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Subjective experience is transformed into objective reality for societal members through cultural idea systems that can be represented with theory and data models. A theory model shows relationships and their logical implications that structure a cultural idea system. A data model expresses patterning found in ethnographic observations regarding the behavioral implementation of cultural idea systems. An example of this duality for modeling cultural idea systems is illustrated with Arabic proverbs that structurally link friend and enemy as concepts through a culturally defined computational system. Computational systems also generate new concepts, as will be illustrated through a theory model for the structure of a kinship terminology system. This examples accounts for what otherwise appears to be an anomaly in the terminology thereby illustrating the constructive role that modeling of cultural constructs can play in ethnographic research.

Language is . . . a symbolic, intersubjective, self-referential system of signs we use to structure a meaningful existence among ourselves. (Hustvedt 2009, p. 23)

1. Introduction

In this paper we will explore some of the uses of models for representing and analyzing the structural properties of cultural idea systems through which individual, subjective experience is transformed into objective reality for societal members. By a cultural idea system is meant the concepts and ideas, transmitted through enculturation, that provide the conceptual basis upon which systems of social organization are predicated. These idea systems frame culturally meaningful behavior through cultural rules. As the anthropologist Claude Lévi-Strauss wrote, "Wherever there are rules we know for certain that the cultural stage has been reached" (1971, p. 8).

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Yet cultural rules may be "invisible"—we act according to them but as culture-bearers we need not be aware of them, for "cultural rules are often outside your cognizance, beyond your conscious attention" (Spradley and Mann 1975, p. 7). Our goal here is to make the rules "visible" through formal modeling of cultural idea systems and then to see how the formal modeling enables us to explore further the patterning we identify in cultural phenomena.

For the modeling part of this paper, we will distinguish between theory models and data models (Read 1990, 2008). By a *theory model* will be meant a representation of a theory from which expected patterning for data observations may be deduced. By a *data model* will be meant a representation of patterning in phenomena induced from data values. A canonical example of this distinction is provided by the difference between Johannes Kepler inductively determining an elliptical form of planetary motion from empirical observations (a data model) and Isaac Newton deductively arriving at that form through his laws of motion and gravitational force applied to planetary motion (a theory model). Isomorphism between the elliptical orbit expressed in the data model and the elliptical orbit predicted from the theory model implies that the theory is explanatory for the form of planetary orbits expressed in the data model.

The distinction need not be sharp in that a data model can be constructed in parallel with a theory model and vice-versa. In some domains, such as ethnographic accounts, the complexity of human behaviors has led to confounding a data model with a theory model. Edward Evan Evans-Pritchard's (1940) classic discussion of social organization based on segmentary lineage systems in tribal societies such as the Nuer is a case in point. Though his account is referred to as an example of "lineage theory" (Kuper 1982, p. 71), his account "does not refer to actual social processes" (Holy 1996, p. 89), hence, by not incorporating process, does not provide a basis from which expected, observable patterning of group relations can be derived. Instead, his account refers to empirical patterns—the hallmark of a data model, though it may lack validation as the asserted patterns are said to be without adequate empirical support (Kuper 1982).

We will explore the formal modeling of cultural idea systems using the distinction between a data model and a theory model by beginning with a simple social behavior for which explanatory arguments can be developed without reference to cultural idea systems. Then we will introduce a cultural component that brings into play the ideational domain of cultural concepts. Next we explore how cultural idea systems can be viewed as providing a theory expressing structural relationships among the concepts comprising a cultural idea system. We will first illustrate the argument with an example using the concepts of "Friend" and "Enemy" and then apply it to the domain of kinship and the culturally constructed system of relations expressed through a kinship terminology—the collection of terms culture-bearers use to refer to those with whom they have a kinship relation. We will conclude by showing that predictions made from a theory model for a kinship terminology are verified through ethnographic observation, hence the modeling enriches our ethnographic accounts of social systems.

2. Modeling of Behavior: Simple Social Behavior

We begin our exploration with simple social behavior such as interaction between a pair of individuals varying along a continuum ranging from, say, negative, hostile behavior to positive, supportive interaction. In between are behaviors that only evoke indifference by the interacting individuals. Behaviors along this continuum have patterning for group members expressible through a network data model showing who interacts with whom and in what manner using behaviors from this continuum.

3. Culturally Categorized Behavior

We next introduce a cultural transformation of this continuum using a culturally framed, discrete categorization of behaviors. In human societies, individuals generally refer to the behavior of others qualitatively by categorizations such as "friend-like" or "enemy-like," rather than quantitatively. The boundaries of the categorization may be individual specific and are used to divide those with whom one interacts into groups such as "my friends" and "my enemies." With this transformation, the network data model can be re-expressed qualitatively through interactions subjectively identified as friend-like or enemy-like.

Subjectivity limits the utility of the categorization for making the assessments Talcott Parsons identified as a critical component of social interaction: ". . . in the case of interactions with social objects a further dimension is added. Part of ego's expectation . . . consists in the *probable reaction of alter to ego's possible action,* a reaction which becomes anticipated in advance and thus to affect ego's own choices" (1964, p. 5, emphasis added). Suppose person A meets person C and wants to know the likelihood that C will act towards A as a friend, absent evidence from prior interaction. To determine this, A may refer to a third person, B, who is a mutual friend of A and C. Will C be motivated to act in a friend-like manner to A since B is a friend of C and B is a friend of A, or will C act using some other criterion? The characterization of friend-like and enemy-like behaviors, based on individual-specific dichotomization of a continuous scale, does not, by itself, allow for the calculation of the "probable reaction" discussed by Parsons since there need not be a consistent, emergent, global pattern across individuals when behavior is subjectively characterized as enemy-like or friend-like.

4. Cultural Computation System

Some cultures have circumvented this limitation by stipulating how concepts such as *friend* and *enemy* are conceptually interrelated through culturally specified computations. For example, the anthropologist Martín Gusinde commented, regarding those he worked with in Tierra del Fuego, "A person who has quarreled with someone from another group does not hold back his dislike . . . he wears his innermost feelings clearly drawn on his face as soon as he meets his enemy *or the latter's friends*" (1931, p. 626, emphasis added). Thus the friend of an enemy is to be treated as an enemy for that fact alone. We can represent formally the cultural knowledge involved in an encounter like this by saying that the Tierra del Fuegans compute *friend* of an *enemy* and *enemy* is the resulting value. Adherence to culturally specified computations like this make the likelihood of friend-like or enemy-like behavior predictable, from the viewpoint of the culture-bearers, by knowing who is a friend of whom.

Making computations using the concepts of friend and enemy is explicit in Arabic proverbs such as: "Another proverb [from Morocco] . . . *r-'adhu nj-'adhu-inu dh-imdukkar-nu,* 'the enemies of my enemies are my friends'" (Hart 1989, 767). The proverb asserts that *enemy* is not just part of a categorization of a continuum of behaviors, but is part of a system of concepts determined by computations made with the concepts, friend and enemy. The Arab proverbs express the four possible computations as follows:

1) A friend of a friend is a friend
2) A friend of an enemy is an enemy,
3) An enemy of a friend is an enemy,

and

4) An enemy of an enemy is a friend.

The statements are cultural rules that transform the meaning of friend and enemy from the phenomenal domain of behavior to the ideational domain with the meanings of the friend and enemy concepts expressed through the computations.

5. Culture Theory of Concept Interrelationships

The proverbs provide a culture theory for the meaning of the concepts, friend and enemy, expressed through these computations. The theory is formally analogous to, for example, a gravitational theory expressing the interrelationships among the concepts force, mass and acceleration, but differs in that the validity of the culture theory for the outside observer does not lie in comparing it to empirical behaviors as the proverbs *define* a conceptual universe within which behavior takes place. For the outside observer, validity lies in establishing that the culture theory is part of the cultural idea systems of the culture-bearers. For the culture-bearers, validity lies in the fact that this is part of their shared, cultural idea systems. This implies, as Clifford Geertz (1973) expressed it, that the culture theory must be a model *for* behavior by the culture-bearers, not a model *of* behavior by the observer. It follows that if behavior *is* structured according to this culture theory by culture-bearers, then a data model for behaviors will have structure isomorphic to a theory model derived from the culture theory and isomorphism between the structure expressed in a theory model and in a data model for behaviors makes the theory explanatory for the patterning expressed in the data model (Read 2008).

Accordingly, we need to consider friend and enemy as cultural concepts at two different levels of abstraction. The first is at the more concrete level of a partition of a continuum of behaviors that enables us to characterize those with whom we interact as either friends or enemies (or neither). The second is the more abstract level where friend and enemy are considered to be concepts with meaning constructed through the relationships given in the four proverbs/rules. As a theory, the four rules are not validated by agreement with observations of behavior since the rules construct the social universe in which behaviors take place and not the reverse. They are validated, instead, by ethnographic elicitation that demonstrates the way the rules form a cultural idea system for the societal members.

6. Theory Model for the Culture Theory

Now let us derive a theory model for the culture theory expressed in these four statements. For simplicity, assume (as is likely to be the case for small-scale societies) that a friend network composed of all members of the society is connected. From the subjective viewpoint of each person, p, the set G of persons making up the society will be divided into two subsets: the set G_1 of persons that p categorizes as Friend, and G_2, the set of persons that p categorizes as Enemy (see Figure 1). Although G_1 and G_2 are from the perspective of p, hence constitute a subjective subdivision of the entire society, the theory implies that the categorizations will actually be socio- and not just ego-centric (see Figure 1 for details of the argument). Hence we have as a theory model that the society will be divided into two, absolute categories, with all members of a category either categorized as Friend or as Enemy by each person in the society.

In this culturally constructed universe, all persons are coordinated

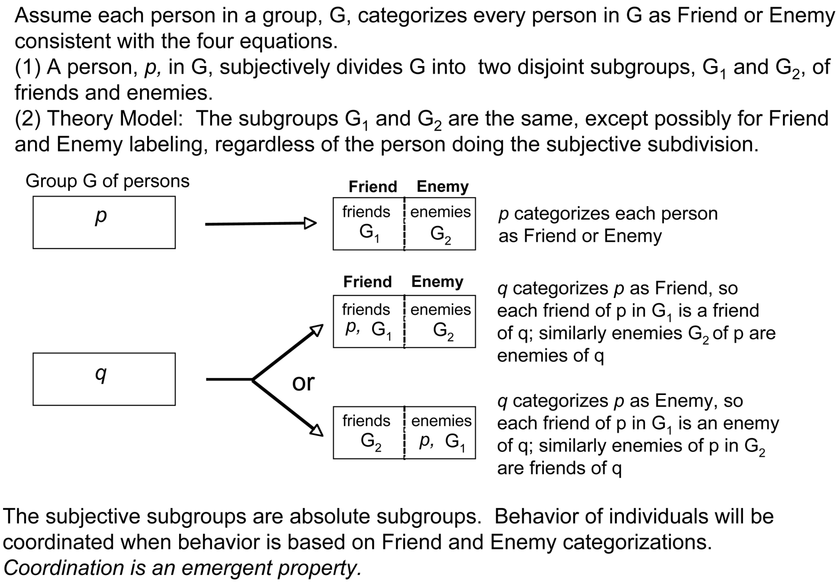


Figure 1. Theory model for Friend/Enemy rules. Individually subjective divisions into Friend and Enemy categories based on these rules are consistent across individuals, thereby leading to coordination among societal members as an emergent property, hence to an objective division into Friend and Enemy categories.

globally in their perception that the society is divided into either those categorized as Friend or those categorized as Enemy, with differences between individuals only relating to which of the two groups is categorized as Friend and which is categorized as Enemy. Consequently, a data structure for this society will be one in which there is a (conceptual) division of the society into two "sides" in opposition. Empirically, this is precisely the case for village factions in India.

Village factions are denied to exist (that is, there is no explicit criterion for what constitutes a faction or for membership in a faction) and yet clearly they are real (Leaf 2009). When Murray Leaf asked his informant about factions in the village where he was doing fieldwork, his informant drew a diagram with a single vertical line as a data model for a faction. With further queries, it became apparent to Leaf that his informant was indicating that factions are the alignments that arise in a village on some issue, with the vertical line in the diagram signifying a division between sides that is in accordance with the calculations expressed in the four equations since those who are in agreement on the issue perceive themselves as friends to each other and perceive those in disagreement with them as enemies. As a consequence, the factions emerge as diagrammed by his informant and so the factions are real, yet without an overt, publicly acknowledged criterion for membership.

The four rules also appear in other contexts with different meanings. For example, with positive and negative numbers: (1) positive × positive = positive, (2) positive × negative = negative, (3) negative × positive = negative and (4) negative × negative = positive. These equations were used by the Indian mathematician Brahmagupta (b. 598 AD, d. 670 AD) to define the concepts of negative and positive numbers (O'Connor and Robertson 2000, as referenced in Read 2010) and are isomorphic to the four rules under the correspondence: Friend → positive, Enemy → negative, "of a" → "×" and "is a" → "=". Yet other examples include odd and even numbers under addition and binary addition of 0 and 1. Common to these different rule sets is the idea of two concepts in opposition: Friend in opposition to Enemy, positive in opposition to negative, even in opposition to odd and 1 in opposition to 0.

7. A Kinship Terminology as a Theory Model: Concept Generation

The four equations for the Friend Enemy concepts define a product computation system for the two concepts Friend and Enemy since they define the result when doing each of the four possible products with Friend and Enemy. In this example, the computation maps a product of any two of the concepts, Friend and Enemy, back to Friend or Enemy. However, new concepts can also be generated through taking products of already defined concepts and this provides the key to understanding the richness of culture idea systems. We will illustrate the argument with kinship terminologies. The concepts making up a kinship terminology are generated through a culture theory for connections among the family concepts of father and mother, their reciprocal concepts of son and daughter, the marriage concepts of wife and husband, and the concept of sibling.

In a series of publications (especially Read 2007; Leaf and Read 2012), Read has presented a culture theory for the generation of kinship terminology structures whose instantiation leads to the semantic content and syntactic structure of among the kin terms in a kinship terminology. The culture theory was abduced (to use Charles Sanders Pierce's term for inferring a hypothesis from observations) from patterning revealed through data models for the kin term computations culture-bearers make when determining kin relations. Culture-bearers compute kin relations in the following manner:

> Kinship reckoning on Rossel does not rely on knowledge of kin-type strings [genealogical pathways] . . . What is essential in order

> to apply a kin term to an individual X, is to know how someone else, of a determinate kinship type to oneself, refers to X. From that knowledge alone, a correct appellation can be deduced. For example, suppose someone I call a tîdê "sister" calls X a tp:ee "my child," then I can call X a chênê "my nephew," without having the faintest idea of my genealogical connection to X. (Levinson 2006, p. 18)

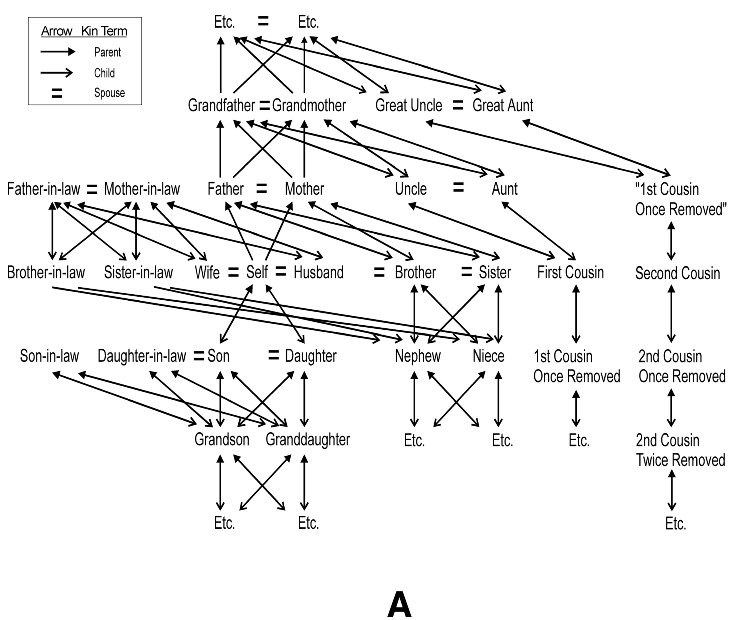
Kin term calculations like this have been reported widely in the ethnographic literature (see Read 2001 for other examples) and determine a terminology specific, binary product over a set of kin terms. We will call the binary product a *kin term product* (Read 1984) and define it as follows:

> *Definition:* Let *K* and *L* be kin terms in a kinship terminology, **T.** Let ego, $alter_1$ and $alter_2$ refer to three persons each of whose cultural repertoire includes the kinship terminology, **T.** The *kin term product* of *K* and *L,* denoted $K \circ L$, is a kin term, *M,* if any, that ego may (properly) use to refer to $alter_2$ when ego (properly) uses the kin term *L* to refer to $alter_1$ and $alter_1$ (properly) uses the kin term *K* to refer to $alter_2$.

The cultural knowledge that enculturated individuals have of their kinship terminology is expressed by them through kin term computations and can be elicited systematically with kin term products based on primary kin terms for the positions within a family (Leaf 2006; Leaf and Read 2012). We can graph the products and their outcome in a manner similar to graphing the structure for the Friend/Enemy rules. The resulting graph is a data model that we will refer to as a *kin term map.* Figure 2A shows a kin term map for the American/English terminology and Figure 2B shows a kin term map for the terminology used by the Shipibo, a horticultural group in eastern Peru. Structural differences between the two terminologies can be seen easily by comparing their respective kin term maps.

8. Culture Theory for the Generation of Kinship Terminology Structures

We now consider the abduced culture theory for the generation of a kinship terminology structure using kin term products of the primary kin terms for a kinship terminology (Read 2007; Leaf and Read 2012). Briefly, the theory asserts that a kinship terminology can be generated sequentially, starting with the primary terms for the structural positions that determine a family space of positions around a *self* position. Using the vocabulary of English terms, the family positions are determined by the ascending terms *father* and *mother* (or possibly *parent*), their reciprocal,



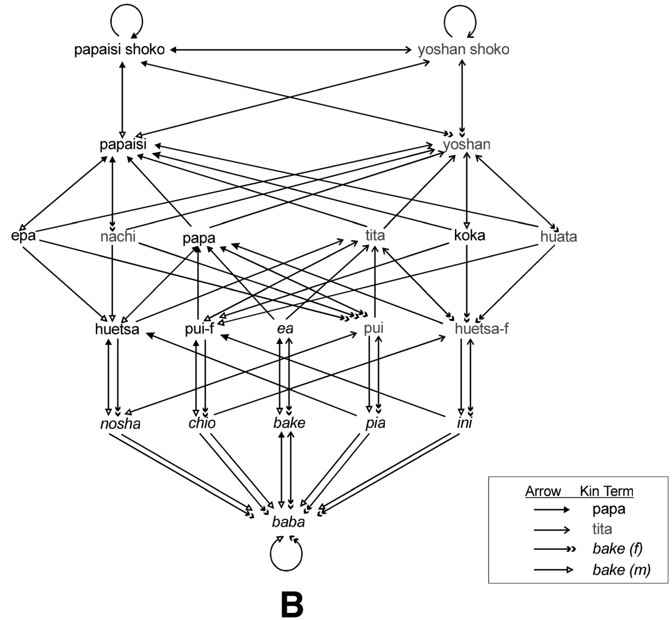


Figure 2. (A) Kin term map for the American/English kinship terminology. (B) Kin term map for the kinship terminology of the Shipibo Indians, a horicultural group in eastern Peru.

descending terms *son* and *daughter* (or possibly *child*), the affinal (marriage) terms *husband* and *wife* (or possibly *spouse*) and horizontal sibling terms expressed either (depending on the society) in the form (a) *child* of *parent* is *sibling* or (b) *parent* of *sibling* is *parent.* The former expresses a lineal relation going from *parent* to a sibling position distinguished horizontally from *self* and the latter a horizontal relation between *self* and *sibling* established through the persons occupying these positions sharing a common parent.

According to the theory, the generating sequence begins with an ascending structure, then adds a reciprocal descending structure, next sex marking of kin terms is introduced, then affinal (marriage) terms are added, followed by introducing local properties of the terminology structure and finally terminology properties, if any, whose rationale possibly derives from another culture idea. The steps in the sequence are as follows. Step 1: Begin with *self* and construct an ascending structure of kin terms using kin term products with a primary, ascending term for the family space (such as *parent* in the American/English terminology). Step 2: Construct an isomorphic, descending structure of kin terms using a primary, descending term for the family space (such as *child* in the American/English terminology). Include a structural equation that defines the descending term to be reciprocal to the ascending term. Step 3: Introduce sex marking of kin terms either by (a) introducing a pair of male/female sex marker elements or (b) by forming two structures, each isomorphic to the combined ascending and descending structure, with one structure consisting of male-marked (including neutral) terms and the other structure consisting of female marked (including neutral) terms. Step 4: Introduce a term for the affinal relation in the family space connecting the *mother* and *father* positions. This is done in some terminologies by adding an element and structural equations that define it to have the structural properties of an affinal term or, in other terminologies, through defining some of the terms generated in Step 3 to be affinal terms. Step 5: Introduce terminology specific rules that locally modify the structure determined from Steps 1–4 (such as a rule in the American/English terminology limiting which terms are sex marked). Step 6: Introduce other, relevant culture-specific kin term distinctions.

9. Theory Model for the American/English Kinship Terminology

We now construct a theory model for the American/English kinship terminology following the steps outlined above. To anticipate, the resulting theory model is structurally isomorphic to the kin term map (a data model) for the American/English kinship terminology and hence the theory is explanatory for the kin term distinctions expressed in the kin term map.

We begin by simplifying the kin term map down to a core structure through reversal of the sequence of steps outlined above. This makes it easier to abductively infer the content for the under-specified elements in the theory, such as whether the primary ascending term is sex marked or whether a sibling term is a primary term. Next we construct a theory model for the ascending terms, using kin term products of the primary term, and determine if it is structurally isomorphic to the data model for the ascending terms. Then we expand this initial theory model using the steps outlined above to determine whether it is possible to account for all of the structural properties of the kin term map through a theory model.

9.1. Simplification of the Kin Term Map

We begin simplifying the kin term map for the AKT by removing the affinal portion. We do this by removing all kin terms linked to *self* only through products with *wife* or *husband.* Next, we find that the structure of the AKT (but not necessarily that of other terminologies) is made clearer after we group together pairs of terms that have the same pattern of arrows to and from them. These two simplifications give us the reduced structure shown in Figure 3 where the two terms grouped together differ only by their sex marking, hence sex marking bifurcates non-sex marked terms into a pair of sex marked terms for this terminology. Lastly, we remove the descending part of the structure formed from products with {*son, daughter*} (= *child*) and arrive at the core structure shown in Figure 4(A).

9.2. Theory Model for the Core, Ascending Structure

The core structure does not include a sibling term, so we abductively infer that generating the AKT structure starts with *self* as an identity term and proceeds by taking products using a single, primary ascending term. Consequently, let A = {*self, parent*} be the set of generating terms for the ascending structure, where *parent* is a neutral, ascending kin term. We also infer by abduction that all kin term products using *parent* define new kin term concepts since in the terminology we have the unending sequence of terms: parent, grandparent, great grandparent.

A new concept is generated whenever a kin term product cannot be reduced to an existing term through a structural equation. Not all concepts generated in this manner are labeled and thereby given status as kin terms; e.g., there is no label in the AKT for *parent* of *parent-in-law,* though the concept, *parent* of *parent-in-law,* is meaningful. The structural meaning for a kin term concept follows from its definition as a kin term product. For example, *grandparent* is the name for the product, *parent* o *parent,* hence by definition of a kin term product, *grandparent* is the kin term ego would

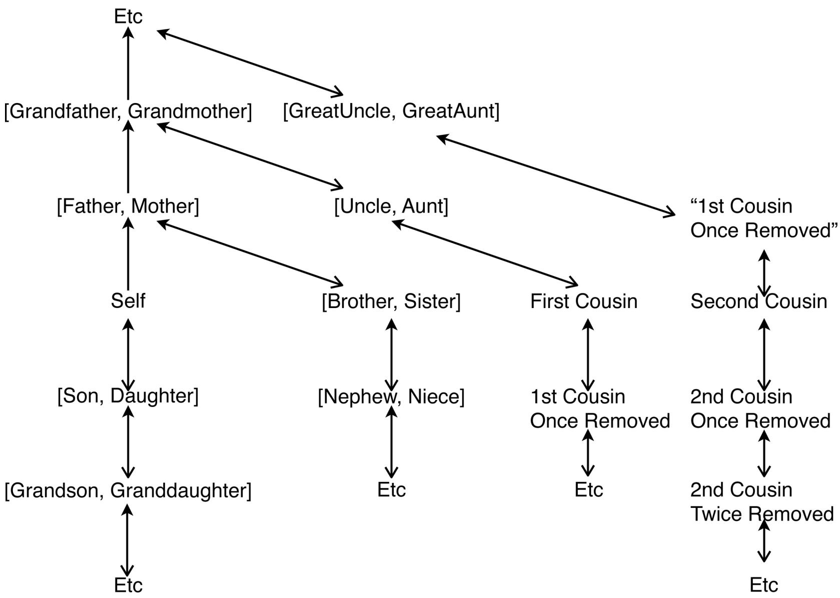


Figure 3. Simplified kin term map for the English kinship terminology. Affinal terms have been removed and pairs of terms that differ only by sex marking have been combined together in square brackets.

use for $alter_2$ when ego uses the kin term *parent* for $alter_1$ and $alter_1$ uses the kin term *parent* for $alter_2$.

Indefinitely taking products with the term *parent* generates the sequence of kin term concepts: *self, parent, parent* o *parent* (= *grandparent*), *parent* o (*parent* o *parent*) (= *great grandparent*), and so on (see Figure 4(B)). This theory model for the ascending structure is isomorphic to the data model for the ascending structure shown in Figure 4(A).

With *grandparent* as an example, note that *grandparent* is the label for the product *parent* o *parent* and *parent* is the term ego uses for genealogical *father* and/or genealogical *mother.* It follows that *grandparent* must be the term ego uses for ego's genealogical father's father, ego's genealogical father's mother, ego's genealogical mother's father or ego's genealogical mother's mother; that is, the categorization the *grandparent* term makes of genealogical relations is the *consequence* of the *grandparent* concept generated through kin term products and not the reverse, as has generally been

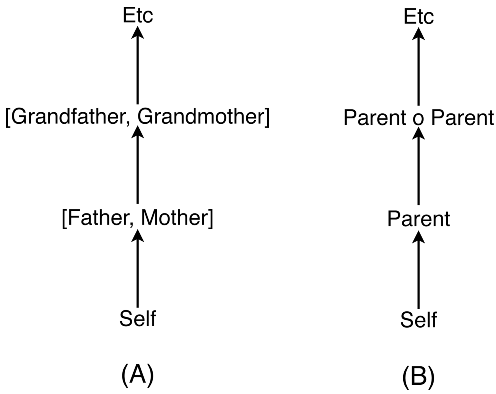


Figure 4. (A) Core, ascending structure for the American/English kinship terminology. (B) Structure generated from the generating set A = {self, parent}.

assumed. The categorization of genealogical relations is *constructed* through the kinship terminology (Read 2001, 2007).

9.3. Theory Model Expanded to Include the Descending Structure

Next we generate a structure of descending kin terms isomorphic to the ascending structure by using the generating set D = {*self, child*}. Altogether, our set of generating terms will now be G = {*self, parent*} ∪ {*self, child*} = {*self, parent, child*}, where ∪ stands for set union. Reciprocity between the kin terms *parent* and *child* is introduced in the theory model through the structural equation:

(1) *parent* o *child* = *self.*

The equation states that when ego refers to $alter_1$ as *child,* and $alter_1$ refers to $alter_2$ as *parent,* then ego refers to $alter_2$ as *self,* which is precisely what we mean by *parent* and *child* being reciprocal terms in the domain of consanguineal relations (affinal relations are not yet part of the theory model) due both to the fact that $alter_2$ must be ego if ego and $alter_2$ are related consanguineally and to the fact that ego refers to him(her)self as *self.* This expanded theory model is shown in Figure 5 and is structurally isomorphic to the kin term map in Figure 3. Note that the theory model implies *child* o *parent* = *sibling* = [*brother, sister*], hence we have the implication that, for English speakers, both *brother* and *sister* are concepts constructed from *parent* and *child.*

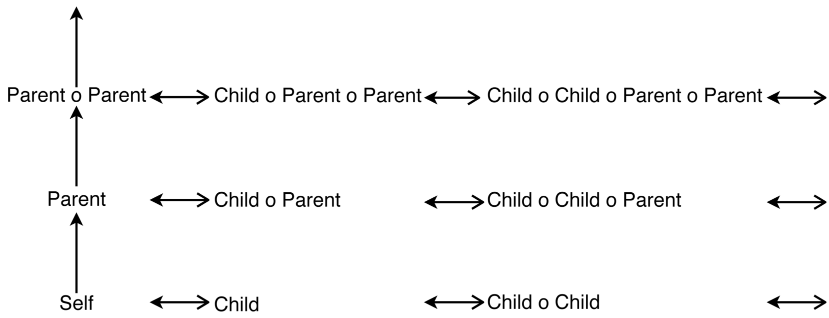


Figure 5. Structure generated by the set of generating terms G = {self, parent, child} and the equation parent o child = self that makes parent and child into reciprocal terms.

9.4. Theory Model Expanded to Include Sex Marking of Kin Terms

We introduce sex marking of terms through adding two sex marking elements, *M* and *F,* that are right identities (i.e., XM = XF = X for any element X), so any product involving the sex marking elements reduces to a term with its leftmost element a sex-marking element (see Read 2007 for details).

9.5. Theory Model Expanded to Include Affinal Kin Terms

Affinal relations are introduced through adding a *spouse* element to the generating set and the following structural equations that express the conceptual relations between the spouse element and other generating elements:

(2) *spouse* o *spouse* = *self* (equation structurally defining a spouse term under a monogamous marriage rule),

(3) *spouse* o *parent* = *parent* and reciprocally, *child* o *spouse* = *child* (universal equations relating the *spouse, parent* and *child* concepts),

(4) *spouse* o (*child* o *parent*) = (*child* o *parent*) o *spouse* (i.e., *spouse* of *sibling* = *sibling* of *spouse;* this and the following two equations restrict the size of the affinal structure),

(5) *parent* o (*parent* o *spouse*) = 0 and reciprocally, *spouse* o (*child* o *child*) = 0 (i.e., *parent* of *parent-in-law* and *spouse* of *grandchild* are not kin terms),

and

(6) *parent* o (*spouse* o *child*) = 0 (i.e., *parent* of *child-in-law* is not a kin term).

9.6. Theory Model Expanded to Include Local Restriction of Sex Marking of Kin Terms

Sex marking of kin terms for the AKT is restricted by the rule that a kin term K remains sex marked only if *spouse* o K or *spouse* o *(reciprocal term for K)* is a kin term. This restriction implies that the self-reciprocal term *cousin* is not sex marked since *spouse* o *cousin* = *spouse* o (*child* o *child* o *parent* o *parent*) = *spouse* o (*child* o *child*) o *parent* o *parent* = 0 o *parent* o *parent* = 0 from Equation (5). This derivation also agrees with the fact that there is no commonly recognized English kin term for spouse of cousin.

10. Logical Implications of the Theory Model: Accounting for "Anomalies" in the Terminology

The theory model generated from the kinship theory is shown in Figure 6 and is structurally isomorphic to the data model shown in Figure 2A. Thus the culture theory for kinship terminology structures is explanatory for the structural features found in the data model for the kinship terminology used by English speakers. We also find explanation for an apparent anomaly in the American/English kinship terminology. The suffix, *-in-law,* appears to be a linguistic device for marking relatives by marriage, except for the *aunt* and *uncle* terms for which *spouse* of *aunt* (*uncle*) = *uncle* (*aunt*). The theory model implies that there is no anomaly because logically *spouse* o *aunt* (*uncle*) = *uncle* (*aunt*) (see Figure 6, [*uncle, aunt*] node) in the theory model. What *-in-law* marks, instead, are the terms making up a third dimension introduced by the *spouse* term. The *spouse* product does not map *aunt* and *uncle* into this third dimension due to Equation (4) (Read 1984, vol. 25) and so the *-in-law* suffix does not apply.

11. Conclusion

This excursion into the formal representation of cultural idea systems explores the way that the latter determine a social universe in which behavior takes place. One goal is to formally represent a culture theory in a manner faithful to the concepts involved, rather than using imposed concepts. A theory model in this context expresses properties of the social universe engendered by a cultural theory.

Modeling of cultural idea systems has prerequisites. With kinship terminologies, for example, theory modeling begins with concepts elicited from culture-bearers through ethnographic research and not with imposed, analytical concepts. Use of the latter has led to analytical cul-de-sacs (Leaf and Read 2012) and what has passed for analysis has sometimes been little more than description (Read 2000)—which is not to belittle the value of good description. We obtain good description when we begin with ethnographic observations showing that culture-bearers compute

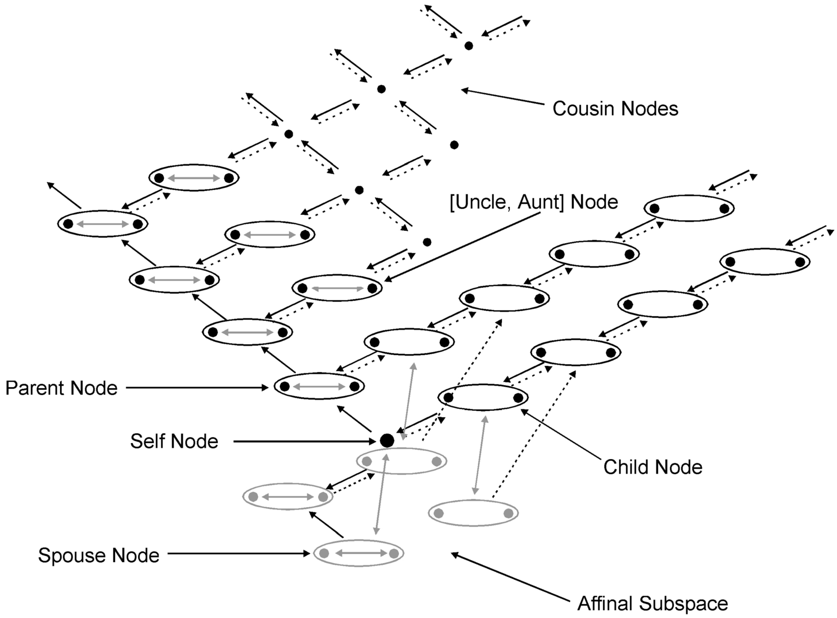


Figure 6. Theory model for the English kinship terminology. The solid, single-headed arrows show the result of taking a product with the generating term, *parent.* The dashed, single headed arrows show the result of taking a product with the reciprocal generating term, *child.* The gray, double-headed arrows show the result of taking a product with the affinal generating term, *spouse.* The oval around a pair of nodes indicates that the pair of nodes differ by sex marking. The gray nodes are the affinal nodes generated by the *spouse* generating term. The gray double-headed arrows indicate products with the *spouse* generating term. The structure is isomorphic to the kin term map shown in Figure 2B.

kinship relations through products of kin terms, as this provides an effective way to experimentally make evident and to represent patterning arising from implementation of the cultural knowledge embedded in a kinship terminology (Leaf 2006). Similarly, we need to distinguish between, on the one hand, modeling aimed at accounting for patterning in the culture idea systems of culture-bearers and, on the other hand, modeling that focuses on patterning expressed in the behavioral context of the instantiation of those culture idea systems. The two approaches can be complementary, but failure to recognize the difference has led to the mistaken assumption that, for example, Darwinian evolutionary models framed at the level of behavior are somehow explanatory for structural changes in cultural idea systems. When modeling focuses on both a theory model and a data model (Read 2007), we have modeling that incorporates ethnographic observations at both the ideational level of culture and the phenomenological level of behavior. When there is isomorphism between these two kinds of models, we have explanation and we should not be surprised that predictions from a theory model are borne out by ethnographic observations. The outcome of the formal representation is modeling that enriches our ethnographic accounts of social systems.

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