WORD-BASED MORPHOLOGY:
SOME PROBLEMS FROM A POLYSYNTHETIC LANGUAGE

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Arnoff (1976) proposes a theory of word or stem-based morphology in which the word/stem is taken as the minimal sign not only for syntax but also for morphology. As Scalise (1985) puts it, "All regular word-formation processes are word-based. A new word is formed by applying a regular rule to a single already existing word. Both the new word and the existing one are members of major lexical categories." This word based hypothesis is claimed to be universally valid. In the following, I intend to examine some of the problems this hypothesis presents for the analysis of a polysynthetic language, Koyukon. Koyukon is an Athabaskan language of Alaska. It is a moribund language, with approximately 650 speakers left (Krauss, 1981), all over the age of 20 (Krauss, 1980). There are three main dialects of Koyukon; this paper will consider data only from the Central dialect. After a brief sketch of the verbal system of Koyukon, the following specifics of the word based hypothesis will be considered: 1. The Binary Branching Hypothesis, and 2. the No Phrase Constraint. The remainder of the paper will outline some of the complications involved in a computational analysis of Koyukon following a theory of word based morphology.

Structure of the Koyukon Verb. The Koyukon verb is made up of a stem plus prefixes. The stem is composed of root plus suffixes (and/or ablaut, and/or lengthening) indicating mode and aspect. Prefixes indicate person, status, gender, mode, adverbials, and transitivity. The prefix complex of Athabaskan languages can be analyzed as a template comprised of nine basic positions. The two positions to the immediate left of the stem are occupied by classifier elements--a 1 component and a d component. The third position is the aspect/mode prefix *nə-. This prefix appears in neuter and perfective derivations. The 4th prefix position can be filled by the 1 sing. and 2 sing. and pl. subject pronouns. The 5th prefix position is that occupied by aspect, mode, and status (negative vs. affirmative) prefixes. Thematic, anatomical, and gender prefixes occupy the 6th position. The directive, connative, and future prefixes fill the 7th position. The 8th position is that region occupied by object prefixes and the so-called deictic subject prefixes (1 pl., 3 pl., areal). In the 9th and last position are incorporated nouns and bound adverbials. Some of these prefixes are obligatory in the sense that the particular position they occupy must be filled by one of the possible variants of that prefix class in every derivation of the verb. These obligatory prefixes are the person, mode, and classifier prefixes. Other prefixes, i.e., gender, adverbial, status, are optional--the positions these prefixes occupy may or may not be filled depending on the meaning of the derivation. Some prefixes are thematic, that is, they have become lexicalized and are present in every derivation of a particular verb. These thematic prefixes along with the root of the verb are referred to as the verb theme.

Freidrich (1974:3) defines the verbal theme as "a basic variant defined both in terms of semantic features and the derivational morphology." As noted above, an Athabaskan verb theme consists of a root and the thematic prefixes occurring in all derivations. It is the underlying skeleton of the verb to which prefixes or strings of prefixes and suffixal elements are added in producing an utterance. The theme itself has a meaning and, according to Rice (1983) is the basic unit of the Athabaskan verbal lexicon. The theme is inflected for person, mode and aspect, and may also take a gender prefix or derivational prefix string. The theme meaning 'go by boat, paddle', for example, is Ø + qæ (where Ø is the classifier prefix and qæ is the verb root). A derivational product of this theme, inflected for person, mode, and aspect is:

1) nəsqæ̃ŋ   'I arrived paddling'

nə	+	sə	+	Ø	+	qæn
perf	+	1 sg.	+	classifier	+	momentaneous stem

A derivational prefix string is composed of one or more prefixes which combine to add a particular meaning to the theme. Derivational strings may be aspectual, that is they may occur only with a particular mode prefix and aspect, or they may be non-aspectual, i.e., strings which appear with a verb regardless of mode and aspect. Non-aspectual derivational strings include the reflexive, causative, passive, and benefactive. Aspectual derivational strings have meanings which are generally adverbial in nature. One of this latter type of derivational string which may be added to the theme shown above (Ø + qæ 'go by boat, paddle') is ni + γɔ # (nə- impf., nə- perf.) + momentaneous stem '(go) ashore'. (Note that the # indicates a morpheme boundary. In Athabaskan terminology this boundary separates disjunct from conjunct prefixes. Disjunct prefixes are those to the left of the # boundary marker (in prefix position 9) and are less tightly bound phonologically than are conjunct prefixes though they remain bound prefixes.) An inflected form containing this string is:

2) niγɔnəsqæ̃ŋ   'I paddled ashore'.

Note that the required mode prefixes and aspect are included as part of the string. It is this type of derivational prefix string which is crucial in the examination of the whole aspectual system and which presents some of the most significant difficulties for a word or stem-based theory of morphology.

Aspect in Koyukon is expressed by a complex, multi-dimensional system. There are two major temporal categories which combine in expressing the temporal contour of the state or activity described by the verb. The first of these two categories is called mode and includes imperfective, perfective, future, and optative. The second category, which is called aspect, crosscuts the first and characterizes the event in terms of durativity, punctuality, cyclicity, etc. There are approximately 18 Koyukon aspects, each of which is marked by a pattern of stem variation including suffixation and/or vowel lengthening and/or ablaut. Each aspect has a particular stem shape for each of the four modes. For example, the following table illustrates the stem shapes for all four modes of several of the aspects possible for the root -qæ 'go by boat, paddle':

	impf.	perf.	future	optative
momentaneous	qæ̰x	qæ̃ŋ	qæl̥	qæl̥
durative	qæ	qæ̃ŋ	qæl̥	qæl̥
persistive	qæx̰	qæx	qæx	qæx
perambulative	qæx̰	qæ̃ŋ	qæk	qæk
customary	qæx̰	qæk	qæk	qæk
neuter	qæ̃ŋ	qæ'ʔ	qæ'ʔ	qæ'ʔ

The Athabaskan modes are marked not only by stem shape but also by one or more prefixes. The optative marked by a γu- prefix and the future by tə + γɔ prefixes in all aspects. Imperfective and perfective are marked by one of several possible prefixes depending on the aspect. For example, verbs of the momentaneous aspect may have a nə - imperfective mode prefix and nə- perfective prefix as in the examples shown above, 1) nəsqæ̃ŋ 'I arrived in a boat' and 2) niγɔnəsqæ̃ŋ 'I paddled ashore'. Momentaneous derivations are also possible

with a Ø imperfective and γə- perfective prefix, a lə- imperfective and lə- perfective prefix, a Ø imperfective and lə- perfective prefix, or a Ø imperfective and Ø perfective prefix. Each different combination enters into its own particular set of aspectual derivational strings. Other aspects do not allow this range of possible perfective and imperfective prefixes. Verbs in the semelfactive aspect, for example, may have only Ø imperfective and lə- perfective mode prefixes.

Quite often an aspect is marked by more prefixes than just the combination of mode prefix and aspectual stem variant. One can think of the combination of elements added to the theme in order for the theme to be inflected for aspect as the 'zero' aspectual derivational string. There are some 300 aspectual derivational strings in Koyukon, each of which adds a particular meaning to the derivational product. Most choose (or trigger) specific imperfective and perfective mode prefixes and aspectual stem forms but many of the non-zero aspectual derivational strings are not limited to use with only one aspect. Many of the strings used with momentaneous stems can also be used with neuter stems. Sometimes a derivational prefix string can occur with any aspect that has a particular mode marker. For example, P + qɔ + nə# # 'on the surface of P' can occur with any lə- perfective derivation (e.g., conclusive, lə-momentaneous, continuative).

The Binary Branching Hypothesis. The Binary Branching Hypothesis as discussed in Scalise (1985) states that a word formation rule attaches one and only one affix at a time, i.e, the internal structure of a derived word will always be binary. Because of the pervasive nature of discontinuous dependencies in Koyukon, it may be more insightful to think of the affixation process as similar to the superimposition of transparency diagrams one atop the other rather than as a binary or nesting structure.

As described above, aspect in Koyukon is marked by more than a single affix. In addition to the affixation/ablaut/lengthening processes by which the stem is derived from the root, a mode prefix is obligatory and, in some cases (e.g., the perambulative, certain momentaneous verbs), adverbial prefixes may also be required in the marking of aspect. In other words, the zero aspectual derivational string may contain a string of two or more discontinuous prefixes in addition to stem variation. The addition of such a string may be better described as a Gestalt than as a binary process. In many cases it is possible to find a less complex 'lexeme' onto which the derivational string can be said to be superimposed, but in general the strings cannot be broken into individual morphemes with some ordering involved in their affixation to a more basic form. Note that since the mode prefixation is dependent on stem marking of aspect and vice versa, Koyukon can only be described by a context sensitive grammar.

Non-aspectual derivations are also problematic in just this way. Examples of non-aspectual derivations will be presented with the verb root γæc 'accumulate due to melting'. This root has the following stem shapes depending on mode and aspect:

	impf.	perf.	future	optative
transitional	γæs	γæc	γəsX̌	γæs
perambulative	γæs	γəsk	γəsk	γəsk
durative	γæs	γæs	γæs	γæs
customary	γəsk			
progressive	γəsX̌			

Every derivative of this verb has a nə- prefix (which can be assigned no particular meaning) and Ø classifier prefix. These, then, are said to be thematic prefixes and the theme from which all verbs with this root are derived is described as nə + Ø + γæc '(liquid) accumulated (from melting snow, ice, or fat)'. The least morphologically complex derivatives of this theme are perfective transitional ones with Ø perfective prefix:

3) niγæc   'it (e.g., water) accumulated'

A causative derivation changes the Ø classifier to a ɬ- classifier and adds the third singular object prefix yə-. The third singular subject prefix is Ø.

4) yəniɬγæc   'he made it accumulate'

Note this single derivational operation entails the simultaneous addition of two separate affixes (the direct object prefix and the ɬ- classifier).

Perfective momentaneous derivations of this verb take the perfective momentaneous stem shape -γæc plus one of three possible perfective prefixes. Momentaneous derivations most frequently also require one of the set of bound adverbials or adverbial prefix strings. The following example has the nə- perfective prefix plus the (non-aspectual) prefix string dɔ#də- which carries the meaning, 'a lot':

5) dɔdənəniγæc   'a lot of it (liquid) accumulated'

A nominal subject can be incorporated into the prefix complex in a position following the dɔ- adverbial prefix. In the following example, tu 'water' is incorporated:

6) dɔtudənəniγæc   'a lot of water accumulated (from melted ice or
                          snow, forming a pond or large puddle)'

Analyzing such a form into nesting structures would seem impossible; it is difficult to imagine a tree structure or bracketing, binary or otherwise, that could adequately describe the Koyukon verb. One could argue that it is possible to view non-aspectual derivational strings like the ones shown above as single discontinuous affixes. This possibility must be rejected though since these strings can be analyzed into separate elements which function elsewhere in the language in other combinations. The ɬ- classifier prefix which is used to mark causative, for example, also appears as a thematic classifier in many themes and is added to a theme by aspectual derivational strings such as,

7) hôydɔ##də + ɬ + (γə- impf.) + neuter stem   'be a long/short
                                                     winter'.

The dɔ#də prefix string exemplified above with the meaning 'a lot of' is apparently isomorphic with another non-aspectual derivational string indicating that the activity described by the verb is a verbal one and also with an aspectual string requiring a nə- perfective prefix and momentaneous stem which carries the meaning 'all over, all up'. Aspectual derivational strings are also ill-suited to consideration as single entities since most trigger the use of one or more aspects which can occur with either a perfective or imperfective prefix.

Aspectual derivational strings present another serous problem for the Binary Branching Hypothesis: the lack of a consistent correlation between the number of affixes and the number of derivational operations. Compare the following derivatives of the verb root yɔ '(singular) go by foot':

8)   niyɔ   'he/she arrived'

9)   nɔ'idəyɔ   'he/she came back'

10) niniyɔ   'she walked up to a point'

11) ninɔ'idəyɔ   'she came back (to a point)'

12) hænɔdidəyɔ   'she started back out again'

Example (8) is clearly the least morphologically complex of these derivatives, containing only the nə- perfective marker and momentaneous perfective stem (i.e., the zero aspectual string) plus thematic Ø classifier and third singular person inflection. In (9) the iterative derivation has applied, adding the nɔ# iterative prefix and the d element to the classifier. (10) contains the aspectual derivational string ni# (nə- impf., nə- perf.) + momentaneous stem, which carries the meaning 'going to a point, place (in time, space) and stopping.' (11) is the iterative derivative of (10). Notice that the iterative derivation, which has applied to the form produced by addition of the aspectual derivational string, prefixes elements to the right of those prefixed previously--closer to the stem instead of further away.

(12) is also a product of an iterative derivation. In this case, the form to which the iterative has applied has been marked for aspect by the application of the following aspectual derivational string: hæ# də+ i + (Ø perf.) + momentaneous stem 'beginning, starting, extending out laterally'. Both (11) and (12) have undergone an equal number of derivations (aspectual, iterative) and both then, must be said to be equally morphologically complex, yet (12) has a greater number of affixes.

No Phrase Constraint. Aronoff (1983:369) discusses the question of "the extent to which descriptions of phenomena which lie unquestionably within the domain of word formation must make reference to syntactic notions." The traditional position, he says, is to restrict the operation of word formation rules to major lexical categories. Scalise (1985) too states that a word formation rule can take as its base only major lexical categories (N, A, V) but not phrases (NP, AP, VP) or sentences. Aronoff (1983) however, expands the domain of word formation rules to include phrasal categories in order to account for object incorporating languages and to make it possible to include subcategorization frames within lexical entires. Word formation rules involving verbs then, according to Aronoff, may include reference "to direct objects, indirect objects, or manner adverbs, because these are part of the verb phrase, but not to time adverbs or subjects because they are outside the verb phrase" (370).

In order to describe word formation rules involving verbs in Koyukon, however, information about material outside the subcategorization frame of a given word must also be allowed, since both subject incorporation and adverbs of time included within aspectual derivational strings are important and productive components of the language. The following data illustrate subject incorporation with both intransitive and transitive verbs.

13) yədɔk'əq'ôʌniyɔ 'cold air (k'əq'u #) rushed in (when the door opened)'

14a) John niniyɔ — 'John went up to a point (and stopped)'

b) nitɔniyɔ — 'the water (tɔ#) stopped rising'

15a) John hɔlyɔ — 'John went up to the bank'

b) hɔtɔlyɔ — 'the water (tɔ#) rose over the bank'

16) nic'ixniɣəl — 'the boat (c' ix#) came to a stop'

17a) a t n — 'it (dead fish) is there'

b) John yəx yiλtæ̨ŋ — 'John is keeping it (dead fish) in the house (yəx##)'

c) hɔ̀t'ɔtɔyədiɬtæ̨ŋ — 'water (tɔ#) (i.e., the current) is keeping it in between logs (hut' ##)'

18) q'ɔ'ɔ̨lc'ixyi'ɔx — 'the wind (lc'ix#) is blowing it around'

Most of the adverbial aspectual derivational prefix strings in Koyukon refer to place or manner but several can be construed as adverbs of time, including the following:

19a) P+æ#time incorp.#hɔ̀ + (ɣə- prog.) + progressive-momentaneous stem
'P was out, gone all of the time indicated by incorp.(day, night, summer, winter)'

b) N#(#) (də) # (ɔ)ɣɔ#k'ə + (ɣə- perf., prog.) + momentaneous or progressive stem
'all N (morning, evening, spring, fall) long'

c) ʒæn# (ɣə- neuter, ɣə- momentaneous)
'during the day, the span of a day'

d) ʒæn#(#) k'ə + (ɣə- neuter, ɣə- momentaneous)
'all day long'

e) λəd #k'ə + (ɣə- neuter, ɣə- momentaneous)
'all night long'

f) yi#q'ə#nɔ# (k'ə) + (lə- momentaneous, ɣə- progressive)
'all night'

It seems then that the boundary between lexical category, phrasal category, and sentence is ambiguous enough in Koyukon to necessitate the inclusion of information about syntactic operations in the formatulation of word formation rules.

Computational Analysis. Byrd, Klavans, Aronoff, and Anshen (1986) describe a system for computationally analyzing affixation in English. The system employs four word lists and eight computer programs which allow researchers to input morphologically complex words and receive as output a structure which identifies the base and "shows the affixes and marks the parts-of-speech of the components." To implement such a system for the verbal system of a polysynthetic language like Koyukon, some adjustments would need to be made.

First, rather than just monomorphemic words, all roots would need to be available on a list for the programming system. Because suppletion and irregularity are so prevalent in the stem sets for each root, many roots would need to be listed with their associated stems in addition to listing the regular rules by which aspectual stem variants are derived. Further, since verbal utterances are derived from non-predictable themes, rather than from simple roots, these too would need to be entered in a dictionary. Lists of aspectual and non-aspectual derivational strings, gender prefixes, postpositions, incorporating forms of nouns, and phonological rules would be necessary as well. This would entail a certain amount of redundancy since gender prefixes and postpositions both participate in many aspectual derivational strings with unique meaning and also function as separate elements.

Because this is a language that can only be described by a context sensitive grammar, a finite state automaton would be inadequate to parse it. Parsing a verb form of Koyukon would require a device that could look both forward and backward and which could remember what it saw. It would need to operate more along the lines of Koskenniemi's TWOL, a morphological parser developed for Finnish which scans words from left to right devising possible candidates for what the word might be in the process of recognizing that word--a process of analysis by synthesis. Such a parser for Koyukon would have to scan from right to left, first matching the stem with possible source roots, then simultaneously matching the prefix combination with possible source themes and determining the aspectual string in order to compare it with the aspectual potential of each candidate theme (e.g., if the aspectual string is a semelfactive one, the theme from which it is derived must be one that permits semelfactive derivations). Finally, the parser would need to identify inflectional affixes.

Rather than producing a bracketed structure like the one described by Byrd et al (1986), a parser for Koyukon would need to produce the discontinuous affix strings from which the word is constructed: theme and derivational strings. Identifying the theme is a complex task. The parser would have to know, for example, the derivations which alter the classifier prefix. Passive, benefactive, reflexive, and reciprocal derivations, among others, add a d element to the classifier so that a thematic Ø classifier will be də- in the derived form and thematic ł- will be lə- in the derived form while the thematic də- and lə- classifiers remain unchanged. The causative derivation changes any thematic classifier prefix to ł. The parser, then, must be able to see a də-, ł-, or lə- classifier and know that it might represent a thematic or derived form and proceed accordingly.

This brings us to a more important problem. If the computer scans the də- classifier prefix and finds a nɔ# prefix later, how is it to know whether it has found an iterative form, which is marked in just this way, or a verb with a thematic də- classifier and one of two other nɔ# prefixes which occur in the same position as the nɔ# iterative prefix but have entirely different meanings? Speakers are able to resolve this kind of potential ambiguity via the conversational context. Clearly, in order for the parser to make a decision of this sort, it would need access to the meaning of the word. A parser without a rather elaborate semantic component would be unable to do more than provide a list of possibilities for the identification of affixes within a given word.

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STRUCTURAL ANALYSIS OF THE VERB COPYING CONSTRUCTION IN MANDARIN CHINESE[*]

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Abstract. This paper examines a Chinese-specific sentence structure conventionally called **verb copying construction**, within the framework of generative grammar. It is aimed at providing a descriptive account of this structure as well as explaining the syntactic constraints of its occurrence.

The verb copying construction refers to the type of sentences in which a transitive verb reoccurs after the direct object in the presence of certain adverbial phrases. The Chinese equivalent to the English sentence He washes clothes very fast may serve as an illustration.

[Ta xi yifu] xi de hen kuai.
He wash clothes wash MOD very fast

It is apparent that the verb wash is reduplicated after the direct object. In previous studies, this phenomenon has been viewed with relation to the word order change or surface conditions in Chinese.

Assuming a different point of view, the present research reanalyzes verb copying in the light of the general characteristics of Chinese sentences. It is proposed that as a topic-prominent, pro-drop language, Chinese has a basic S´ structure: TOP (topic) + S. In view of this, verb copying construction is realized as having a topic-comment structure due to the application of 'Move-α' (postulated as Move-to-TOP) which moves the subject, verb, and direct object to the topic node and leaves overt in S a lexically recovered trace of the verb and the post-verbal adverbial phrase. In support of the postulation of Move-to-TOP, the grammatical properties of the verb copying construction are discussed and some theoretical issues relevant to movement are also addressed. Finally, as an attempt to account for the structural difference between sentences with a copied verb and those without it, the paper concludes that Move-to-TOP can operate at least in five different ways as regards what is extracted from S.

Goal. This paper examines a Chinese-specific sentence structure conventionally called **verb reduplication** or **verb copying**, within the framework of generative grammar. It is aimed at providing a descriptive as well as explanatory account of this sentence.

The verb copying construction refers to sentences in which a transitive verb reoccurs after the direct object in the presence of certain adverbial phrases. For example, to express the idea 'He washes dishes very fast,' a Chinese speaker would say:

(1) ta xi wan xi de hen kuai.
     he wash dishes wash MOD very fast

Sentences (2)-(4) below are some other examples of verb copying:

(2) ta nian naben shu nian le sange zhongtou.
     he read that book read PFV three hours