Isolating the CVC Root in Tzeltal Mayan: A Study of Children's First Verbs

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1. Introduction

The verbs of Mayan languages have an important structural property: they are based on canonically CVC roots, which underived belong to a certain form class (Transitive, Intransitive, Positional) and take affixes characteristic of their form class. There is a very productive derivational morphology that can shift a word's form class from transitive to intransitive, from verb to noun or adjective, and so on. The basic building blocks of the language are these CVC roots; these are the core semantic packages which stay constant across many different derived forms. These are the forms which are entered in dictionaries, which a child learning the language must somehow enter in her mental lexicon.

However, in natural speech these CVC roots do not often occur in isolation; they are accompanied by the prefixes and suffixes appropriate to their form class (which depend in turn on whether and how the roots have been derived). Furthermore the rhythmic structure of the language tends to mask the identity of roots; Tzeltal Mayan[1] seems to be *syllable-timed* (a bit like French, with neither intervocalic intervals nor vowel amplitude varying very much - in contrast to a *stress-timed* language like English). In Tzeltal stress is word-final, clause-final, and there is special prosodic emphasis on the utterance-final syllable. There is massive resyllabification, so this utterance-final syllable often consists of the final consonant of the root plus a suffix or particle; this, not the root, receives the prosodic prominence. Now Pye (1983) has shown that, in K'iche' Mayan acquisition, prosodic salience overrides semantic salience, so that children's first verbs in K'iche' are often composed of only the final (stressed) syllable constituted by the final consonant of the CVC root and a "meaningless" termination suffix.

[1] This paper is based on fieldwork in the Tzeltal Mayan community of Tenejapa, Chiapas, Mexico. The longitudinal data base consists of several hundred hours of taped recorded and/or videotaped natural interaction of children ranging in age from 1;6 to 5;0 and their caregivers, in five extended family households, collected monthly (audio) and every six weeks (video) over two and a half years.

Intonation thus plays a crucial role in early K'iche' morphological development, promoting the very early production of these suffixes. In Tzeltal, however, we do *not* find children doing this, despite what appears to be a comparable prosodic structure of the languages. The first words of Tzeltal children starting around the age of 1;6 are predominently bare roots; children strip off all prefixes and suffixes which are obligatory in adult speech. They gradually produce them, starting with the suffixes (which tend to receive the main stress), but the development is not linear from the end of the verb to the beginning as Pye reports for K'iche' - certain person prefixes and one aspectual prefix (obligatory, and always produced, in adult speech) which are verb-internal (neither first nor last in the verb) are systematically omitted in some contexts for one to two years after the child starts to talk.

How can we explain the Tzeltal child's initial faultless isolation of the root despite the complex input, and how can we explain the differences from K'iche'? An account in terms of intonation or stress cannot explain the Tzeltal children's ability to isolate the root (neither the prefixes nor the roots are always syllables; the roots are often not stressed). In this paper I will look first at the child's segmentation problem in detail, then at what children actually produce as their first verbs, and try to tease apart the factors which help them in what seems a daunting task.

2. The Child's Segmentation Problem

2.1. Structure of the Tzeltal Verb

Tzeltal has ergative/absolutive person cross-referencing on the verb. The minimally required morphology for a transitive verb is:[2]

(1) ASPECT + ERG. PREFIX + ROOT + ABS. SUFFIX
ya s-**nutz**-on [syllabifies as: yas nu tzon]
ICP 3ERG-push-1ABS
'He is chasing me.'

For a ditransitive verb it is the same, with the addition of a 'benefactive' suffix:

(2) ASPECT + ERG. PREFIX + ROOT + BENEFACTIVE + ABS.
ya j-**pas**-bet [syllabifies as: yaj pas bet]
ICP 1ERG-do-2BEN
'I'll do it for you.'

For intransitive verbs, aspect particles and an absolutive suffix flank the root:

[2] Verb roots are in boldface in the Tzeltal examples. A practical orthography is used, with symbols corresponding roughly to their English equivalents except that j=h, x=sh, and ' indicates a glottal stop or glottalization of the preceding consonant.

(3) ASPECT + ROOT + ABS. SUFFIX
ya x-'**och**-at [syllabifies as yax 'o chat]
ICP ASP-come-2ABS
'You enter.'

For transitive and intransitive verbs, there is often resyllabification such that the syllable consists of the final consonant of the root plus the suffix. There is also a large set of optional particles that can occur between the aspect and person markers, so that the latter syllabicize with the root. The root, therefore, rarely constitutes a syllable by itself.

The difficulty of identifying of the root is exacerbated because there are two sets of ergative person-markers (which cross-reference both *agent* of transitive verbs and *possessor* of nouns). One set is for consonant-initial roots (including most verb roots) and another for vowel-initial roots, so that a child has to distinguish between, for example, *k-il* meaning 'I see' and *kil* meaning 'drag it', or between *y-al* 'she says' and *yal* 'fall'. The two sets are given in Table 1.

Table 1: Ergative prefixes in Tzeltal

	Before a root beginning with a consonant:	**Before a root beginning with a vowel:**
1st	j-	k-
2nd	a'-	a'w-
3rd	s-	y-
	Examples:	
1st	j-pas 'I make (it)'	k-uch' 'I drink (it)'
2nd	a'-pas 'you make (it)'	a'w-uch' 'you drink (it)'
3rd	s-pas 'he/she/it makes (it)'	y-uch' 'he/she/it drinks (it)'

So Tzeltal verbs present segmentation problems at the front (non-syllabic prefixes, non-canonical VC roots), and problems at the end (resyllabification), which should cause difficulties for the child in identifying the root.

2.2 Null Affixes.

Against these problems we may set some helpful structural and distributional facts. There are some linguistic contexts where prefixes or suffixes "aren't there" so the beginning or ending of the root is bared. Positive imperatives have no prefix, only a suffix (*-a* for transitives, *-be* for ditransitives, *-an* for intransitives):

(4) Transitive: **pas**-a 'Do it!'

(5) Ditransitive: **k'an**-be 'Ask him for it!'

(6) Intransitive: **'och**-an 'Enter!'

However, this does not help with some verbs which never occur imperatively (eg. *-tak'* 'be able to do it') but which children still use at the one-word stage. And many directives (including all negative and volitive ones) use another form which does have a prefix:

(7) ma x-a'-**pik.** 'Don't touch it!'

(8) x-a'w-**ak'** xan tal ya'tik.
'Give (the fire) some more (wood) in a little while.'

There are also null places in the intransitive verb paradigms: some forms of completive aspect, and third person singular person-marking are null:

(9) 0-**tal**-on ta lum. 'I came to town.'

(10) ya x-**tal**-0 ta lum j'alux. 'Alux is coming to town.'

(11) 0 **tal**-0 ta lum j'alux. 'Alux came to town.'

Intransitives with perfective aspect have no prefix, just a suffix:

(12) '**och**-em 'He/she has entered.'

The transitive paradigms also have null places: 3rd singular absolutive (marking transitive objects) is a null suffix:

(13) ya s-**maj**-0 swix 'He is hitting his elder-sister.'

and passive and adjectival forms of the verb have no prefix:

(14) **maj**-ot yijtz'in. '(She was) hit (by) her younger-brother.'

(15) **tz'us**-ul, **tz'us**-bil 'closed, having been closed.'

Hearing verbs in these linguistic contexts must help children distinguish the stable root from the contextually varying and sometimes non-present (null) affixes, although, as we will see in a moment, these contexts are not overwhelmingly frequent in the input to 2-year-olds. Most input verbs in the sample I looked at have linguistic material before and after the verb root.

But let's look first at the structure of children's early verbs.

3. Children's Performance

Here I present the first 35 verbs produced in my samples by two Tzeltal children.

3.1 Mikel

The first child, a boy named Mikel, was recorded from the age of 1;0, his first intelligible utterances were at 1;6 when he was not yet walking freely. His first verbs appeared at 1;8, and from age 2;0 new verb types exceed new noun types in his data. His first 35 verbs are listed in Table 2. Note that all

of this child's first verbs are CV(C) except for one -VC (*-ak'*, 'to give'), and all are correctly analyzed. All are bare roots, no affixes are produced yet. This child's first verb productions support the view expressed by Demuth (1996), that children have accurate phonological representations of words (and in this case roots) very early - in her view, by the end of their first year, certainly by the time they begin to use verbs.

3.2 X'anton

Recording of a second child, a girl X'anton, started before she was 1 1/2. Her first words appeared at around 1;6, but her first verbs in my data not until 2;1. At this point she was at a more advanced stage than Mikel, with many 2- and 3-morpheme utterances. Her first 35 verbal utterances are listed in Table 3 (with a blank _ indicating where obligatory grammatical morphemes are missing). In these utterances, aspect marking is missing except on three verbs: *ya _xi'* (probably rote-learned), *ya _we' ch'o* (repeated from the preceding utterance) and *a pach* (with *a* as syllable-holder for the aspect particle *ya*). Ergative person-marking is missing except in the two vowel-initial roots (*k-a'y* and *k-ak'be*); there is no evidence yet that these are productive, but they are used correctly. This set seems among all the children to be the first ergative person-markers learned. Absolutive suffixes are sometimes present, if not always correct: *_ti'at wakan* '(It) bit your foot', and *_we'on* 'I('ll) eat'. The missing grammatical morphemes are missing even in contexts immediately preceded by a parental correct model - the child's repeats *edit out* these grammatical morphemes:

(16) Mo; ma ba ya j**tek'** uta i. 'I won't tread on it, say.'
Ch; ju'uk, _**tek'**. 'No, tread.'

A relevant point to mention here is that Tzeltal offers a discourse model of natural 'elicited repetition': it is conversationally appropriate to repeat an interlocutor's words as backchannel, and children do this from very early on, demonstrating their ability to extract the appropriate part to repeat from a long stream of speech:

(17) Mo; ya me s**we'** ch'o waj teme ya 'wixlane.
'Mice will eat the tortillas if you play with them.'
Ch; aj ya _**we'** ch'o.
'Ah, mice eat.'

3.3 Resistent grammatical morphemes

In Tzeltal verb development is *not* strictly linear (back to front) - unlike in K'iche'. There are systematic "holes" in the verb which persist for up to two years after the child begins to talk. Taking a long-term look at the verb productions of a third child, a girl called Slus, we can see that certain

Table 2: First 35 verb types of Mikel

[age 1;8-2;0. mlu 1.0. Criterion: not a repeat of previous utterance, and meaning clear in the context]

Age	Utterance	Target (if different)	Gloss
1;8	ba		'go'
	la'		'come!'
1;9	ak	ak'	'give'
	tzak ~ tak		'take'
1;10	po	poj	'take away'
	ay		'exist'
	muk		'cover'
	tak	ma s-tak'	'(I) can('t)'
	wa ~ way	way	'sleep'
	ajx	ajch'	'get wet'
	we wa	ya j-we' waj	'(I) eat tortilla'
1;11	pas ~ pax	pas	'do'
	laj		'finish'
	tek'		'step on'
	chux		'pee'
	tap' ~ ta'p	tz'ap	'insert'
	kan	k'an	'want'
	'och		'enter'
	ka	kay	'open (door)'
	ti'		'eat meat, bite'
	pach		'set down upright (bowl)'
2;0	nu	nuj	'invert'
	k'ux ~ kus	k'ux	'hurt'
	xi'		'fear'
	pet		'carry'
	ch'ay ~ tz'ay	ch'ay	'fall/drop'
	pok	pok'	'wash'
	lap		'put on (clothes)'
	'ok'		'cry'
	lok'		'exit'
	mal		'spill'
	chu'	tuy	'cut (wood)'
	tup	tup'	'turn off (light, recorder)'
	ja' ni	ja' ini	'this is it'
	pa'y	ba'ay	'where is it?'

Table 3: First 36 verb tokens of X'anton [age 2;1-2;2 (mlu 1.13-1.47)]

Utterance	Target (where different)	Gloss
_lo' matz'	ya j-lo' matz'	'(I) eat corngruel'
_chi'	ya j-chik'	'(I) burn (wood)'
xi		'he/she said'
_ta	ma j-ta	'(I can't) reach'
ba'	bajt	'he/she went'
bajt-ix _ paxyal	bajt-ix ta paxyal	'he's gone (for a) walk'
_tij son	ya s-tij son	'(he) play(s) radio'
k-ak'-be	ya k-ak'-be	'I'll give (it to) them'
laj mamal		'old one died' [chicken]
we'_	we'-ix	'(it has) eaten (corn)'
_k'op-oj son	ya x-k'op-oj son	'the radio is talking'
tal-ix		'it has come'
li' ay i		'here it is'
tal we' i		'came (to) eat'
poch'-em s-jol		'its head is peeled' [chicken]
_k'ux	ya s-k'ux	'(he) eat(s) (beans)'
ay _chu'	ay x-chu'	'it has a breast' [balloon]
och ini		'entered here'
och ja'		'water entered'
_juch' painil	ya j-juch' painil	'(I) grind corn'
juch' bojnuk'	ya j-juch'-be bojnuk'	'(I'll) grind (corn for) cutneck' [a chicken]
laj		'(it's) finished'
_kuch	ya s-kuch	'(he) carry(s)'
_t'ux	ya j-tz'us	'(I) shut it'
_k'ej	ya j-k'ej	'(I) put it away'
ya _xi'	ya j-xi'	'(I'm) afraid of it'
lok' bel		'It went out'
k-a'y chux	ya x-ba k-a'y chuxnel	'I'm (going for a) pee'
til-ix		'it's burning'
ya _we' ch'o	ya s-we' ch'o	'a mouse will eat it'
_ti'-at w-akan	la s-ti'-bet a'w-akan	'(it) bit your foot'
ba-em il wakax	baem ta il wakax	'he's gone (to) see the bull'
puk' tat	ya s-puk'-ben jtat	'father will mix it (corn-gruel)'
puk' ja'at	ya '-puk'-ben	'you mix it'
_'ok ek	ya x-'ok' ek	'it's crying too'
_a pach	ya j-pach	'(I) carry (bowl) (upright)'

grammatical morphemes continue to be systematically omitted even after her fourth birthday. At 2;0 Slus was more advanced than X'anton at 2;1; she could already produce consonant clusters. But at 2;0 her repeats of others' utterances systematically omit the ergative prefixes: for example *ya s-tij-ben k-akan* 'he's biting my foot' is repeated as *_ti'be _akan*, showing a *selective* omission of the ergative prefix. There are persistent gaps in her verb productions, for example the third person singular ergative prefix for consonant-initial roots is an omission characteristic of her utterances for another two years; their production gradually increases but does not reach 90% criterion even by age 4;3. The most persistent omission is the neutral aspect marker *x-* which is obligatory with intransitive incompletives. Some examples from Slus's speech across the years (where _ marks the missing *x'-*) follow:

At age 2;6:

(18) ma _'**och.** 'It doesn't go in.'

(19) ya _**a'tej**onix. 'I'm already working.'

At 3;6:

(20) ya _**ba**on ta na, ya _**tal**on xan tatil.
'I'm going home, I'll come back again, boy.'

At 3;8:

(21) ma me ya _**tajin** _tukeli mali. 'Xmal herself can't play (with us).'

At 4;3:

(22) ya _**a'tej**. 'He's working.'

The aspectual marker *x-* is resistent even in the salient 'repeat' slot:

(23) Fa; ya x**ben** 'It's going (tape recorder).'
Ch; ya _**ben**, ya _**ben** 'It's going.'
Fa; ya x**ben** 'It's going.'

It is resistent even though it would make a good CVC syllable with the *ya*.

Ergative prefixes appear much earlier for vowel-initial roots, in some children by 2;0, and in all cases well before the consonant-initial set of prefixes are produced to criterion. In all the children's data is there is only very rare evidence of misanalysis of VC roots as CVC (incorportating an ergative prefix). Double marking in third person (using *both* the *s-* for C-initial and the *y-* for V-initial roots) does occur occasionally on nouns, but never on verbs (for example, s-y-**awil** 'its place', s-y-**axib** 'its shade'). There are, however, very few such errors. Basically children do not misanalyze these vowel-initial roots.

3.4 Summary

Children when they start to talk are isolating the CVC and VC verb roots correctly. They are recognizing and repeating the verb appropriately having extracted it from mid-stream of the input utterance. They are adding suffixes respecting the integrity of the root despite resyllabification. So Tzeltal children in this respect are not behaving like their K'iche' counterparts. What could be the explanation for this?

One possibility is that these differences are attributable to different input. Pye says K'iche' mothers simplify (leave off prefixes) in talking to children, whereas the Tzeltal caregivers never do. But is there a lot of speech in linguistic contexts with a bare root (bare at front or at back)?

4. Input

Tzeltal adults in my data never omit aspectual particles, or cross-referencing prefixes or suffixes.[3] In a sample of speech to X'anton[4] comprising 748 input utterances (intonationally complete chunks of speech), 2/3 are clausal and 1/3 are not. The total number of verbs[5] is 556. Of the 495 clausal utterances in the sample, 34% are directives, 52% are declaratives, and 15% are questions. Only 1/2 of directives are root-initial; the others (volative and negative) have prefixes like the declaratives and questions. So only 17% of input utterances are of the speech act type that can have root-initial verbs in them. But other linguistic contexts have root-initial or root-final verbs. Table 4 shows the position of the verb root in the input utterance across all clauses; we find only 11% of verb roots in the sample in a position to carry stress.

Table 4: Position of verb root in input utterance

	Tokens	Types	Percent
Root alone + stress	12		2%
Root final + stress	51		9%
Root final but - stress	21		4%
Root initial, - stress	151		27%
Root medial, - stress	321		58%
TOTAL	556		100%

[3] In rapid speech the aspect prefix *ya* may elide to *a*, but it remains syllabic; and *ya + a'w-* (incompletive + 2nd ergative) may elide to *ya 'w-*.

[4] The sample comprised two session of about 1.5 hours total, audiotaped by X'anton's father when I wasn't there, including the speech of her mother, father, or brother (age 5) addressed to her. She was 2;1 - 2;2, her mlu was 1.15 - 1.30.

[5] Counted as 'verbs' for this purpose were all predicates taking aspect, plus positional and existence predicates.

This apears to go against one of the arguments (Aslin et al, 1996) proferred for the early identification of words - that new words tend to be introduced in utterance-final position: loud, lengthened, and high-pitched. This is definitely not the case for Tzeltal verbs, yet children correctly segment them.

5. Explanations for Tzeltal Children's Performance

On semantic grounds we would predict roots to appear first, along the lines first argued by Roger Brown (1973). Verb roots are semantically weightier than affixes - their meanings express basic semantic roles not modulations. This however was not what Pye found in his K'iche' data.

5.1. Phonological and Prosodic Cues

Peters (in press) suggests that the more reliably in a language stress or pitch accent predicts word, phrase, or clause boundaries, the easier it will be for children to add morphemes along the boundaries. On these grounds, Tzeltal children should have difficulty adding morphemes at word boundaries. There are, however, some other helpful cues to root boundaries in Tzeltal:

i. The predictability of root shape (CVC) and the absence of consonant clusters in morphemes (but not in syllables) are good cues to the root.

ii. As in other syllable-timed languages there is a very limited number of syllable-types: (C)CV, (C)CVC and (C)CVhC, and only a limited number of word-shapes built on them.

iii. Beyond this, phonotactic patterns don't provide many cues: any C can occur root-initially or root-finally or utterance-initially or finally, but there are relatively minimal morphophonemic alternations at morpheme boundaries: roots keep their shape across linguistic contexts.[6]

iv. However, in general the perceptual salience of Tzeltal roots in speech is relatively low: they are susceptible to heavy stress and high pitch only in utterance-final position. But in utterances, any particle or word that can be utterance-final can receive the intonational/stress prominence. And these in the input are verb roots only 11% of the time. Thus there must be other factors than phonology/prosody helping the child to segment the roots.

5.2. Distributional Cues

For verbs which appear frequently in CDS in contexts where the root is bare at the front or back, that is, in intranstive completive, transitive or

[6] There is one class of exceptions: An infix *-j-* is inserted in positional roots when they are derived into transitive or intransitive verbs, or numeral classifiers. The frequency in child-directed speech of these non-canonical root forms is not known; the lack of such insertions is an acknowledged feature of Tzeltal child speech. Nor do we have information about the frequency of an analogous disruption in verb roots in K'iche'. This might turn out to be an important difference between the two languages. Other cues may exist - for example vowel lengthening at the ends of words, as in French, but an acoustic analysis of Tzeltal CDS has yet to be done.

intransitive third person, or in the imperative form, children are provided with direct evidence of the beginning or end of the root. Another frequent source of distributional cues is the discourse context: the Tzeltal convention of repeating part of the preceding utterance as backchannel support highlights the constant root, in contrast to the changing affixes. This may play a role in teaching noun and verb morphology, being perhaps especially helpful for the V-initial root prefixes which are acoustically salient:

(24) [Slus is almost 2;6]:
slus; k-ich' ja' ini 'I get this one.'
me't; ya 'w-ich' ini 'You get this one.'

5.5 Differences from K'iche'

At the one-syllable per word production limit, according to Pye (1983), K'iche' children choose perceptual salience over semantic salience and produce the stressed final syllable of their verb; Tzeltal children choose semantic salience and produce the root. What could cause these differences between Tzeltal and K'iche' children's performance? Three factors may make the difference:

i. K'iche' morphological order is different; Tzeltal has no "terminations" linked to verb type, aspect, and location in clause, and K'iche' is relatively prefix-heavy, while Tzeltal is suffix-heavy.

ii. K'iche' verb structure is more variable than Tzeltal: the termination depends on aspect and on presence or absence of a movement particle, and the root itself can change in derived stems. So children may rely more on prosody.

iii. In K'iche' stress on the verb shifts reliably with linguistic context: in clause-final position, the termination is stressed; in clause-medial position, the verb stem receives the primary stress. In Tzeltal stress is less predictably associated with the root, so prosody is a less reliable cue to the root.

6. Conclusions

Prosody plays a smaller role in children's initial segmentation strategies in Tzeltal than in K'iche', illustrating the point that dramatic differences in segmenting strategies are possible between even closely related languages. This underlines the importance of cross-linguistic studies of production in closely related languages where prosodic and distributional phenomena may vary, affecting the relative weighting of each.

Many factors provide the child with cues to what the roots are in Tzeltal speech; no single one is determinative. The child must combine the statistical and distributional evidence across many contexts to achieve correct segmentation. Tzeltal children have accomplished this feat for the verbs they use when they start to speak. This observation fits with the consensus reported in Morgan and Demuth (1996), that children have word-

level segmentation more or less intact by the time they begin to produce structured utterances. To achieve this they have to "at minimum be able to attend to, discriminate, represent, and integrate metrical, phonotactic and distributional properties of input speech, all under the guidance of certain preprogrammed constraints" on what can be a word. (Morgan and Demuth 1996:10). The Tzeltal data suggests that this conclusion applies to the identification of roots as well as words, and in addition there is another factor playing a potentially significant role in the Tzeltal case. The discourse convention of repeating an interlocutor's informationally salient word or words as the response to his utterance provides Tzeltal children with immediate feedback on appropriate verb morphology, analogous to the "variation sets" described by Küntay and Slobin (in press) for Turkish input. It has the effect of making the verb stand out, as a constant Figure against a shifting Ground of affixes. Tzeltal CDS is overall much less accommodating to the child than Turkish seems to be, but an analogous effect is achieved by this stylistic trait of Tzeltal speech in general, not just speech to children. Children show sensitivity to this convention by the time they are 2;0.

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