplification) is found:

7. [// hĩ: / n^{y}á:dʒ-mam / n^{y}adʒ-ma:m-^{m}p^{I}l^y-mám]
"ʔʔ, nya:c ma:m nya:c (ma:m) mapíly ma:m
ʔʔ nya:-c ma:m nya:-c ma:m mapily ma:m
uh=huh I-s now I-s now now now
"Uh huh, [as for]

[p^ə-'á:m-pn̩^{y}:-ve-rá:r n^{y}é: p^ə-'á:mɕ-]
pa'á:mpiny nyawí: 'ará:r nyay pa'á:mṣ
pa-'a:-m-piny nyawi: 'ara:r nyay pa-'a:-m-s
dem-l=go-from-dem=o thing work l=look=for dem-l=go-sr-adv
my going along now, I am on my way to look for a job, and

[m^{ə}k / n^{yI}-ve-rár m^ə-ké n^{yI}-ve-rá:r]
(mak*) (ʌ) nyawí: 'ará:r makáy nyayá:m rar
(makay*) nyawi: 'ara:r makay nya-ya:-m rar
(where*) thing work where then-locate-sr l=work
wherever there happens to be work, I will work

[k^ə-yɷ́x-^{I}t / n^{yI}-ve-rár n^{y}e:]
kayúx 'ic. nyawí: 'ará:r nyay
ka-yu-x 'i-c nyawi: 'ara:r nyay
indef-exist-irr l=say-prf thing work l=look=for
at anything. I am my way looking for a job, whatever it is,

[p^ə-'a:m gím-n^ɛ / n^y-v-rar n^{y}e:-]
pa'á:m kyum, nyawí: 'ará:r nyay
pa-'a:-m k-yu-m nyawi: 'ara:r nyay
dem-l=go-m indef-exist-m thing work l=look=for
I am on my way looking for a job

[pn̩^{y}-'á:m / m̩-p^{I}l^y n^y-ve-rar m^ə-ké]
pnya'á:m mapíly, nyawí: 'ará:r (makay)
p-nya-'a:-m mapily nyawi: 'ara:r makay
dem-then-l=go-sr now thing work where
now, where there is work,

[y^{ə}m-vɛ́lɨ^y / kɷm- kɷm-]
ya:m rarxly 'ic. nypuny nykwiny
ya:-m rar-x-ly 'i-c nypuny nykwiny
locate-sr l=work-irr-des l=say-prf dem be=all
I want to work. That's all now,

[n^{y}a-ʃáiɬ   y-'ώm   pa-'á:m-b^{I}ʃ //]
ma:m ṣa'íc   ɬyyum   pa'á:mc   yuṣ:"
ma:m ṣa-'i-c   ɬyyum   pa-'a:-m-c   yu-ṣ
now dem-l=say-c   l=think dem-l=go-m-c l=exist-evid
I'm thinking of that as I go along."

Short semantic topics are more evenly divided by pauses, i.e., the number of syllables between pauses is more regular, and the rate of speech remains relatively constant. An example of this occurs in 8:

8. [// n^{yI}-xo:l / n^{y}a:dʒ-n^{yI}-ve-rar /]
"... nyxu:l .   nya:c nyawí: 'ará:r
nyxu:l   nya:-c nyawi: 'ara:r
younger=brother I-s   thing work
"...younger brother. I know where

[wi-yá:m   wi-yá:-dɪʃ //   pwi-ya m]
puyá:m   u:yá:c   yuṣ   puyá:m
pu-ya:-m   u:ya:-c   yu-ṣ   pu-ya:-m
dem-locate-sr l=know-c l=exist-evid dem-locate-m
there is a job.

[ki-n^{y}á:t˺ // n^{yI}-k^{I}-n^{y}a:-v^{ə}m-ka / k^{ə}-wi:]
yuk   nya:c nyknya:pkm, ka:k   nyawí:
yu-k   nya:-c ny-knya:p-k-m k-a:-k   nyawi:
exist-k I-s   2o=l-tell-k-sr impv-go-impv thing
When I tell you where it is, go and

[k^{ə}-ra:r //   hĩ: x^{u}é' //   n^{yI}ɬ-a-wíw-m-   ]
krark."   "ą,   pxway." "nysawíwm
k-rar-k   ą   pxway   ny-sawiw-m
impv-work-impv oh   all=right 2o=l-show=pl-sr
work." "Oh, all right." "When I show it to you,

[wɪɬ / wi-yá:-v^{I}c //   n^{y}a:m x^{u}e' //]
mwi:xm   puyá:c   yus."   nya'ám   "pxway."
m-wi:-x-m   pu-ya:-c   yu-s   nya-'a-m   pxway
2-see-irr-sr dem-locate-c exist-evid when-3=say-sr all=right
you will see it." When he said it, [Mule said,] "All right."

There is no immediate explanation for the 'accelerative timing' observed in long semantic topics. One might conjecture that the accelerated rhythmic structure reflects production pressures stemming from the storage limitations of Short Term Memory. Semantic topics represent a linguistic unit on some level of hierarchical organization. If the linguistic generation of all the phrases in a semantic topic is 'linked', then one could conceive of semantic topics being derived as a unit before being sent out of the grammar. Once the entire semantic topic is expressed as an abstract string, the entire string is sent out to STM for temporal restructuring. In the case of long semantic topics temporary storage problems might be encountered as the string is 'held' between the grammar and STM. (It would have to be 'held' while it is being fed into STM in seven-syllable chunks.) Temporary storage might become problematic if the grammar sends out new semantic topics. I am suggesting that in the 'ideal' situation, the rate at which the grammar produces semantic topics corresponds to the rate at which Short Term Memory sends chunks out to the vocal tract musculature for production. If the grammar produces more (or longer) semantic topics than STM can handle then a temporary 'overload' situation is created where too much material is held in temporary storage between the grammar and STM. 'Accelerative timing' occurs in the 'overload' situation -- STM increases the rate at which abstract strings are temporally structured by crowding longer abstract strings into each chunk. 'Overcrowding' leads to increased phonological simplification due to the invariant mechanical limitations of the vocal tract musculature, i.e., although STM can increase its rate of chunk production, the rate at which vocal tract musculature can move (in articulation) has mechanical limits.

'Accelerated timing' would not be encountered in short semantic topics where presumably the rate of the grammar's production of semantic topics corresponds better to the rate at which 'chunks' are temporally structured in STM. There is a two-fold difference in the number of syllables per chunk between short and long semantic topics: 4-5 syllables between pauses in short topics and 10-11 syllables toward the end of long semantic topics.

The number of syllables per STM 'chunk' is of theoretical interest in the evaluation of speech production models. These theories, which hold that the temporal structure of an utterance is superimposed on articulatory programs stored in short term memory, predict that the average number of syllables per STM 'chunk' is seven. This value reflects the storage capacity of Short Term Memory. In the Cocopa text, several timing units contain more than seven syllables. In these timing units, an interesting phenomenon is observed in one of the middle syllables -- a middle syllable is overlong, that is, it appears to contain an internal pause (cf. pre-pausal lengthening). The internal pause is marked by underlining a long syllable in the phonetic transcription. A syllable containing an internal pause may represent the transition between STM-structured chunks. For example:

9. [/ n^{y}adʒ-ma:m-^{m}p^{ɪ}l^{y}-mám p^{ə}-'á:m-<u>pŋ^{y}:</u>-]
nya:c (ma:m) mapíly ma:m pa'á:mpiny
nya:-c ma:m mapily ma:m pa-'a:-m-piny
I-s now now now dem-1=go-from-dem=o
[as for] my going along now,

[ve-rá:r n^{y}e: p^{ə}-'á:mʃ-m^{ə}k /]
nyawí: 'ará:r nyay   pa'á:mṣ   (mak*)
nyawi: 'ara:r nyay   pa-'a:-m-ṣ   makay
thing work   l=look=for dem-l=go-m-adv   where
I am on my way to look for a job, and

[n^{yI}-ve-rár m^{ə}-ké n^{yI}-ve-rá:r]
nyawí: 'ará:r makáy nyayá:m   rar
nyawi: 'ara:r makay nya-ya:-m   rar
thing work   where then-locate-sr l=work
wherever there happens to be work, I will work

[k^{ə}-yɷ́x-^{I}t /]
kayúx   'ic.
ka-yu-x   'i-c
indef-exist-irr l=say-c
at anything.

Syllabification

Syllabification is determined during STM storage when an abstract string is temporally structured into articulatory programs. In Cocopa, syllabification in narratives differs from careful pronounciation in that word boundaries are frequently located within a syllable. This change usually reflects a word-final consonant being pronounced as the syllable onset to the next word. The relocated (word-final) consonant may be a stem-final consonant, a syntactic suffix, or an aspectual suffix. The relocation occurs when the following word begins with a vowel, glide, or nasal.

I suggested above that much linguistic information is lost during the temporal structuring of abstract strings in Short Term Memory. Relocation provides evidence for this hypothesis: the location of word boundaries does not control syllabification (whereas the articulation-based maximum efficiency principle does). Processes of phonological simplification (Consonant Cluster Simplification and Nasal Deletion below) and co-articulation (Nasal Merger) also show little regard for linguistic information. This situation should be contrasted with the location of major and minor pauses -- these normally co-occur with word boundaries. The grammar, then, has some control over how much material is entered into an STM chunk, i.e., where the chunk begins and ends, but it has little control once the string has entered STM.

Examples of phonological simplification and co-articulation are presented below under Nasal Merger/Deletion and Consonant Cluster Simplification.

In Nasal Merger, two identical nasals separated by a word boundary 'coalesce' to form the onset of the following word:

10. pnyawám ma:m 'while I sit here now'
[nʸo-wᴵ-má:m] -m switch reference

11. makám ma:x 'where you will go'
[mᵊ-ká-màx] -m direction away from

12. pa'á:mpiny, nyawí: 'ará:r 'my going along here, work'
[pᵊ-'á.m-pn̩ʸ:-ve-rá.r] -piny object case marker

13. uyúmxany. nyawí: urárṣ 'he is very much, he works but'
[kɷ-yɷ́m-ma-nʸᴵ-ve-rar-rɪ́ʃ] -xany 'be very much'

In Nasal Deletion, a word-final nasal is deleted before a word beginning with a non-identical nasal. This process applies with few exceptions to all nasals within an STᴹ chunk. Occasionally, nasalization occurs on the vowel preceding the deleted nasal:

14. ma:m "nyawí: ará:r 'now "work ...'
[ma:-nʸᵊ-vé-rá:r] ma.m 'now'

but 15. ma:m . nyawí: 'ará:r 'now. "work'
[ma:m / nʸᴵ-vé-rá:r]

16. ma:m numák 'now he leaves'
[maa: nu-mʌ́k]

17. upí:m šwa:m nynamákm ma:m
'from now on when I fire you'
[bínʃ-mã:-yʌ-na-mʌ́k̚-kᵊ-ma.m]
-m switch reference

Consonant Cluster Simplification

In tri-consonantal clusters occurring within STᴹ chunks, the medial consonant is dropped. This process occurs most frequently when the consonant is word-final, i.e., CC#C. Bi-consonantal clusters in word-initial position seem more protected. The pattern of consonant deletion supports Margaret Langdon's description of post-tonic consonants being weaker than those occurring in pre-tonic position. (Langdon, 1975.) It is also predicted by Fowler's (1977) suggestion that speech production is targeted from stressed vowel to stressed vowel and, hence, that pre-tonic consonants are more precisely articulated than post-tonic consonants.

The deleted consonant may be stem-final, a syntactic suffix, or an aspectual suffix. The suffix -ṣ, 'assertion; but', is the primary exception to this rule. It never undergoes deletion. Perhaps -ṣ carries emphatic stress. This would explain its behavior with respect to this rule, and the fact that an epenthetic vowel is frequently inserted before this suffix. Examples of consonant clusters are presented in 18:

18. nyayxm yuṣ " 'ac
[nʸe:-mə-ʃlɛt//]
1=look=for-irr-sr exist-evid 3=say-c
-x intentive irrealis
-m switch reference

19. ma:mkṣ pxwayxm puyá:m
[mám ʃᵘéy pʰu-yá:m]
be=all-df-adv be=good-irr-sr dem-locate-m
-k dependent future (coordinated with -x, irr)
-ṣ adversative 'but'
-m switch reference

20. ṣayúk pa'á:mk makám
[ʃai-yɷ́k mã́: mᵊ-kʌ́m]
dem-exist-k dem-1=go-m-k where
I-will be there while-I-will-be-going-away-from-here where
-k dependent future, or uncertainty

21. ma:m, kspak ka:mk makay
[ma:m-ṣ-pʌ́k˺-kʌ: mᵊ-kéy]
now impv-leave-impv impv-go-from-impv where
"Now, go-out! go-away! where ever"
k-...-k discontinuous imperative

22. ṣayá:m nykumís
[ʃe-yá:m gɷ́m-nᶦs]
dem-locate-sr 3pl=arrive
"it-was-there they-arrived"

Below, counterexamples with -ṣ are indicated:

23. ma:mkṣ pxwayxm
[mám ʃᵘey]
be=all-df-adv be=good-irr-m
"that-will-be-all-but it-will-be-fine"

24. pa'á:mṣ (makay)
[pᵊ-'á:mʃ-mᵊk]
dem-1=go-m-adv (where)
"I-go-along-here-but (where)..."

25. nyawí: urárṣ ma:m
[n^{yI}-ve-rar-rí∫ -ma:m]
thing 3-work-adv now
"he-works-but now"

Tri-consonantal clusters across pause boundaries rarely show deletion. The pause boundary, rather, is the most common environment for vowel epenthesis:

26. pnyuyíwc nyawí:
[mi$^{n^y}$-yé::-wit / n^{yI}-ve]
dem-then-3-arrive=pl-c thing

27. Mú:lpic pnypu'á:c
[mɷ́:r^{I}-v^{I}t / p^{I}-n^{y}u-'á:dʐ]
mule-dem=s dem-then-3-stand-c

28. nya:c nyknya:pkm
[n^{y}a:t$^{\urcorner}$ // n^{yI}-k^{I}n^{y}a:-vəm]
I-s 2o=1-tell-k-sr

29. rark pa:k pa:xm puyá:m
[rá:rk / pá:k / pá:x-m pu-yá:m]
1=work-df 1=go=along-df 1=go=along-irr-sr dem-happen-m

One final difference in the phonological structure of Cocopa free narratives versus careful speech should be noted. There is a distinction, in free speech, between 'real' glottal stops -- those which always appear in the surface phonetic form, and 'quasi' glottal stops -- those which rarely (if at all) occur in spontaneous narratives. The presence of a glottal stop in a word was determined by Crawford's phonemic transcription and by personal elicitation with an informant. The glottal stop in p'a. , 'to stand', and 'a., 'to go', always occur. They are 'real' glottal stops:

30. pnypu'á:c 'then he stood here'
[p^{I}-n^{y}u-á:dʐ]

31. pa'á:k 'I will go along here'
[p^{ə}-'a:k]

32. pnya'á:m 'then I go along here'
[pn̩^{y}-'á:m]

33. pa'á:mpiny 'my going along here'
[p^{ə}-'á:m-pn̩^{y}:]

The glottal stop in 'a, 'he says', is 'quasi':

34. nya'ác 'then he said'
[nʸa:dʒ]

35. pa:'ás 'they call him'
[vas]

The glottal stop in <u>'a.</u>, 'to go', occasionally appears as an amplitude drop.

Conclusions

I. The Cocopa narrative is 'punctuated' at regular intervals by pauses. The interval, i.e., the time elapsed between pauses, appears to correspond to the storage capacity of STM. (This is apparent on a physical recording of speech, e.g., a spectrogram, where the speech utterance is broken by pauses at fairly regular intervals.)

The length of pauses may be linguistically controlled, viz. to reflect the nature of semantic juncture. Major pauses reflect major semantic junctures, minor pauses occur at phrase boundaries, syllable-internal pauses occur at 'chunk' boundaries.

The location of major and minor pauses appears to be under linguistic control to the extent that the grammar is able to control how much of an abstract string enters a given STM 'chunk'. The linguistic control of pause location 'breaks down' in accelerative timing, when the grammar is generating strings faster than Short Term Memory is able to temporally structure them. The location of (syllable-internal) pauses in long semantic topics suggests that the grammar 'sacrifices' some control of pause location in the overload situation.

II. The phonetic changes in the abstract string entered into an STM 'chunk' suggest that the grammar has little control over the temporal structuring of an utterance. The syllabification created during the formation of articulatory programs may ignore word boundaries. Co-articulation phenomena may delete morphological, syntactic and semantic information. These findings suggest that speech rhythm, beyond the specification of segmental durations as long or short (relative to one another), is determined outside the grammar.

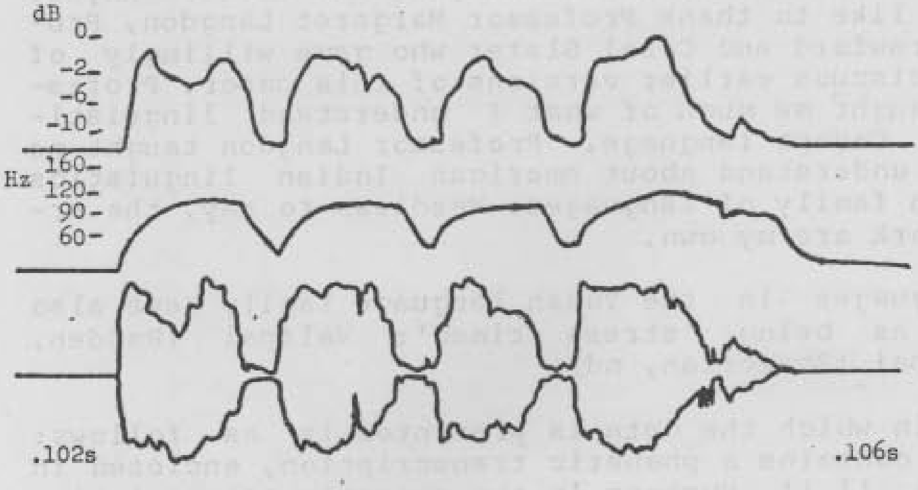
Appendix

The following two tracings are included in order to provide the reader with some sense of the physical data. Three 'signals' occur in each tracing: the top line is an amplitude contour, showing changes in loudness. The second line is a fundamental frequency contour, 'Fo', which registers changes in pitch. The bottom line is the speech wave, a rapidly changing sine wave. The changes in the sine wave are enclosed in an envelope

The physical recording was derived from the tape by sending the output of the tape to three separate 'signal analyzers'. The pitch 'signal analyzer' consists of a Transpitch Meter which extracts the fundamental frequency from the speech wave. The output of the Transpitch Meter was sent into a pitch extractor which converts the Fo into a continuous waveform. (The pitch extractor was developed by Jeff Hardy and Bob Barker of the UCSD Phonetics Laboratory.) The amplitude 'signal analyzer' extracts the amplitude of the speech waveform and converts it into a continuous waveform. This device was developed by Bob Barker and Professor Timothy Smith.) The speech waveform, in conjunction with the fundamental frequency and amplitude waveforms, is sent into an oscillomink which produces a physical copy of the changing values of each of these signals across time. (The scale is 50mm/s.) The amplitude contour is a good indicator of the location of syllable boundaries. The waveform usually drops at these boundaries. In slow speech, the fundamental frequency curve shows word boundaries by a contour drop. During accelerative timing only pre-pausal phrase boundaries are shown.

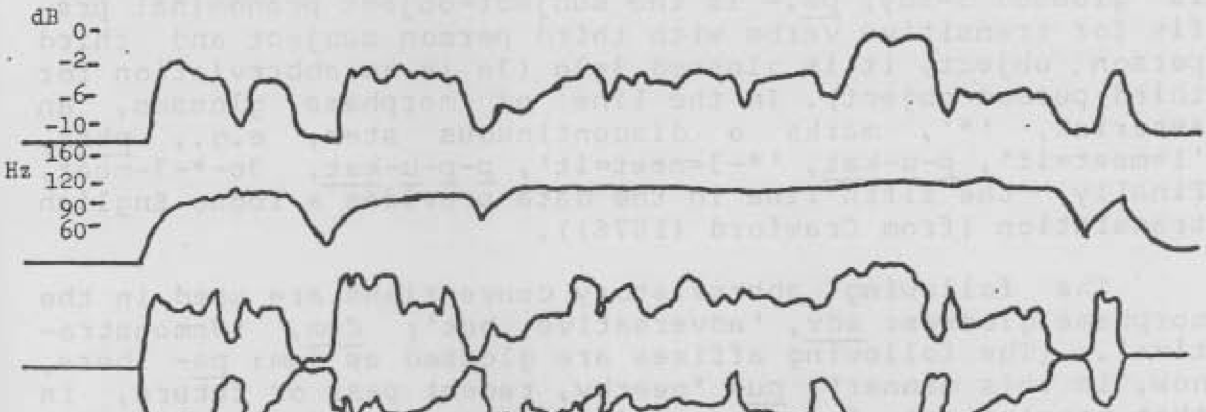
A short semantic topic and a long semantic topic are presented. The former shows fairly regular stress timing. The latter indicates accelerative, with less prominent amplitude, i.e., stress, contours.

Figure 1. A Short Semantic Topic .



// mo nʸi xo:l /mʌ ka: ma: x myu: / ʌ //
"mu: nyxu:l, makam ma:x myu " 'a
"Well, younger brother, where are you going," he says

Figure 2. A Long Semantic Topic with Accelerative Timing



nʸa:dʒ mʌm mᵊprɪlʸnʌm pᵊ' a: m nʸɪ ve: : ra:r nʸ e:ʸ pᵊ'a:m ṣ mʌk

"/ nʸa:c ma:m mapilʸ ma:m pa'a;mpinʸ nʸawi: 'ara:r nʸay pa'a:ms, "

" As for my going along here now, I am on my way to look for a job, "

Scale: 50 mm/s

Footnotes

1. I wish to thank the Cocopas who shared their language with me, especially Hope Miller, Lillian Hayes, and Victor Hayes. I would also like to thank Professor Margaret Langdon, Professor James Crawford and Carol Slater who gave willingly of their time to discuss earlier versions of this paper. Professor Crawford taught me much of what I understand linguistically of the Cocopa language. Professor Langdon taught me most of what I understand about American Indian linguistics and the Yuman family of languages. Needless to say, the errors of this work are my own.

2. Other languages in the Yuman language family have also been described as being 'stress timed': Walapai (Redden, 1966) and Yavapai (Shaterian, nd).

3. The format in which the data is presented is as follows: the first line contains a phonetic transcription, enclosed in square brackets, '[ ]'. Hyphens in the phonetic transcription mark syllable boundaries. The second line is a phonemic transcription drawn from Crawford's published version of this narrative (1976). The third line indicates morphological structure, hyphens separate individual morphemes. The fourth line glosses each morpheme isolated in the third line. Again, hyphens separate morphemes. An equal sign, '=', separates meaning subparts of a single morpheme. For example, 'i, 'I say' is glossed 1=say. The suppletive third person form, 'a, is glossed 3=say; pa.- is the subject-object pronominal prefix for transitive verbs with third person subject and third person object, it is glossed 3=3o (3o is an abbreviation for third person object). In the line of morpheme glosses, an asterisk, '*', marks a discontinuous stem, e.g., pkat, '1=meet=it', p-u-kat, '*-3=meet=it', p-p-u-kat, 3o-*-3-meet. Finally, the fifth line in the data provides a loose English translation (from Crawford (1976)).

The following abbreviatory conventions are used in the morpheme glosses: adv, 'adversative, but'; dem, 'demonstrative'. (The following affixes are glossed as dem: pa- 'here, now, in this manner', pu- 'nearby, recent past or future, in that manner', sa- 'overthere, distant past or future, in that strange manner' -pic 'demonstrative subject case marker', -piny 'demonstrative object case marker'. evid, 'evidential, 'this is true''; irr, 'intentive irrealis', o, 'object (direct or indirect)'; pl, 'plural'; prf, 'perfective'; s, 'subject'; sr 'switch reference, indicating that the following verb has a different subject from the current verb'; ss, 'same subject, indicating that the following verb has the same subject as the current verb'; ":", 'length (marked on vowels and sonorants)'; 1, 'first person pronominal prefix'; 2, 'second person prononinal prefix'; 3, 'third person pronominal prefix'.

4. The asterisk on this form, and its glosses on succeeding

lines, indicates that this was a speech error. My consultant suspected that the speaker intended to say makay, 'where', but changed his mind.

BIBLIOGRAPHY

Applegate, Richard B., 1972, Ineseño Chumash Grammar, University of California, Berkeley, Ph.D. dissertation

Beeler, Madison S., 1976, Barbareño Chumash: A Farrago, in Langdon, M., & S. Silver, eds., Hokan Studies: Papers from the First Conference on Hokan Languages, The Hague, Mouton, 251-69.

Beeler, Madison S. & Kathryn A. Klar, Island Chumash Sketch: Grammar and Lexicon, forthcoming.

Bright, William, 1957, The Karok Language, UCPL 13.

Campbell, Lyle, & David Oltrogge, 1980, Proto-Tol (Jicaque), IJAL 46:3:205-23.

Comrie, Bernard, 1976, Aspect, New York, Cambridge University Press.

Crawford, James, 1966, The Cocopa Language, University of Caloformia, Berkeley, Ph.D. dissertation.

_____, 1976, A Cocopa Tale: The Alligator Who Couldn't Turn Over, in M. Langdon, ed., IJAL Native American Text Series, Yuman Texts.

Dixon, R. M. W., 1979, Ergativity, Language 55:1:59-138.

Fowler, Carol, 1977, Timing Control in Speech Production, University of Connecticut, Ph.D. dissertation.

Givón, Talmy, 1979, On Understanding Grammar, New York, Academic Press.

Gordon, Lynn, 1980a, Maricopa Morphology and Syntax, UCLA, Ph.D., dissertation.

_____, 1980b, -k and -m in Maricopa, UCLA Papers in Linguistics 8:119-44.

Halpern, A. M., 1947a, Yuma V: Conjugation of the Verb Theme, IJAL 13:92-107.

_____, 1947b, Yuma VI: Miscellaneous Morphemes, IJAL 13:147-66.

Hardy, Heather K., 1979, Tolkapaya Syntax: Aspect, Modality, and Adverbial Modification in a Yavapai Dialect, UCLA, Ph.D. dissertation.

Harrington, John P., papers, in the National Anthropological Archives, Smithsonian Institution, Washington, DC.

_____, n.d., Fieldnotes on Chimariko.

Harwell, Henry O., 1976, The "say" Auxiliary Morpheme in Maricopa: Some Notes and Speculations, in J. E. Redden, ed., Proceedings of the 1975 Hokan-Yuman Languages Workshop, SIU University Museum Studies 7: 63-70.

Hinton, Leanne, 1977, Havasupai Songs: A Linguistic Perspective, UCSD, Ph.D. dissertation.

Jacobsen, William, 1954, Fieldnotes on Salinan, Jacobsen, William, 1967, Switch-Reference in Hokan-Coahuiltecan, in Hymes, D., & H. Bittle, Studies in Southwestern Ethnolinguistics, The Hague, Mouton, 238-63.

Kendall, Martha B., Selected Problems in Yavapai Syntax: The Verde Valley Dialect, New York, Garland.

Klar, Kathryn A., Topics in Historical Chumash Grammar, UCB, Ph.D. dissertation, 1977.

Kozhevnikov, V. A., & L. A. Chistovich, 1965, Rech: Artikulyatsiya i Vospriyatiye, Moscow-Leningrad.

Kroeber, Alfred L., The Chumash and Costonoan Languages, UCPAAE 9:2:237-71, 1910.

Langdon, Maragert, 1970, A Grammar of Diegueño: The Mesa Grande Dialect, UCPL 66.

_____, 1975, Boundaries in Lenition in Yuman, IJAL 41:3:218-33.

_____, & Pamela Munro, Subject and (Switch-)Reference in Yuman, Folia Linguistica, forthcoming.

Munro, Pamela, 1976a, Mojave Syntax, New York, Garland.

_____, 1976b, Subject Copying, Auxiliarization, and Predicate Raising: The Mojave Evidence, IJAL 42:99-112.

Oswalt, Robert, 1970, Comparative Verb Morphology of Pomo, in M. Langdon, & S. Silver, eds., Hokan Studies, The Hague, Mouton.

_____, 1971, Inanimate Imitatives, in J. Sawyer, ed., Studies in American Indian Languages, UCPL 65:175-90.

_____, 1975, The Word for "Water" Revisited, paper presented at the 1975 American Anthropological Association meeting, San Francisco.

_____, 1977, The Word for "Tongue": The Pomo Evidence, in J. E. Redden, ed., Proceedings of the 1976 Hokan-Yuman Languages Workshop, OPLing 2:69-78.

Redden, James E., Walapai I: Phonology, IJAL 32:1:1-16, 1966.

Sapir, Edward, The Hokan Affinity of Subtiaba in Nicaragua, Ammerican Anthropologist (N.S.)27:3:402-35, 27:4:491-527, 1925.

_____, & Morris Swadesh, 1960, Yana Dictionary, UCPL 22.

Shaterian, Alan, n.d., Yavapai Phonology, ms.

Silver, Shirley, 1976, Comparative Hokan and the Northern Hokan Languages, in M. Langdon & S. Silver, eds., Hokan Studies, The Hague, Mouton, 193-202.

Silverstein, Michael, 1976, Hierarchy of Features and Ergativity, in R. Dixon, ed., Grammatical Categories in Australian Languages, Canberra, Australian Institute of Aboriginal Languages.

Webb, Nancy M., 1980, Esselen-Hokan Relationships, in J. E. Redden, ed., Proceedings of the 1979 Hokan Languages Workshop, OPLing 7:72-77.

Winter, Werner, 1976, Switch Reference in Yuman Languages, in M. Langdon, & S. Silver, eds., Hokan Studies, The Hague, Mouton.

Addendum

Kendall, Martha B., 1975, The /-k/ and /-m/ Problem in Yavapai Syntax, IJAL 41:1:1-9.

Langdon, Margaret, 1976, The Proto-Yuman Vowel System, in M. Langdon, & S. Silver, eds., Hokan Studies, The Hague, Mouton.

____, & Pamela Munro, 1980, Yuman Numerals, in K. Klar, M. Langdon, & S. Silver, eds., Papers in Honor of Madison S. Beeler, The Hague, Mouton.

Munro, Pamela, 1980, Types of Agreement in Mojave, in J. E. Redden, Proceedings of the 1979 Hokan Languages Workshop, OPLing 7:1-14.

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PREFACE

Unfortunately, everyone who presented a paper at the 1980 Hokan Languages Workshop was not able to prepare a final version for inclusion in this volume. All papers in this volume except two were presented in an earlier version at the 1980 workshop. The papers are arranged in the order they appeared on the program.

The paper by Birgitte Bendixen was presented at the 1979 Hokan Languages Workshop. The camera-ready manuscript for her article arrived at the editor's office more than three months before the publication deadline. The editor is so used to having to call up contributors and begging them to get their manuscripts in that he totally forgot Dr. Bendixen's paper was in his files and left it out of the 1979 volume. The editor humbly apologizes for this oversight. The second paper by Pamela Munro was discussed in part at the 1980 workshop, and the editor asked her to include it in this volume.

The participants of the 1980 Hokan Languages Workshop gratefully acknowledge all the work done by Leanne Hinton and several of her students, which made the workshop run so smoothly and enjoyably. We also wish to thank the College of Letters and Sciences at the University of California, Berkeley, for a grant to help defray the costs of holding the workshop.

Copies of the 1977, 1978, and 1979 workshop proceedings are still available from the Department of Linguistics, Southern Illinois University, Carbondale, IL 62901. The volumes for the 1975 and 1976 workshops, which appeared in the SIU-C series, University Museum Studies, are now out of print, but copies may be obtained in microfiche or hardbound volumes from ERIC Clearinghouse on Languages and Linguistics, Center for Applied Linguistics, 3250 Prospect St., N.W., Washington, DC 20007.

The 1981 Hokan Languages Workshop will meet jointly with the Penutian Language Conference at Sonoma State University, Rohnert Park, California, June 29 to July 2, 1981. The proceedings of the 1981 workshop will appear in Occasional Papers On Linguistics in early 1982. For the first time, the papers of the Penutian Language Conference will be published in the same volume as the Hokan papers. Copies may be ordered from the Department of Linguistics, Southern Illinois University, Carbondale, IL 62901.

James E. Redden
Carbondale, June 1981

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