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A PRODUCTION GRAMMAR FOR ENGLISH KINSHIP TERMINOLOGY*

This is an exposition of the method, used elsewhere for Malagasy and Hindi, to describe kinship terminologies by means of production grammars. Such a grammar should generate all admissible kinship descriptions and then convert these into actual kinship terms. Among the productions one finds not only the reduction rules of interest to anthropologists, but also structure and morphological rules of interest to linguists.

0. Introduction.

The kinship terminologies of many languages display surprising degrees of ingenuity. Their invention must have provided an outlet for the creative talents of potential mathematicians long before there was any mathematics to speak of. In recent years such terminologies have been studied mostly by anthropologists, who made free use of one rather elementary mathematical concept, that of relative product.

Another notion also proved to be useful, known in mathematics are "semi-Thue systems" [K 1952], in computer science as "production grammars" [HU 1969, B 1971] and in linguistics as "rewriting systems" [G 1972] or "generative grammars" [C 1957]. It was Lounsbury who first used rewriting rules or productions in discussing how semantically distinct kinship descriptions can have the same phonetic representations by kinship terms [L 1965]. A fuller treatment of kinship terminologies must take into account also the structure of kinship descriptions and the morphological rules which convert these into kinship terms. Techniques for doing so were developed for Malagasy [LL 1981], Hindi [BL 1983] and Sanskrit [BL 1985]. The present paper aims to give an exposition of these techniques by using as object language one that is understood by a larger audience.

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While English kinship terminology is much poorer in several respects than that of other languages studied, it suffices to illustrate most of the points made in connection with the other languages. As regards mathematical sophistication, it may even surpass other languages: if i^{th} cousins j times removed are admitted for consideration, English kinship grammar must incorporate the number system and two primitive recursive functions, the minimum and the absolute difference.

Which dialect of English should be investigated? To do serious fieldwork by questioning older members of one's speech community is tedious. Fortunately, there is a classical paper by Goodenough [G1965] on what he calls "Yankee" kinship terminology, which will serve the purpose of providing our data. We are not concerned here with Goodenough's taxonomic analysis of the meaning of kinship terms, componential analysis, which expresses the meaning of a term as a Boolean intersection of certain basic features. However, we shall accept his basic data, with some minor exceptions to be pointed out as we go along.

I would like to thank Michael Lambek for introducing me to anthropological linguistics and for initiating [LL1981], which also contains a rudimentary sketch of English kinship grammar, Mira Bhargava for collaborating on [BL1983, 1985], George Bergman for his stimulating comments during our correspondence and Bill Anglin for his critical reading of the present text.

1. Consanguineous data.

We begin by listing the primarily consanguineous kinship terms along with their descriptions. To understand these descriptions, the reader should read:

M as "male",
F as "female",
P as "parent (of)",
C as "child (of)",
S as "sibling (of)",
Σ as "spouse (of)".

Thus, for example, M(Σ)SP should be read, in this order, as

"male (spouse of) sibling of parent",

which is the description of the term *uncle*. We shall make this kind of interpre-

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tation more precise later, involving the so-called "relative product". Note that the preposition "of" is omitted at the end of a description, that is, before a blank space. As a blank space is easy to overlook, we shall usually denote it by the symbol #.

When we say that a kinship term is primarily consanguineous, we mean that the symbol Σ enters its description not at all or only parenthetically.

In order to express the data as succinctly possible, we shall make use of natural numbers as exponents. Thus $P^1 = P$, $P^2 = PP$ etc; $(great\#)^0$ *uncle* = *uncle*, $(great\#)^1$ *uncle* = *great# uncle*, etc. In the following table, m and n are supposed to be arbitrary natural numbers, that is, nonnegative integers.

Table I. Primarily consanguineous kinship terms in English

$M(\Sigma)SP^{n+1} \rightarrow (great\#)^n uncle$	$F(\Sigma)SP^{n+1} \rightarrow (great\#)^n aunt$
$M(\Sigma)P^{n+2} \rightarrow (great\#)^n grandfather$	$F(\Sigma)P^{n+2} \rightarrow (great\#)^n grandmother$
$M(\Sigma)P \rightarrow father$	$F(\Sigma)P \rightarrow mother$
$MS \rightarrow brother$	$FS \rightarrow sister$
$MC^{m+1}SP^{n+1} \rightarrow cousin$	$FC^{m+1}SP^{n+1} \rightarrow cousin$
$MC(\Sigma) \rightarrow son$	$FC(\Sigma) \rightarrow daughter$
$MCS(\Sigma) \rightarrow nephew$	$FCS(\Sigma) \rightarrow niece$
$MC^{m+2}(\Sigma) \rightarrow (great\#)^m grandson$	$FC^{m+2}(\Sigma) \rightarrow (great\#)^m granddaughter$
$MC^{m+2}S(\Sigma) \rightarrow (great\#)^m grandnephew$	$FC^{m+2}S(\Sigma) \rightarrow (great\#)^m grandniece$

Here are some remarks about Table I. $M\Sigma P$ may be rendered as *father*, but, under certain circumstances, also as *stepfather* (see Section 6 below). $MC^{m+1}SP^{n+1}$ may also be rendered, by genealogical enthusiasts, as i^{th} *cousin* j *times removed*, where $i = \min(m,n) + 1$ and $j = |m-n|$. The lack of symmetry between $MSP^2 \rightarrow$ *great# uncle* and $MC^2S \rightarrow$ *grandnephew* is by no means universally accepted, but Goodenough stresses it for his own idiolect, although he spells the latter *grand# nephew*.

We add some etymological observations. The basic kinship terms *father, mother, brother, sister, son* and *daughter*, referring to the nuclear family, are of surprising antiquity: they all have Sanskrit cognates.

The word *nephew* is ultimately derived from Latin *nepos*, which, however, means not only "nephew" but also "grandson". Its Sanskrit cognate means only "grandson". The word *uncle* is derived from Latin *avunculus*, literally "little grandfather", with the meaning MSFP. It replaces two separate words in Middle English which may be described by MSMP and MSFP respectively.

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2. Production grammars.

The question arises how to explain the infinite collection of data in Table I by means of a finite set of grammatical rules. More precisely, we want to know how to generate the kinship descriptions in the table, namely

$$G(\Sigma)(S)P^{n+1},\ GC^{m+1}SP^{n+1},\ GC^{m+1}(S)(\Sigma),$$

where G = M or F, and we want to know how to convert these into the corresponding kinship terms.

To be quite honest, we would look for such rules even if Table I had contained only a finite number of data, say with m, $n \leq 3$. We would then be tempted to use the rules found in the short table to extend the table by "analogy". In fact, that is pesumably how we constructed the present table in the first place.

It is customary to express such rules in the framework of a production grammar, which, as has already been pointed out, is essentially the same as a generative grammar, except for a difference in emphasis.

A *production grammar* consists of a finite set V, the *vocabulary* (often called *alphabet*) together with a finite set of given *productions* $\Gamma \to \Delta$, where $\Gamma = A_1 \dots A_m$ and $\Delta = B_1 \dots B_n$ are strings of elements A_i, B_j of V. The binary relation $\to$ is understood to be a partial order in the free monoid generated by V. Usually two subsets of V are specified, an *initial* vocabulary V_i and a *terminal* vocabulary V_t.

In the present setup, $V_i = \{R\}$ consists of a single symbol R, meaning "relative" or "relation", and V_t consists of the following English words: *father, mother, brother, sister, son, daughter, uncle, aunt, cousin, nephew* and *niece*, and the following *prefixes* (which also happen to be words): *grand* and *great*. Later we shall add other words, including other prefixes and one suffix, to the terminal vocabulary. It is convenient also to include in V_t the symbol # denoting a blank space between words.

In addition to the subsets V_i and V_t, V may have other elements, in the present case the following *auxiliary* symbols: M, F, P, C, S and Σ.

The properties of the binary relation $\to$ may also be expressed by saying that we have a *deductive system* with axioms $\Gamma \to \Gamma$ and rules of inference

$$\frac{\Gamma \to \Delta \quad \Delta \to \Lambda,}{\Gamma \to \Lambda} \qquad \frac{\Gamma \to \Delta \quad \Gamma' \to \Delta'}{\Gamma\Gamma' \to \Delta\Delta'},$$

in addition to the given productions $\Gamma \to \Delta$ which serve as axioms or

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postulates. The second rule of inference is equivalent to the substitution rule:

$$\frac{\Gamma \to \Delta}{\Phi\Gamma\Psi \to \Phi\Delta\Psi}.$$

Here Φ or Ψ may be the empty string, which we usually denote by 1.

Our project then is to find a set of postulates or given productions so that the productions in Table I and the productions

$$R \to G(\Sigma)(S)P^{n+1},\ GC^{m+1}SP^{n+1},\ GC^{m+1}(S)(\Sigma),$$

with G = M or F, are provable productions or theorems. Moreover, we don't want to be able to prove $\#R\# \to \#\Gamma\#$, where Γ is a string of elements of V_t, unless Γ is a kinship term listed in Table I. That is, Table I should contain every conceivable kinship term predicted by the grammar. It helps that we did not impose any bounds on m and n.

A kinship description is said to be *consanguineous* if the symbol Σ does not occur in it. In the next section, we shall state the given productions for English consanguineous kinship terminology. Thus, for the moment, we shall ignore the parenthetical Σ in Table I, but we shall return to it in Section 6.

In stating productions, it is often convenient to render context sensitive rules

$$\Phi\Gamma \to \Phi\Delta,\ \Gamma\Psi \to \Delta\Psi,\ \Phi\Gamma\Psi \to \Phi\Delta\Psi$$

by spelling out the context restrictions explicitly. Thus we shall often write, instead of the above,

$\Gamma \to \Delta$ after Φ,
$\Gamma \to \Delta$ before Ψ,
$\Gamma \to \Delta$ in the context $\Phi - \Psi$

respectively.

3. Consanguineous kinship grammar.

We shall classify the given productions into three groups:

structure rules (1) and (2),
reduction rules (3),
morphological rules (4) and (5), later also (6).

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(1) *Provisional structure rules:*
$R \to S$, CR, RP,
$R \to C$ before $\#$,
$R \to P$ after $\#$.

(2) *Gender insertion rules* after a prefix or $\#$:
$C \to GC$,
$S \to GS$,
$P \to GP$,
where $G = M$ or F.

(3) *Reduction rules:*
$C^2SP \to CSP$,
$CSP^2 \to CSP$.

(4) *Word assignments* after a prefix or $\#$ and before a suffix or $\#$:

$MSP \to$ *uncle*,	$FSP \to$ *aunt*,
$MP \to$ *father*,	$FP \to$ *mother*,
$MS \to$ *brother*,	$FS \to$ *sister*,
$MCSP \to$ *cousin*,	$FCSP \to$ *cousin*,
$MC \to$ *son*,	$FC \to$ *daughter*,
$MCS \to$ *nephew*,	$FCS \to$ *niece*.

(5) *Prefix assignments* after a prefix or $\#$:
$GP^2 \to$ *grand*GP before $\#$,
$GC^2 \to$ *grand*GC before $S\#$ or $\#$,
$GXP^2 \to$ *great*$\#GXP$ if $X = S$ or P,
$G\Gamma C^2 \to$ *great*$\#G\Gamma C$ if $\Gamma = C^{m+1}$ before $S\#$ or $\#$.
Here $G = M$, F or 1 (the empty string).

We shall discuss the consanguineous productions.

(1) The provisional structure rules generate the following neutral kinship descriptions in the context $\#-\#$:

$$R \to C^{m+1},\ P^{n+1},\ C^mSP^n;$$

for example

$$R \to CR \to C^2R \to C^2RP \to C^2SP.$$

The purpose of the context restrictions on $R \to C$ and $R \to P$ is to avoid the combination CP. Moreover, the given productions are such as to never generate the combinations PC, PS, SC or S^2. Why should all these combinations be avoided?

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By now the reader will have guessed that P, C and S are to be interpreted as binary relations. For example, xPy is to be read as "x is a parent of y". Juxtaposition of relation symbols usually denotes the *relative product*. For example, xCPy then means

$$\exists_z(xCz \wedge zPy),$$

that is, x and y have a common parent. We can by no means identify CP with S; in fact, it is the disjoint union $CP = I \cup S$, where I is the identity relation and S means "sibling" in its widest sense, including halfsiblings. Unfortunately, English kinship terminology was not designed by a modern mathematician, so S is not a reflexive relation. If we interpret S in its narrowest sense as meaning "full sibling", CP is the disjoint union

$$CP = I \cup S \cup S_{1/2},$$

where one should read

$S_{1/2}$ as "halfsibling (of)".

In Section 5, we shall include $S_{1/2}$ in the auxiliary vocabulary.

Concerning the "forbidden" combinations, clearly

$$PC \subseteq I \cup \Sigma,\ SC \subseteq C,\ PS \subseteq P,\ S^2 \subseteq I \cup S,$$

where the first presupposes a very wide interpretation of "spouse". I know of no language which dignifies any of the relations PC, SC, PS or S^2 by a special kinship term.

The provisional (neutral) kinship descriptions C^{m+1}, P^{n+1} and C^mSP^n appear in many languages, but my own idiolect excludes $C^{m+2}SP^{n+1}$ and $C^{m+1}SP^{n+2}$, as I recognize only first cousins CSP.

(2) The gender insertion rules assure that most English kinship terms T have a gender denoting the sex of x when x is in the relation denoted by T to y. Sometimes the gender is obligatory, e.g. there is no word denoting SP, whereas there are words for MSP and FSP. Sometimes the gender is optional, e.g. there is a word *parent* in addition to the words *father* and *mother*. Although Goodenough explicitly excludes neutral terms such as *parent* or the neologism *sibling*, we shall consider them in Section 7 below. In the word *cousin* the masculine and feminine forms coalesce, whereas French has preserved the distinction between *cousin* and *cousine*.

In modern English, gender need only be expressed at the beginning of a kinship description, that is, after #. This is not so in many languages,

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such as Hindi or even Middle English, where one must distinguish between MSMP and MSFP.

In line with reading a kinship description as a relative product, one may also interpret M and F as denoting relations. Thus xMy means "x is male and x = y", and so xMPz will mean "x is a male parent of z" as is intended.

(3) The reduction rules $C^2SP \to CSP$ and $CSP^2 \to CSP$ reduce all kinds of farfetched relatives to cousins. In Hindi and Malagasy there is a more stringent reduction $CSP \to S$ and in Latin one has $CS \to C^2$. There are languages with even more startling reductions; in fact, reduction rules are the very meat of anthropological linguistics [BS 1968]. While anthropologists may view reduction rules as reflecting some important traits of the cultures studied by them, I tend to see them merely as devices for reducing an infinite number of kinship descriptions to a finite number.

(4) The word assignments merely state the basic meanings of certain terms pertaining to the slightly extended nuclear family. In addition to these basic meanings, others may be justified by calculation, e. g.

$$MC^2SP \to MCSP \to \textit{cousin}$$

using (3) and (4).

Note the context restriction: before #. For example, we are not allowed to write

$$MCSP \to \textit{son}SP,$$

which would get us into a blind alley.

(5) English is rather poor in non-lexical morphological rules. The only prefixes appearing in consanguineous terms are *grand* and *great#*. One reason for the complicated context restrictions is that we do not want to infer

$$MC^2SP \to \textit{grand}MCSP \to \textit{grandcousin},$$

as this term does not exist. As it is, we are forbidden to apply the rule $C^2 \to \textit{grand}MC$ in this context. This does not imply that with MC^2SP we have reached an impasse; fortunately, the reduction rule $C^2SP \to CSP$ will help us out.

Note that the rules as stated yield before #:

$$MC^2S \to \textit{grand}MCS \to \textit{grandnephew},$$
$$MSP^2 \to \textit{great\#}MSP \to \textit{great\#uncle},$$

thus accounting for the asymmetry in Table I.

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In (5) we allowed the gender to be expressed not only by M or F, but also by the empty string 1. This is in anticipation of the neutral kinship terminology to be discussed in Section 7 below.

4. Some reflections on the order of representation.

We have presented our production grammar as a deductive system, but it also serves as a program for converting the symbol R, in the context #–#, into an English kinship term, via a kinship description. We may think of the execution of this program as modelling what goes on in the mind of a person who first conceives of a kinship description and then transforms it into a kinship term.

We shall assume that strings are processed from left to right, in the order in which we write them down.

Let us take another look at the last production of (5) in the previous section. We may calculate, before #:

$$MC^{m+3}S \rightarrow (\textit{great}\#)^{m}\textit{grandnephew}.$$

On the other hand, we obtain:

$$MC^{m+2}SP \rightarrow \textit{cousin},$$

using the reduction rule $C^2SP \rightarrow CSP$ m+1 times. As we assume that our calculation proceeds from left to right, it follows that the symbols MC^{m+2} must be held in some kind of storage while we examine the three following symbols (including #) to decide whether to begin uttering *great#*... or *cousin*. For large value of m this may overload our short-term memory.

There is one apparent solution to this problem. We might write the kinship descriptions in reverse order, thus $SC^{m+3}M$ and $PSC^{m+1}M$ in place of $MC^{m+3}S$ and $MC^{m+1}SP$ respectively. This would be justified if we thought of xPy as standing for "x's parent is y" rather than "x is a parent of y". Let us call this the (Saxon) *genitive* interpretation of relation symbols.

The genitive interpretation is in fact the one practised by most anthropological linguists. In some languages, there may be an inherent reason for favouring this over the "of" interpretation that has been used in this paper. For example, in Sanskrit [BL 1985], it has the advantage of exhibiting a strong correlation between the order of symbols in the kinship description and the order of corresponding morphs in the associated kinship term.

Unfortunately, the genitive interpretation would not help us out of

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the present predicament. It would merely shift the problem from the last production of (5) to the penultimate one.

Nonetheless, it is quite possible that the genitive interpretations will simplify the presentation of English kinship grammar or render it more elegant. The reader is invited to try his hand at writing the productions using the genitive interpretation. This is not just a trivial matter of looking into a mirror, but involves some reformulation of the context restrictions.

Inasmuch as calculations with productions may reflect what goes on in the human mind, one may ask: what is the true order of the mental representations of kinship descriptions? For example, is the representation of *uncle* given by MSP or by PSM? It is not obvious that different speakers necessarily pick the same order. One may even doubt whether a mental representation of concepts is constrained to be linearly ordered at all, as in the semantic networks advocated by Mel'chuk [1981].

The problem of overloading the short term memory does not arise in my own idiolect, in which $C^{m+1}SP^{n+1}$ is not a valid kinship description unless m and n are both zero.

5. Additional consanguineous productions.

Table I does not quite exhaust the consanguineous kinship terms listed by Goodenough. He also discusses halfsiblings, ancestors and descendants. To handle these we should include in the terminal vocabulary the prefix *half* and the words *ancestor, ancestress* and *descendant*, and in the auxiliary vocabulary the symbol $S_{1/2}$ meaning "halfsibling".

Here are the additional productions, numbered to correspond to the numbering in Section 3, accounting for halfsiblings:

(1′) $R \to S_{1/2}$;

(2′) $S_{1/2} \to GS_{1/2}$ after #, where G = M or F;

(3′) $S_{1/2} \to S$;

(5′) $\Gamma S_{1/2} \to$ *half*ΓS after #, where Γ is any string of auxiliary symbols.

From (1′), (2′) and the old structure rules we can obtain any kinship description in which S has been replaced by $S_{1/2}$, e.g. $MS_{1/2}$, $MCS_{1/2}P$, $MS_{1/2}P$.

We may calculate

$MS_{1/2} \to$ *half*MS $\to$ *halfbrother*

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using (5′) and (4), or

$$MS_{1/2} \rightarrow MS \rightarrow \textit{brother}$$

using (3′) or (4). Similarly, we may obtain

$$MCS_{1/2}P \rightarrow \textit{halfcousin, cousin.}$$

While Goodenough does not list *halfcousin* and I have never heard it before, the grammar will generate it, unless more stringent restrictions are imposed on (5′) or (2′).

In the same way, we can obtain *halfuncle, halfnephew, halfgrandnephew* and *halfgreat#uncle*, but not *great#halfuncle*, unless we allow $X = S_{1/2}$ in the prefix assignment for GXP^2. These playful innovations are generated by the productions we have adopted. If necessary, they could be avoided by imposing the restriction on (1′): in the context #–#.

To account for Goodenough's "ancestors" and "descendants", we require the following additional word assignments and contraction rules:

$P^3 \rightarrow$ *ancestor* before #,
P *ancestor* → *ancestor*,
M *ancestor* → *ancestor*,
F *ancestor* 1 → *ancestress;*
$C^3 \rightarrow$ *descendant* before #,
C *descendant* → *descendant*,
G *descendant* → *descendant*, where G = M or F.

For example, we can now calculate before #:

$$FP^5 \rightarrow FP^2\textit{ancestor} \rightarrow FP\ \textit{ancestor} \rightarrow F\ \textit{ancestor} \rightarrow \textit{ancestress.}$$

Personally, I do not believe that ancestors and descendants begin only with the third generation. For me, a son is a descendant, and so, for my own idiolect, I would postulate

$C \rightarrow$ *descendant* before #,

in place of the above production involving C^3.

6. Affinal kinship grammar.

We call *affinal* any relationship whose description involves the symbol Σ. Strictly speaking, this includes the in-laws but not the steprelations. To do justice to the latter it is convenient, though not absolutely necessary, to

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introduce three additional auxiliary symbols:

P' for "stepparent",
C' for "stepchild",
S' for "stepsibling".

We observe that

$$\Sigma P \subseteq P \cup P',$$
$$C\Sigma \subseteq C \cup C',$$
$$C\Sigma P \subseteq \text{product } CP \cup S'.$$

These unions are disjoint only if P, C and S are understood in the narrowest possible sense. In a very puritanical society, or if Σ is understood rather widely, we may replace inclusion by equality so that

$$P' = \Sigma P - P,\ C' = C\Sigma - C,\ S' = C\Sigma P - CP.$$

We also adjoin to the terminal vocabulary the English words *husband* and *wife*, the prefix *step* and the suffix *-in-law*.

The following table contains all the affinal kinship terms listed by Goodenough.

Table II. Principal affinal kinship terms in English

$M\Sigma \rightarrow$ *husband*	$F\Sigma \rightarrow$ *wife*
$M(\Sigma)P\Sigma \rightarrow$ *father-in-law*	$F(\Sigma)P\Sigma \rightarrow$ *mother-in-law*
$MS\Sigma$, $M\Sigma S \rightarrow$ *brother-in-law*	$FS\Sigma$, $F\Sigma S \rightarrow$ *sister-in-law*
$M\Sigma C(\Sigma) \rightarrow$ *son-in-law*	$F\Sigma C(\Sigma) \rightarrow$ *daughter-in-law*
$MP' \rightarrow$ *stepfather*	$FP' \rightarrow$ *stepmother*
$MS' \rightarrow$ *stepbrother*	$FS' \rightarrow$ *stepsister*
$MC' \rightarrow$ *stepson*	$FC' \rightarrow$ *stepdaughter*

We shall write down some simple productions which will not only account for the data in Table II but will also predict other terms. These, while not standard, will be understood by most English speakers, if not spontaneously then after some reflection.

Affinal Productions

(1″) *Provisional structure rules:*

$R \rightarrow \Sigma$, in the context $\#-\#$,
$\# \rightarrow \#\Sigma$ before C, P or S,
$\# \rightarrow \Sigma\#$ after C, P or S,
$P \rightarrow P'$ after any symbol except Σ,
$S \rightarrow S'$,
$C \rightarrow C'$ before any symbol except Σ.

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(2″) *Gender insertion rule:*
$\Sigma \rightarrow G\Sigma$ after a prefix or #, where G = M or F.

(3″) *Reduction rules:*
$\Sigma P \rightarrow P$,
$C\Sigma \rightarrow C$,
$\Sigma S \rightarrow S\Sigma$.

(4″) *Word assignments* before #:
$M\Sigma \rightarrow$ *husband*,
$F\Sigma \rightarrow$ *wife*.

(5″) *Prefix assignments* after # or *step*:
$\Gamma P' \rightarrow$ *step*ΓP,
$\Gamma C' \rightarrow$ *step*ΓC,
$\Gamma S' \rightarrow$ *step*ΓS.

(6″) *Suffix assignments:*
$P\Sigma \rightarrow$ P-*in-law*,
$S\Sigma \rightarrow$ S-*in-law*,
$\Sigma C\Gamma \rightarrow C\Gamma$-*in-law* before #.

Here Γ may be any string of auxiliary symbols. We shall discuss the affinal productions.

(1″) The new provisional structure rules introduce the kinship descriptions for "spouse" and "steprelations" and allow one to put "spouse of" in front of any neutral consanguineous kinship description, that is, before the gender has been inserted, as well as "of spouse" after it.

(2″) The new gender insertion rule provides gender for the initial "spouse (of)".

(3″) The new reduction rules tell us, for example, that the spouse of a parent may be called "parent" even if he is a stepparent. (He may be called "stepparent" only if he is one.) They account for the parenthetical appearance of Σ in Table I. For example, using $\Sigma P \rightarrow P$, we obtain:

$$M\Sigma P^2 \rightarrow MP^2 \rightarrow \textit{grand}MP \rightarrow \textit{grandfather}.$$

Similarly, using $\Sigma S \rightarrow S\Sigma$ and $\Sigma P \rightarrow P$, we have:

$$M\Sigma SP \rightarrow MS\Sigma P \rightarrow MSP \rightarrow \textit{uncle}.$$

In some variants of the present grammar one may also require the converse of the last reduction rule, namely $S\Sigma \rightarrow \Sigma S$. Usually the two are combined

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into a so-called "equivalence rule" $\Sigma S \leftrightarrow S\Sigma$. In some variants of the present grammar the symbol Σ is allowed to be placed before the gender symbol in a kinship description, which may necessitate two further equivalences: $\Sigma M \leftrightarrow F\Sigma$ and $\Sigma F \leftrightarrow M\Sigma$.

(4″) The new word assignments account for the only two words in Table II which are not composites.

(5″) The new prefix assignments allow us to calculate, for example:

$MP' \rightarrow$ *step*MP $\rightarrow$ *stepfather*,
$MPP', MP'P \rightarrow$ *step*$MP^2 \rightarrow$ *stepgrand*MP $\rightarrow$ *stepgrandfather*,
$MP'P' \rightarrow$ *step*$MPP' \rightarrow$ *stepstep*$MP^2 \rightarrow$ *stepstepgrand*MP $\rightarrow$ *stepstepgrandfather*,
$MSP', MS'P \rightarrow$ *step*MP $\rightarrow$ *stepuncle*,

only the first of which is listed in Table II.

(6″) In two of the suffix assignments the relation symbol Σ and the morph *-in-law* occupy the same position, hence we could have written instead: $\Sigma \rightarrow$ *-in-law* before # and after P or S. Here is a sample calculation:

$$MS\Sigma \rightarrow MS\text{-}in\text{-}law \rightarrow brother\text{-}in\text{-}law.$$

Using the reduction rule $\Sigma S \rightarrow S\Sigma$, we also have:

$$M\Sigma S \rightarrow MS\Sigma \rightarrow brother\text{-}in\text{-}law.$$

While this term appears in Table II, the following do not. We calculate before #:

$$M\Sigma SP\Sigma \rightarrow MS\Sigma P\Sigma \rightarrow MSP\Sigma \rightarrow MSP\text{-}in\text{-}law \rightarrow uncle\text{-}in\text{-}law,$$
$$M\Sigma C^2 \rightarrow MC^2\text{-}in\text{-}law \rightarrow grand\text{MC-}in\text{-}law \rightarrow grandson\text{-}in\text{-}law.$$

As a final example, let us derive a word which appeared in a recent magazine article:

$$FPP'\Sigma, FP'P\Sigma \rightarrow step FP^2\Sigma$$
$$\rightarrow step FP^2\text{-}in\text{-}law \rightarrow stepgrand FP\text{-}in\text{-}law$$
$$\rightarrow stepgrandmother\text{-}in\text{-}law.$$

7. Neutral kinship terms.

The kinship terms admitted into the terminal vocabulary so far possess gender. With the exception of *cousin*, each refers to one sex only. However, there are terms such as *parent, child, spouse* and *sibling*, the last perhaps a bit technical, which may be used to denote either sex, and they were so used

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in the auxiliary vocabulary. While Goodenough explicitly excludes these terms from consideration, for reasons that need not concern us here, it is not difficult to incorporate them into the terminal vocabulary. Thus we postulate the following new word assignments.

After prefix or # and before suffix or #:

$P \rightarrow$ *parent*,
$C \rightarrow$ *child*,
$S \rightarrow$ *sibling*,
$\Sigma \rightarrow$ *spouse*,
$CSP \rightarrow$ *cousin*.

Unfortunately, there are no neutral terms denoting "uncle/aunt" and "nephew/niece".

Let us examine the neutral kinship terms in connection with the prefix and suffix assignments discussed earlier. In all the examples that follow, the context #–# is presupposed. We calculate:

$P^2 \rightarrow$ *grand*$P \rightarrow$ *grandparent*;

recalling that G was allowed to be empty in (5);

$P^3 \rightarrow$ *great*#$P^2 \rightarrow$ *great*#*grandparent*;
$SP^2 \rightarrow$ *great*#$SP \rightarrow$ *great*#$MSP \rightarrow$ *great*#*uncle*,

where the gender insertion rule (2) rescues us from getting stuck;

$C^2S \rightarrow$ *grand*$CS \rightarrow$ *grand*$MCS \rightarrow$ *grandnephew*,

recalling that (2) specified: after # or a prefix:

$S_{1/2} \rightarrow$ *half*$S \rightarrow$ *halfsibling*,

using (5′) with Γ being the empty string;

$P' \rightarrow$ *step*$P \rightarrow$ *stepparent*;
$P\Sigma \rightarrow$ P-*in-law* $\rightarrow$ *parent-in-law*;
$CC' \rightarrow$ *step*$C^2 \rightarrow$ *stepgrand*$C \rightarrow$ *stepgrandchild*,

using (5″) with $\Gamma = C$;

$C'C \rightarrow$ *step*$C^2 \rightarrow$ *stepgrandchild*,

using (5″) with Γ empty.

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8. Summary.

We have presented a production grammar to account for all the kinship terms considered by Goodenough, with two exceptions. His "foster" relations seem to us somewhat extraneous and the "i^{th} cousins j times removed" we discussed but did not account for by productions. Indeed, a production grammar to generate the latter would have to incorporate all numerals, both ordinal and cardinal, and programs for calculating the primitive recursive functions min(x,y) and $|x-y|$. Our grammar also generates many kinship terms not admitted by him, neutral terms such as *grandparent* and "analogical" formations such as *stepgrandmother* and *uncle-in-law*, which he does not accept as standard in his culture.

There is clearly an analogy between syntax, as developed by Chomsky (1957), and kinship grammar, as is seem from the following comparison:

syntax	*kinship grammar*
rewrite S	rewrite R
kernel sentence	kinship description
phrase structure rules	structure rules
morphophonemic rules	morphological rules.

Not surprisingly, transformation rules (see below) will appear on both sides of the comparison. We now discuss the kinship productions in some detail.

The structure rules are context-sensitive rules of the form:

$$A \to B_1 \dots B_n \text{ in the context } \Phi - \Psi,$$

where A is a single element of the vocabulary. It appears that they create information or generate concepts, namely kinship descriptions.

The word assignments and some other morphological rules have the form:

$$A_1 \dots A_m \to B \text{ in the context } \Phi - \Psi.$$

However, there are among the morphological rules also transformations of the form

$$\Gamma P \to Q \Gamma.$$

The number of such transformations may be reduced considerably, although not to zero, by judicious choice of notation, for example, by adopting the genitive interpretation of relation symbols, which would cause the order of symbols in kinship description to be reversed. The morphological rules preserve information, they transform kinship descriptions into kinship

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terms. In the absence of other rules, and if we ignore steprelations, they induce a one-to-one correspondence between the set of kinship descriptions and the set of kinship terms. In the presence of other rules, this becomes a many-to-many correspondence. On the one hand, P may be converted into *parent* or *stepparent*, on the other hand ΣS and $S\Sigma$ are both rendered by *sibling-in-law*.

On the whole, the reduction rules forget information. For example, when we apply the rule $\Sigma P \rightarrow P$, we no longer care whether the parent in question was married or whether he was an actual progenitor. On the other hand, the rule $P \rightarrow P'$ creates information. It tells us that the spouse of the parent under consideration is not an actual progenitor.

Finally, let me say that this is just one attempt to present a complete kinship grammar for English and that improvements are undoubtedly possible.

9. Notes added in proof.

Section 2. In the definition of a production grammar given here we have stipulated that the set of given productions should be "finite". Strictly speaking, we have not adhered to this definition, unless we count as productions also "production schemes" involving an arbitrary string Γ, such as appear in (5), (5′), (5″) and (6″). Perhaps a more careful analysis can make the number of productions strictly finite (see the suggested revision of (5) below).

Section 3. A better way of handling (5) is by introducing a prefix [*grand*] with three allomorphs: *grand, great #* and 1, the empty string. Thus (5) should be stated as follows, where G = M, F or 1:

$$GP^2 \rightarrow [\text{grand}]\ GP;$$
$$GC^2 \rightarrow [\text{grand}]\ GC;$$
$$[\text{grand}] \rightarrow \begin{cases} 1 \text{ before } \textit{cousin}, \\ \textit{great } \# \text{ before any prefix}, \\ \textit{grand} \text{ before any other kinship term without prefix.} \end{cases}$$

This allows us to calculate GC^2S but not GSP^2, for which a separate rule is required, namely

$$GSP^2 \rightarrow \textit{great } \# \text{ GSP}.$$

If Goodenough is right about the spelling, the symbol # should be omitted here.

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Section 4. The revised version of (5) above would resolve the problem of storage and could be used to argue against the genitive interpretation.

Section 5. A better way of treating the halfsiblings, which is more in line with Section 6, is to replace (1′) as follows:

(1′) $S \rightarrow S_{1/2}$,

and to abolish (3′) altogether. This would permit the derivation of *great # halfuncle* in a devious way.

Section 6. Since we did not provide for gender insertion before P′, S′ and C′ in (2″), we may be led into what looks like a blind alley, for instance, after deriving $R \rightarrow P \rightarrow P'$. Fortunately, Section 7 will show a way out by supplying a neutral kinship description.

The present rules allow the derivation of $MP^3P' \rightarrow$ *great # stepgreat # grandfather*, in addition to the more reasonable *stepgreat # great # grandfather*.

Section 7. I learned from David Caldwell the neutral terms *nibling* for CS and *avuncular* for SP.

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