ABSTRACT

In keeping with the objective of the Navajo Reading Study, to investigate the feasibility and effect of teaching Navajo children to read their own language first, it was decided that more needs to be known about Navajo children and the language they know. Thus, between October 1969 and June 1970, 22 adult Navajo interviewers recorded free conversations with over 200 6-year-old Navajo children at 10 locations on the Navajo Reservation. Interviews were transcribed, in normalized orthography, by one transcriber and key-punched for computer processing. From the total of 11,128 sentences processed, the complete sample of 52,003 words (tokens) represented 8,775 different words (types). Output of the processing included (1) a number of statistical measures, (2) complete concordance giving sentence context, (3) a list of all the words in alphabetical order giving frequency and range, (4) a list of all the words in alphabetical order from the end of the word, (5) a frequency listing, and (6) a number of lists according to various spelling patterns. A concordance giving English loan words in the sample in the context of the sentence in which they occurred was also produced. It should be noted that word lists resulting from this study will be used as a filter in preparing reading material for 6-year-old Navajo children. The body of the report provides a description of the study; the appendix includes translated extracts of the interviews and samples of program output. Related documents are ED 035 484, ED 043 004, ED 043 005, ED 043 413, and ED 048 584.
A COMPUTER ASSISTED STUDY OF THE VOCABULARY
OF SIX-YEAR-OLD NAVAJO CHILDREN

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The symbol chosen for the Navajo Reading Study is an adaptation of one of the graphically elegant Rainbow Protector figures used in the Coyote Chant. Coyote is always a dynamic figure, clever and powerful. When he gets too greedy or vain or arrogant he is killed. But he always returns to life to triumph again. The chant itself, as told by Yoh Hatrali in 1931, tells how the people got corn from the Coyote People, along with the "all important ritual which will keep man safe from harm and in proper balance with the great forces of nature." In the myth the grand-nephew of the Leader of the Yellow Corn People is a hunter. Over near Debeh-entsah he got lost and found himself in the land of the Coyote People. Here he was given four ears of corn, white, yellow, blue and black and as he was given each one he was told, "When you get back to earth take that ear of corn with you and plant it and you will always be able to live on it and increas

(1) Slide F 23 #4 Pana-vue slide 2-6, "The Coyote Chant", from the Museum of Navajo Ceremonial Art, Santa Fe.


(3) Ibid. p. 99.
Background

Started in 1969, the central purpose of the Navajo Reading Study is to investigate the feasibility and effect of teaching Navajo children to read in their own language first. It will thus take its place with a small, but growing body of research into the hypothesis that children can learn to read a second language more easily and with better results if their first introduction to the reading process has been through the medium of their native language.

Before this hypothesis can be tested, it is of course necessary to have available good methods and materials for teaching reading in Navajo. Our first step, therefore, was to make a survey of all Navajo reading materials we could find and to prepare an analytical bibliography (Navajo Reading Study Progress Reports 3 and 7). Materials for teaching reading in Navajo falls into several groups. A number of small books have been prepared by the Wycliff translators working under the auspices of the Summer Institute of Linguistics. Still in print are a 68-page beginning reader and a set of charts and teaching aids, and a few readers with portions of the bible. A second group of materials are those prepared for the BIA in 1940-50: four bilingual "Little Herder" readers, a bilingual "Little Man's Family" series, and a bilingual "Navajo Life Series". While
these are usable, the religious bias of the former groups and the emphasis on English of the latter limit their suitability considerably. A third group of materials that is just starting to appear is being prepared in connection with the pilot bilingual education programs at Rough Rock Demonstration School, Rock Point Boarding School, and the Bicultural Kindergarten Project. So far, only a few small readers have been published.

To learn more about the possibility of these materials and the methods used to teach reading in Navajo, we organized a conference of Navajo educators with experience in the area (Navajo Reading Study Progress Report No. 6). Each teacher had developed his or her own approach, using whatever materials could be found or developed. Each was thus a pioneer in establishing methods and materials, but no one would suggest he had the method or enough material.

The survey and meeting made clear that before we could make a fair test of the value of teaching reading in Navajo, we would need to see that good materials were available. As a first step to this end, we realized that we must find out more about Navajo children and the language they know.

For a number of years, there has been controversy about the best way of teaching reading in English, focused
especially on what Jeanne Chall has called the "great debate". In simplest terms, the question is whether to emphasize the presentation of the written words as whole units or whether to emphasize the alphabetic nature of the writing system. However one feels about the question, its importance has been to focus attention on the nature of the reading process. A view that we accept is that reading is the process used in translating from alphabetic symbols (meaningless in themselves) to the form of language which is meaningful to the native speaker.

The implications of this are important. Learning to read is learning that writing is a specially coded form of speech. It would seem highly probable that the most effective materials for a child to learn to read with will be closely related to the language he already speaks. This is, of course, the justification for the central hypothesis that the Study is intended to investigate: it was thus completely fitting that before we set out to prepare materials for learning reading that we study the language of the children themselves.

Reflecting their frequent claim that the spoken language is primary and the written language a reflection of it, linguists who became involved with reading not unnaturally argued that beginning reading instruction should be based
on the fact that a child has already learned to talk. From this, they generally went on to argue for strict linguistic controls in the development of the beginning reading materials. Without committing ourselves to methodological questions, however, we still accepted the value of some detailed knowledge of the language of Navajo children.

**Approach and limitations.**

In recent years, there have appeared a large number of studies of the language of children. A number of possible models were thus suggested. We could choose to study the language of one child in depth, or to survey the language of a number of children. We could choose to base our study on a corpus of free speech, to elicit specific linguistic forms, or to test for comprehension of specific forms. We could choose to collect and analyze our material, or establish a program of ongoing collection and analysis. We needed to decide whether to concentrate on phonology, syntax, lexicon, semantics, or style, or to attempt to cover all of these.

A meeting with a group of Navajo language experts and linguists gave us a chance to explore the values of these various approaches (see Navajo Reading Study Progress Report No. 4). Considering their suggestions and the possibilities
of the Study, we finally decided to base our first investigations on a corpus of six-year-old speech. This corpus would permit a study of grapheme frequency and grapheme patterns, of lexical frequency, of morphological complexity, and a start on some syntactic analysis.

The limitations of the corpus must be emphasized. First, much depends on the interview itself. Our sample was collected in free conversations between adult Navajos and one or more six-year-old children; in only a few cases did we manage to record free conversation between children. It is necessary to recognize that the child's speech in such a situation will not display the full power of his command of language, and may reflect inhibition in the interviewing situation. From the texts, however, we believe that our interviewers were generally successful in overcoming this inhibition.

A second limitation of a corpus is that it does not expose potential. The presence of a word or structure is evidence that a child knows it, but its absence is not evidence that it is not known. Therefore, it must be noted that the various descriptions and lists are not in any way exhaustive. The lists can be used to justify including a word on them in a reader as a word children know,
but the absence of a word or form from the list is not evidence it is not known. A later study will collect data on word availability and possibly word familiarity.

The third limitation of the corpus is that it involves only the topics covered in the interviews. There are a number of domains that have probably not been fully sampled, and one suspects that the interviews reflect the interviewer's beliefs about the children's interest. The planned word availability study will fill in the gaps.

The present study then has been largely limited to the collection of a corpus of the speech of a number of six-year-old Navajo children, and to an analysis of the lexicon. As will come clear, a good deal of phonological and grammatical information has been gained in the process, but this has not been our main present concern.

Our primary aim has been to establish a beachhead: to get a first picture of the language of these children. But there have also been some very practical aims. The word lists produced by the study will be used as a filter when we start preparing reading material for six-year-old Navajo children: if a word occurs in the sample with reasonable frequency and range, a curriculum writer need
have little hesitation in using it. Second, the word frequency list will give indications of words that might well be included in early reading materials. Finally, the whole corpus and the lists derived from it have provided data for a study of the present orthography and its usefulness for writing Navajo.

What we did then was this. Between October 1969 and June 1970, twenty-two different adult Navajo interviewers recorded conversations with over two hundred six-year-old Navajo children at ten different locations on the Navajo Reservation. All the interviews were transcribed, in normalized orthography, by one transcriber and key-punched for computer processing. Altogether, a total of 11,120 sentences were processed. The complete sample consists of a total of 52,008 words (tokens), representing a total of 8,775 different words (types). Output of the processing includes a number of statistical measures, a complete concordance giving sentence context, a list of all the words in alphabetical order giving frequency and range, a list of all the words in alphabetical order from the end of the word, a frequency listing, and a number of lists according to various spelling patterns. Also produced was a concordance giving English loan words in the sample in the context of the sentence in which they occurred.
Collection of the Sample

The interviewers were all Navajo adults with experience working with Navajo children. One of them is an interpreter for a school board; the others are generally teachers, teacher aides, or students in training for teaching. Their instructions were minimal: they were told of the purpose of the study, and of our desire to gain samples of children's speech. No attempt was made to establish interview protocols, to delimit topics, or to prescribe techniques.

Had we at the time had knowledge of the study by Wepman and Hass (1969) of the oral language of English five-, six-, and seven-year-olds, we might have tried to emulate their technique. In their work, they interviewed a smaller number of children (thirty for each age group). Each child was given the sex-appropriate twenty-card array of the Thematic Appreciation Test, and asked to tell a story for each card. There was no prompting by the examiner after the practice session. The influence of the interviewer's language was thus minimized.

It might be argued however that this technique would give a much more limited and perhaps more artificial style than that we obtained in our free-ranging conversations.
Some of our texts were in fact collected by giving the children pictures and asking them to tell the story in their own words. The pictures used were from a set of color photographs of a day in the life of a young Navajo child (Crowder 1970).

The interviewers generally selected the children to be recorded, depending on situation, setting, and availability. The only instruction was that the children should be six years old and able to speak Navajo, although a few older and younger children are in fact included in the sample. The children come from a number of different parts of the Reservation, so that the sample covers the possibility of dialectal variation; some of this may have been lost in the transcription process. A good number of the interviews were at Rock Point Boarding School: there were others at Crystal Boarding School, Cottonwood Day School, Lake Valley Boarding School, Valle Vista School, and Dzilth-Na-O-Dith-Lhe Boarding School. Some of the interviews were made in classrooms: a good number were made in offices and teacher's lounges. Other tapes were made in homes in these areas: Newcomb, Bloomfield, Monument Valley and Shiprock.
A wide range of topics was covered. Some interviewers had the children talk about books or objects in the classroom. A good number had the child talk about home and family life. There was a set of questions on color in one group, and a half dozen children who talked about coyote tales. A couple of children talked about science concepts. A dozen told of field trips. Six told stories to go with the Crowder pictures. Four talked about a picture of a space ship. And several were permitted to talk about what they liked. In some cases, pairs or small groups of children were permitted to converse freely without the intervention of the interviewer.

Some idea of the interviews is given by the translated extracts which appear as Appendix A.

Transcription

An early decision we made was to transcribe in normalized spelling rather than to attempt a phonemic transcription. Our policy was to follow the Young and Morgan orthography with the modifications accepted by the 1969 Conference on Navajo Orthography, and following the computer conventions established by Professor Oswald Werner.

The Conference on Navajo Orthography was called in 1969 by the Center for Applied Linguistics on the
recommendation of an earlier Planning Conference for a Bi-
lingual Kindergarten Program for Navajo Children, which had
suggested that a single orthography be adopted for use
in the BIA educational system. The general principles
on which the 1969 Conference's decision was based were
as follows:

1. Consistency is required for pedagogical
   reasons, but flexibility must be allowed
   for some time in such matters as shapes
   of letters, spelling patterns and punct-
   uation. It is premature to expect stan-
   dardization.

2. The system should be based on the needs of
   the Navajo speaker, not the non-Navajo.

3. Some consideration should be given to ef-
   fects of transfer to and from English
   orthography, but it is more important to
   base the orthography on the facts of
   Navajo.

4. Generally, the orthography should attempt to
   maintain a close phoneme-grapheme fit, but
   study should be made of tendencies to mor-
   phophonemic spelling.
After a review of the various systems that have been used, it was agreed by the Conference to use the modified "Government System", as established by Robert Young and William Morgan. The alphabet agreed on was as follows:

- a
- b
- ch
- ch'
- d
- dl
- dz'
- e
- g
- gh
- h
- hw
- i
- j
- k
- kw
- kw
- k'
- l
- r
- m
The prosodic markers to be used were:

1. Length indicated by doubling letter.
2. High tone indicated by acute accent above letter; low tone unmarked.
3. Nazalization indicated by hook under letter.

Among spelling conventions accepted was a decision not to write initial glottal stops.
In order to use this orthography in a computer, certain modifications are necessary: these had been worked out by Professor Oswald Werner for his computerized studies.

1. Upper case letters must be used throughout.

2. The following letters are changed:
   - i is written LH
   - tL is written TL
   - tL' is written TL'

3. High tone is indicated by a "7" after the vowel.

4. Nasality is indicated by an "8" before the vowel.

5. Syllabic 'n's are written with a following "I".

With our decision to use this orthography and to normalize spelling of the texts, a great deal of importance was necessarily given to the selection of a transcriber. We were fortunate in being able to obtain the services of Babette Holliday, who had been trained in transcribing Navajo by Kenneth Begishe for Professor Werner's project.

To start, Miss Holliday typed the text from the recorded tapes. However, rather than go through a separate stage of key punching, it was later decided to have her do this. Once she had learned to operate the IBM key punch machine, she was able to transcribe directly from tape onto IBM punch cards.
The text was printed from cards and returned to Miss Holliday for editing and correction. As will be readily understood by anybody who has been involved with transcription of this nature, a number of slips and systematic errors have continued to turn up, but basically, the transcription has turned out to be of very high quality.

Editing

As the text, word lists, and concordance have been worked with over the past year, a number of errors in transcription have been noted, and corrections made in the final versions.

The Problem of Word Division

A central problem in our work was computer recognition of words. The problem is that for our purposes, we were forced to accept a definition of a word as something written with blanks on either side of it. This leads to treating BIGHAN 'his house', BIGHANIDI 'at his house', and SHIGHAN 'my house' as separate words.

An effect of this, in our study of word frequencies, is to have a large number of low frequency words. There are two main factors contributing to this in Navajo. First is of course the complexity of the Navajo verb. We made no attempt to deal with this: Werner (1966)
will help make clear our decision. The second is concerned with the use of affixes.

Consider for example the following words which appear in our texts:

<table>
<thead>
<tr>
<th>Word</th>
<th>Occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>07LTA'</td>
<td>33</td>
</tr>
<tr>
<td>07LTA'DAH</td>
<td>1</td>
</tr>
<tr>
<td>07LTA'DI</td>
<td>12</td>
</tr>
<tr>
<td>07LTA'DIDAH</td>
<td>1</td>
</tr>
<tr>
<td>07LTA'DISH</td>
<td>1</td>
</tr>
<tr>
<td>07LTA'DO707</td>
<td>1</td>
</tr>
<tr>
<td>07LTA'D8E7E7</td>
<td>1</td>
</tr>
<tr>
<td>07LTA'GI</td>
<td>3</td>
</tr>
<tr>
<td>07LTA'GO7NE'</td>
<td>2</td>
</tr>
<tr>
<td>07LTA'GO7NE'E7</td>
<td>3</td>
</tr>
<tr>
<td>07LTA'GO707</td>
<td>10</td>
</tr>
<tr>
<td>07LTA'GO707SH</td>
<td>2</td>
</tr>
<tr>
<td>07LTA'JI7</td>
<td>2</td>
</tr>
<tr>
<td>07LTA'J8I'</td>
<td>12</td>
</tr>
</tbody>
</table>

What we clearly have here is a single word 07LTA, which occurs 84 times, 33 without and 41 with various suffixes. If we could find a way of handling the suffixes, we could get a better picture of the frequency.
In the texts, there are several kinds of affixes:

1. **Enclitics:**
   
   KIN 'his house'
   KIN-DI 'at his house'

2. **Prefixed possessive pronouns:**
   
   NAALTSOOS 'book'
   BI-NAALTSOOS 'his book'

3. **Prefixed post positions:**
   
   DEEYA7 'he will go'
   BEE-DEEYA7 'he will go by means of it'

   A further problem is raised by the fact that our transcriber often wrote words together that are separated in Young and Morgan, writing DOO A7T'E7E DAH where they would use DOO A7T'E7E DA.

**Enclitics**

Some enclitics are suffixed; others are written separately. (See Hale (1965) for a list of enclitics, Young and Morgan (16-20) for information on word status.) All postpositional enclitics are suffixed. Most 'sentence' enclitics are written as words. By convention, DOODA is a single word but negation as three DOO ___ DA.

Sandhi occurs with many, but not all enclitics.
DOO A7'T'E7E DA doo-á-t'é-da
CH'I7NI7L8I7I7G0707 Ch'iinií+góó
NAAT'A7A7NII NE7EZDI Naat'áánii Néez+di
With some words an extra vowel occurs between the word and
the enclitic.

HOOGHANIDI hooghan+di
The same enclitic may occur in a reduced form.

HA7A7D8E7E7'SH haaá'-'+shè'
Or it may assimilate to the preceding vowel:

SIDA7A7SH sidá+ísh
Two or more enclitics may occur together.

O7LTA'DII7SH ólta'+di+ísh
These may collapse and assimilate.

KINTAHG0707SH kintah+góó+ísh
(Werner gives an example, borrowed from Hale, of a sequence of
three enclitics.)

Possessive Pronouns
Possessive pronouns are prefixed to the noun. There are
some instances of assimilation: BA'A7LHCHI7NI7 bi-áchíní
"his/her children" affecting the form of the pronoun, or the
noun: BE'EWE7E' bi'-awéé' "his/her baby". Secondary pos-
session is marked somewhat differently. BE'ABE' is "her
(indefinite) milk" bi-'a-be'; BIBE' would be "her own milk
(from her own breast)".

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The initial letters of possessive pronouns resemble those of a number of postpositions. The latter might be analyzed as a sequence of pronoun + postpositional element. Thus

- **BI- 'his' BIKAN** 'on him'
- **NI- 'your' NIKAN** 'on you'
- **SHI- 'mine' SHIKAN** 'on me'

The prefixed possessive pronouns resemble both the independent possessive and independent subjective pronouns.

- **BI- 'his' BI 'he, his'
- **NI- 'your' NI 'you, yours'
- **SHI- 'my' SHI 'I, mine'

They also resemble the object pronouns of some verb forms.

- **BI- 'his' BIDINI 'you say it to him'
- **NI- 'your' NILHNI 'he says it to you'
- **SHI- 'my' SHIDINI 'you ask me'

The **NI- resembles the object pronoun NIHI- 'us two', 'you two':**

- **NI- 'your' NIHILHNI 'he says it to you two'

It also resembles a number of potentially verb-initial verb-prefixes, as **NI7LHMA7A7S 'you roll it', NI7LHMA7A7Z 'I rolled it', ni-imperfectives, ni-perfective, and a number of other forms. Some nouns require a high tone possessive. Thus, **NI7LA' 'your hand', not *NILA'.
The SHI- resembles the SHI- of the similar prefix of si-
perfective verbs with "esh"-initial and or final stem: SHIJAA' 'they are', SHIBÉÉZH 'boiled', SHI7NI7SHISH 'you
poked it'. Finally, the possessive pronouns resemble
the initial syllable of a number of words which are in no
way related: e.g. BILH 'sleep', NI' 'earth', SHIID 'ssst!'.

**Postpositions**

Postpositions are usually written as separate words.
A few are prefixed to the verb.

Postpositions may be thought of as consisting of two
parts: a pronominal and a postpositional element. The
postpositional element may be written immediately after a
noun, the noun in place of the pronominal element. TSIN
BITAH SIZ8I7 'woods-them-among-he stands', TSINTAH 'woods-
among'.

Verb phrase postpositions are usually written as sep-
ate words. YAA NAAGHA7.

Often a form will be normalized as two words even though
phonologically there is but one: /yei'n:i'/ YAA YI7NI7'8A7.

Some forms are written as a single word. BIK'IIDEESHWOLH
might be read as bik'i 'ideeshwol if written BIK'I IDEESHWOLH
(bik'i yideeshwol).

And some forms are written as a single word because they
are, in a sense, idiomatic; the meaning of the sum is more
than that of the parts. BEE DEEYA7 'he's coming by means of it', but with BEE 'ELD800H the derivation is obviously bee, 'by means of it, adildogoh, shooting occurs'. However, BEE'ELD800H is not felt to be 'by means of it shooting occurs', but 'gun'!

Postpositions can occur with enclitics. BITAHDI 'at a place among them'.

Thus, postpositions may occur as words, as prefixes or as suffixes.

**Processing of word division.**

Against this background, we now consider the process of editing the text to achieve appropriate word division. There are three possible approaches: visual inspection, computer-controlled partial matching, and computer-controlled affix stripping.

a) By visual inspection is meant the examination and marking of forms one by one. Only visual inspection will ensure near-complete accuracy. But even this is difficult: relatively few Navajos can do it and then only for a few hours at a time. The texts contain approximately 9,000 tokens. To treat each word as a unique problem, when many are instances of the same problem, seems extremely wasteful of time and effort.

b) By partial matching is meant using the computer to locate pairs of words that match over a predetermined portion or area of their length.
Thus partial matching might help locate words which are essentially the same except for different prefixes or suffixes.

HOOGHAN-D8E7E7 'house-from'
HOOGHAN-J8I 'house-up to'
BI-ZHE7'E7 'his-father'
SHI-ZHE7'E7 'my-father'

There are a number of problems with this approach. It may divide words that we do not want to treat as separate words. Thus, it may separate verb prefixes from stems:

NA7SH- '8I7 'I usually fix it'
NA7SH-CHAH "I usually cry"

NA7SH- is the verb prefix marking first person singular in the iterative mode—not something we would wish to treat as a separate word. And, it leaves as words the verb stems -'8I7 and -CHAH neither of which we wish to treat as words. Or we may find stems divided from prefixes: DAA-NI7 'they say', NA7A7NE7I7LH-NI7 'he says it again'. -NI7 is a verb stem having to do with 'saying'. Not only does partial matching treat the stem as a word but the prefixes are also treated as words. This fault might be remedied by insisting that we must be able to match both portions of the word we wish to divide.
Partial matching, with the requirement that both portions must be matched, still allows one to obtain instances where the one portion is a common recurring verb prefix and the other a common recurring stem. Thus, DEESH-CHA might occur because DEESH- (marking first person singular, future) might be found in: DEESH'A7A7LH, DEESHBISH, DEESHCH'ALH, DEESHDAH, and -CHA 'to cry' in YISHCHA, YI7CHA, NA7SECHA, GHO7SHCHA.

This might be remedied by insisting that both portions also occur as free forms. This requirement, however, would be too strong for it would exclude all but those compounds whose components occurred freely. It would handle only those words which we used to separate, and these only if both words were already in the corpus. Thus, we might wish to separate a form YAANAAGHA7 to read YAA NAAGHA 'he's doing'. If our requirement is that both words already occur as words in the text, and YAA did not happen, then our computer would not separate. It is even less likely that affixes would occur as free forms. Thus, we might wish to mark a form BINAALTSOOS to read BI-NAALTSOOS 'his book'. But if the computer cannot find a word BI in the text, it will be unable to divide the word. Some words, such as body parts, occur only as possessed forms. For the possessed form SHIJAAD 'my leg' there is no free form *JAAD. Thus, the requirement that both elements be found would cause the computer to fail to divide correctly the word SHI-JAAD.
Partial matching then fails as a technique for word-division.

By affix stripping is meant using the computer to set off given affixes from the words to which they are attached. One may wish to begin with a list of affixes and automatically set them off. A number of problems result. A major one is that there are any number of forms homographic with some of the affixes. Thus, the computer may recognize the possessive pronoun BI- in the word BIIZHII and mark it *BI-IZHII.

There are some affixes homographic with verb stems. Thus, our transcriber consistently writes -DAH as a negating element. -DAH represents several homophous verb stems, and several other words. Affix separation would incorrectly separate these. Thus, while the computer would correctly separate the transcribed form *DOO A7TE7EDAH to read DOO A7TE7E DA 'it isn't', it would incorrectly separate a form like DEESHDAH 'I'll wipe it off' to read *DEESH DAH.

Similarly, one affix may be included within a longer one; the possessive pronoun BI- is included in any number of postpositions. Affix stripping would incorrectly separate the shorter form. Thus, the form BIKA7A7'DAH'ASDA7HI7
might be incorrectly separated as *BI-KA7A7' DAH 'ASDA7HI7. Failure to separate the word as *BIK'A7A7' DAI 'ASDA7HI7 precludes the possibility of correct separation on a second pass BIK'A7A7 DAI "ASDA7HI 'chair'. These problems might be handled by insisting that the non-affixed element occur as a free word. At first blush, this combination of the affix-stripping and partial matching seems to offer the best hope of properly dividing words. In practice, however, it runs into all kinds of trouble, basically because the non-affixed element does not necessarily occur in exactly the same form, or because it may not occur in the corpus. Thus, the combination of the two requirements is too strong. It fails to mark any number of real divisions. Some examples follow:

Word initial glottal stops. In earlier orthographies, vowels never occurred at the beginning of words or syllables. In more recent orthographies, the word-initial glottal stop is omitted. This may cause problems. The form *SHIKA7'ANILYEED should be divided as SHIKA7 ANILYEED 'help me' but the computer will attempt to separate SHIKA7 leaving 'ANILYEED; it will be unable to find a free form with a glottal stop initial (the free form, if it occurs, will occur without a glottal stop, as ANILYFED).
might be remedied by allowing a match of a V-initial form with a V-initial word.

**Extra Vowels.** HOOGHANIDAH should be separated (and corrected) as HOOGHANI DA the i appears to be epenthetic). But the program will not find a word HOOGHANI. One cannot very well allow an additional optional consonant unless one can be sure that these enclitics do not occur with words that differ only by a single vowel.

**Geminate Vowels.** AT'E7E7DAH should be separated (and corrected) to AT'E7ED DA 'girl-not' but the program will not be able to find a word AT'E7E7 or AT'E7 lengthened by some other enclitic. One cannot very well allow additional optional consonants between the stem and suffix because verb stems may differ from each other only by the presence or absence of a final consonant.

**Tone Sandhi.** DOO SIDA7ADAH should be separated as DOO SIDA7A DA, but, unless SIDA7A occurs as a free form, we are unable to do so. We might allow an optional V. This may not cause any problem with V7V syllables as stems do not seem to occur in isolation.

The recurrent dilemma here is whether allowances one makes to obtain the correct division of words won't also allow unforeseen incorrect divisions. Even if solutions are found to these problems, some problems would remain.
Thus, one writes BIKA7A7'ADA7NI7 'table' but BIKA7A7' DAH 'ASDA7HI7 'chair'. The same BIKA7A7' occurs in both forms. This is simply a spelling convention partly analogous to SHIPROCK but CHURCH ROCK as English place names on the Reservation. One can handle this problem only by visual inspection or resort to a dictionary.

Relativals also cause real problems. Should they be counted? With verbs they seem to serve to make nouns. Thus, one could argue that HATAALH and HATAALHI7 are related but different words, as are their equivalents 'sing' and 'singer' in English. But they merely relativize nouns. One would probably want to accept SIO' 'stars' and S80'I7GI7I7 'the ones that are stars' as instances of the same word.

The distinction between nouns and verbs cannot be made by computer at this time. A dictionary hook up would be required. But even if one were able to hook up the computer to a dictionary, and to make the proper adjustments for glottal stops, geminate consonants, and sandhi, there is no complete solution.
But we did not have a computer hooked up to a dictionary. And we did not have a working set of rules for adjustment to glottal stops, geminate consonants, or sandhi phenomena. Given plenty of time, one might work out a number of these problems by trying out an adjustment rule, visually inspecting the results and modifying the rule, until by progressive refinement one gets more adequate rules. But we did not have this sort of time, and there is some question whether the results would justify the effort. Given the shortness of time we might write loose adjustment rules, incorrectly marking a number of words and thereby obtaining speciously high frequencies for some forms; or we might write tight adjustment rules, letting a number of words go unmarked and thereby obtaining speciously low frequencies. Or, we could abandon the effort to write adjustment rules for the computer and go back to visual inspection; which is what we have done.

Our first task was to prepare a list of potentially separable words or affixes. In doing this, we were able to make use of a reverse alphabetized listing of the words in the text, which of course placed suffixes together. A program then printed out all words containing these elements and alongside them, put one or more tentative
divisions. Navajo research assistants checked these lists visually, deciding which agreed with the conventions we had laid down.

As is so often the case, we found that it took too much time and effort to have a computer do all the work, but finished up with man-machine cooperation that let each fill its best role.

**Computer Processing.**

Computing was carried out at the University of New Mexico's Computing Center, using an IBM 360/40 until June 1970, and after that an IBM 360/67. The programs were written by Jonathan Embry in PL/I-F. The programs used up to 102 k storage, need two 800 bpi tapes, and one 2314 disk.

From the taped interviews, the text was transcribed onto IBM cards in a free format that allowed as many blanks as desired between sentences or words. Control cards were used to separate and identify interviews. Each speaker was assigned a three character code which was punched at the start of each sentence. These cards were then built onto a disk file by a program that reformatted the material into fixed-length records. Each record contained one sentence (maximum length of 300 characters), along with identifying information. Each sentence was assigned a number
indicating its relative position within the text. This number, along with speaker identification for each sentence is printed out in the TEXT LISTING. The material used consisted of 21 interviews, containing 11,128 sentences spoken by 218 children and 14 adults.

The concordance was generated by building a file containing each word used, along with the appropriate sentence identifying number. When these were sorted alphabetically, the number was used to retrieve the sentence(s) that contained each word. For every word used, each sentence containing that word was printed, along with the speaker code and sentence number (in case it is necessary to refer to TEXT to get the full context of the sentence) for that sentence.

From the same word file, it was possible to produce both a straight alphabetical list (sorted left to right) and a reverse word list (sorted right to left), each containing every word used in the text.

In addition, a file was created that contained each unique word, along with frequency and range figures. From this were printed frequency lists, showing frequencies and ranges for various words and letter patterns.
A program similar to the first concordance program printed entries for selected words only. This was used to produce a concordance of English loan words.

A major problem turned out to be getting similar occurrences of the same word to be listed together. After trying several techniques (partial matching, specific rules, etc.), manual correction by native speakers proved to be the most expedient.

List of computer programs used.

2. Text listing.
3. Separate sentences into words.
5. Alphabetical frequency listing.
6. Reverse word listing.
7. Enclitic stripping.
8. Partial matching.
9. Grapheme and unit frequency count.
10. Text correction 1.
11. Text correction 2.
12. Spelling list.
References


APPENDIX A

Translated Samples of the Interviews

The following excerpts are translations of the original Navajo text. Each sentence is numbered, and followed by the speaker's code. Interviewers are identified by numerical codes (001) and children by initials (OJR). Any words that were in English in the interview are given in quotation marks. Notes are added in square brackets.
What's your name?  
Juanita Nation.

How old are you?  
"six".

Where are you from?  
From home.

What name do they call your place?  
Far away.

Who do you usually stay with at home?  
My mother and my father.

Who else?  
Dennis and Lilly.

Who are they?  
Those that are going to school at "West Mes .

What does your father usually do?  
He doesn't do anything.

He just sits around?  
Yes.

What about your mother?  
She's weaving.

What does your big brother do at home?  
He doesn't do anything.

You mean he also doesn't do anything?  

What about your sister?  
She doesn't do anything.

What do you usually do?  
I don't do anything.
You mean everybody just sits around?

How big is your house?

Not too big.

How many rooms does it have?

"three".

What do you have in the kitchen?

dishes.

What else?

"cups".

What else?

that's all.

You only have dishes and cups?

Do you have a stove?

We don't have any.

What do you cook your food with?

We don't cook our food.

What are in the other two rooms?

"bedroom".

What else?

just one.

What is in that one?

"bed".

What else?

blankets.

What else?

That's all.

What is in the other room?
clothes and "shirt".
What else?
"bed".
There's another bed in there?
What color of paint is your house painted with?
five.
What's five?
Do you have any sheep?
none.
What about horses?
none.
What about cattle?
none.
What about a car?
none.
What do you travel around in?
On foot?
What does your grandmother usually do?
She doesn't do anything.
What about your grandfather?
He's gone.
My father took my grandfather somewhere.
When?
One time.
What happened?
He didn't come back last night.
What about your father?
Your father came back?
Yes.
What about your mother?

She came back.

Where did they go?
Navajo Reading Study Interview No. 3

What is your name?  
"Rebecca Marie".

How old are you?  

What is this town called?  

Do you understand Navajo?  

What do you call this place?  

How do you come here in the morning?  
"Bus".

Do you come everyday?  

What is your teacher's name?  

Did you go to school last year?  
No.

Where did you attend school?  

What did you learn about?  
Right here?

Right at home.

Do you have a mother?  

What is her name?  
"Marie".

Do you have a father?  

What do you usually do here at school?  

What do you usually do around here?

Do you have an older sister?  

How about your younger sister?
I have "three".

What are their names?

"Eva" and "Andrea" and "Maxine".

Where are they now?

They are over at home.

They are at home.

Who are they staying with?

My mother and "Martha".

Who is "Martha".

What do you usually do when you travel on the "bus"?

Does the "bus" come for you?

Do you walk?

No.

How do you arrive at school?

They drive us here.

In what?

"Bus".

What do you usually do when you are on your way to school?

I usually look at a "book".

Where do you eat at noon?

Over there.

Do you eat here?

What do you eat?

What is your name?

"Henry Francisco".
Where do you live?
Where the grey cow is standing.
You live around here.
Do you live in town?
Do you have a mother?
She is called "Lilly".
How about your father?
"Henry"
Does your father work?
Where?
At "Gallup".
How about your mother?
My mother also works.
Where does she work?
I don't know the place.
Do you have older brothers?
What are their names?
"Calvin" and "Emanual" and "Nelton" and "Arnold".
How about sisters?
You mean the younger ones?
Your younger sisters.
Yes.
You have some?
What are their names?
"Karen" and "Jean".
That's all.

Do you have younger brothers?

No.

When did you enroll in school?

When did you come here?

Did you come to school as a beginner?

Do you like school?

What do you do in class?

Tell about what you do.

I usually play.

What else do you do?

Who is your best friend in school?

I don't have one.

How about the girls?

None of them, either.

You play by yourself.

Just a few.

Only four.

You play with them.

Do you have fun playing?

What do you usually do at noon?

Do you understand the word noon?

When you go there at noon, what do you do there?

You mean the eating place?

Not me, I don't eat over there.
I usually eat at home.
Do you live nearby?
Do you usually walk to school every day?
When don't you come to school?
I don't know.
Do you miss school some days?
No, I attend classes.
You go to school every day. Right?
My brother also goes to school.
Where does your brother go to school?
Over that direction.
You mean he goes to another school.
He goes to school here.
Does he help you?
I have another one younger but we are the same height.
Does he go to school, too?
Where does he go to school?
Over there.
Over that way. On the other side.
What is his "teacher's" name?
I don't know.
What do you usually do at home early in the morning?
I put on my clothes.
What else do you do?
I come here with my brothers.
How do you help your mother?
I don't help her.

She works.

Who takes care of you when your mother works?
My father and my "Auntie".

She lives with you?
Just her, only "Auntie".

Do you help her with the housework?
We take out the trash.

Can you name some fourlegged animals?
Which ones do you know?
"Horse".

Horse and what else?

How about those animals with white faces and they have horns?
"Cow".

How do you say it in Navajo?
Cow.

How about those animals that stay around homes and sometimes bark? What are they called?
Dog, Cat.

What else?

There is one that crawls on the ground like this. What is that one called?

It crawls like this. What is it?
Can you say it in Navajo?

Tell me some more about four-legged animals.

How many do you know?

Can you name some pack animals?

Those that you can ride.

Do you understand what I'm talking about?

"Horse"

Say it in Navajo.

Horse.

How about those animals that have white faces with horns?

Cow.

What about those animals that stay around homes and bark?

What are they called?

Dogs.

Again, repeat it.

Cats?

Can you name some more animals?

What do the Navajos herd?

They're white.

Sheep.

What are the ones that are similar to sheep but they have horns. What are they called?

They are the same size as the sheep.
Sometimes these animals are milked. What are they?

They are in the same herd with sheep.

Rams.

There are others that are similar, with horns or no horns and in the same herd with sheep. What are these animals called?

Can you think of those little animals that are usually along side the mature sheep?

They're white.

Do you know it?

Do you sometimes herd sheep?

Just my maternal grandfather herds sheep.

Do you help him sometimes?
"Phillip Ned" will tell us about the growth of a bean plant.

We brought in some red dirt first.

And then we put some black dirt in too.

And then we put in a bean.

And then we watered it.

And then we put it by the window.

Several days later, we opened up a bean. It was still little.

Several days after that, we opened up another because it had grown bigger.

Several days later, we opened up another, and found that the roots had started growing.

After several days, we opened up another, there were lots of roots that had grown.

We opened up another bean, there were even more roots.

And then the leaves came out.

It grew because the sun was shining on it and it was warm in the room and we watered it as needed and we took good care of it.

Leon, what part of a lettuce do we eat?

We eat the leaves.

How about carrot? "carrot"

We eat the root.

How about celery? "celery"

We eat the stem.

How about onions?

We eat the root.

How about potatoes?

We eat the root.
We put in some red dirt and some black dirt. Then we dug a hole for it and put it in. And then we covered it with dirt. And then we watered it. Several days later, we opened up another one and it grew bigger. Several days later, we opened up one and it had roots. Several days later, we opened up another and there were more roots and they grew longer. The potato grew bigger. Several days later, we opened up another one, it grew more roots. There were lots of roots. And it had leaves. We watered it and the sun was shining on it and it was on the windowsill.
The "Beginners" will tell you about animals.
The fox eats food.
What is their food?
Grass, sheep, meat, and they build their homes.
The ducks swim in water.
Some animals live in it.
Rabbits.
Some animals walk.
Animals walk.
Some cats have homes made for them.
Fish swim in water.
Some animals aren't good pets.
Dogs are pets.
Some animals fly.
Some birds fly.
Some animals fly.
Birds fly.
Dogs eat meat.
Some animal babies look like their mothers.
Some are born not looking like their mothers.
Frogs lay eggs and then just run away.
The tadpoles first grow their hind legs by eating weeds under water.
And then their front legs grow again.
Then they are shorter.

Then they turn into toads.  [toads or frogs]

Cats eat rats.

My name is "George Benally".

Mice moved into an all ready home that were already there.

My name is "Vernor Jim".

Homes are made for horses.

Some animals have homes made for them.

Homes are made for cows.

My name is "Lorraine Coggeshell".

Some animals hop.

Rabbits hop.

My name is "Dennis Begay".

Some animals move into natural homes.

Bears move into homes made by nature.

My name is "Ramona Sideburn".

Some animals carry their homes on their backs.

My name is "Kimberly Holly".

Rabbits make burrows and live in them.

My name is "Felisita Gatewood".

Some animals have their homes made for them.

Homes are made for sheep.
What about school, what do you do there?

Are you learning?

Yes.

What are you learning?

Some things from books.

Really?

Yes.

Tell me about that, what kind of things do you learn?

Do you write, too?

No.

Why?

Our teacher just gives those "pencils" to us.

Your teacher gives them to you?

Yes.

And what else?

Then we keep them.

What did you do during Christmas?

What did they send you during Christmas?

Papers, all this size. [The object is a magic slate with cellophane or plastic.]

Some of them were very long.

This narrow,

the papers were this narrow.

Those shiny things on them, there were two, one on top of another.
And the paper is this long.

It is this wide.

It is spread inside and we write on it; some red things, they're rounded like this.

It has a hole in it like this.

We dip it in water, and we draw anything right here, that's what they sent us.

Really?

Yes.

When you lift it up, it erases itself.

Oh, yes, those.

And what else?

That's all.
APPENDIX B

Samples of Program Output
ACTIVITY

SAMPLE
NAVAJO READING STUDY CONCORDANCE
PAGE
AAD0707

SENTENCE SPEAKER

R527
gcg
AAD0707 D1717 ASHKII SI7M17H.

3379
ORW
AAD0707 ERASER T'A7A7 BI7LATTAHODI DAHSHI'B7A7GO N17LE7I7G07NE* NA3'ADZI17LMAAAL.

8299
OTT
AAD0707 KODI LHA* DAMJIZDA7.

2274
OVT
BIDA7A7J17 EFLWOD EII AAD0707 N17LE7I7G07NE* BAA EFLWODAT N17LH'B7I7.

9856
OXI
AAD0707 N17LH'B7I7 MONKEY.

5032
OXX
FILGA7A7 T'A7A7 AAD0707 YILH YADGOLDALH.

9877
OZZ
AAD0707 N17LH'B7I7 K80707 SI'B7A7.

9854
OZZ
AAD0707 FIRE YICH'B17 CALL 1717LE7E7H YA'S.

9887
OZZ
N17LE7I7 TS17D11 TAAHJIJ7EH N17T'B7ET7* TATYI1' VI'OLH AAD0707.

4179
002
AAD0707 T'I7077 BA7HA7T07D17G11 A7T'E7EGO DAHSHI8ID07E7 Y1KA7A7'G07DEI HAAS7A7A7L.

4129
02
AAD0707 HA7LA7T0S07G1717 T'A7A7 A7LHAA K07T'E7EGO KODI HA7LAA7A7Z17HIT YAHOD07ELH17G1717 B17IGHA7HDI K07T'E7EGO NETI10D11EL7E7H.

4522
2
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4196
002
AAD0707 KNE'E7 N17T'B7ET7* GAH ALHYSO7 I717Y07A7A7* N17T'B7ET7* T'AH N17T'B7ET7* K80707 CH'E7E7H D1G17A7H11 BAANA7A7DIILWOD.

1808
003
AAD0707 DIDZE7 IE7E7LH A7JI7LE7EGO BAA17Z07D117T'AT7A7Z17H.

1526
003
AAD0707 LHS17I7H* LHA7H17G7I7D07* NATA7NA7 LHA* J1N17.

3271
003
T'I7077 DAHS07KE7EGO AAD0707 T'A7ADD07E7* N17L'E717 07LAA7G07NE* HA17T'17I7SH1717 BAANA7A7AASH* N17LE7I7 HOOGH8A7D107*.

6090
063
T'I7077 AAD0707 SOOKE7.

7126
003
AAD0707 H17D07NA7*GO 7A7D8E7E7* N1MAA17D17ISHDA7A7LH.

9615
010
T'A7A7 AAD0707 NEH15707T078A7H7.

ACTIVITY

7621
0VE
00707 SWING7BEE A7SH'T'B17I7 N17T'B7ET7* D0707 N17LE7I7G07NE* YAH'ANA7SH17D* ACTIVITY ROOM GO7NE*
D0707 CH'I7N17MA7SH17D.

THIS WORD WAS USED 11 TIMES BY 3 INTERVIEWER(S).
THIS WORD WAS USED 71 TIMES BY 30 CHILDREN.
THIS WORD WAS USED 82 TIMES BY 33 SPEAKERS ALTOGETHER.

THIS WORD WAS USED 0 TIMES BY 0 INTERVIEWER(S).
THIS WORD WAS USED 1 TIMES BY 1 CHILDREN.
THIS WORD WAS USED 1 TIMES BY 1 SPEAKERS ALTOGETHER.

NAVAJO READING STUDY CONCORDANCE
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SAMPLE - Grapheme and unit frequency count

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2. Páhií dóó Mási. Story by Judy Harvey, Illustrations by Caryl McHarney. 16pp. w/cover. (in preparation)


4. Táá' Hastói. Story by Judy Harvey, Illustrations by Caryl McHarney. 8 pp. w/cover. (in preparation)

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