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From Behavior to Culture: An Assessment of Cultural Evolution and a New Synthesis

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Kinship Systems: A Culturally Constructed Reality

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Three approaches to cultural evolution—sociobiology, dual inheritance, and memes—are reviewed and it is shown that each makes use of an incomplete notion of what constitutes culture.

INTRODUCTION

Culture provides for the members of a society a conceptual universe that both frames and constructs patterns of behavior. As one anthropologist has recently phrased it, "Culture and society . . . are mutually constitutive. Culture provides the shared knowledge system that enables members of a society to recognize fellow members and to coordinate their actions with one another, while society provides the communities, and thus the patterned interactions and experiences, out of which individuals construct their representations of culture" ([1]; see also Romney et al. [2] and Berger and Luckmann [3]). This constitutive property of culture underscores the reason that theorizing in anthropology has focused on culture as central for understanding the nature of human societies. Despite the centrality of culture as an organizing concept, though, satisfactory theory about the relationship between behavior and culture has remained elusive. Consequently current theories of cultural evolution are incomplete because "no theory of sociocultural evolution can claim completeness if it is not able to define the generating logic of society and sociocultural evolution" [4, p. 32].

Theoretical positions differ on even a basic issue such as whether we understand culture as arising from human behavior taken to be actions made in response to the evaluation of conditions and consequences external to the individual or whether behavior already presupposes culture so that behavior can be seen as arising from enactment of actions appropriate to the cultural identity the individual takes on [5]. The first position implies that theories of cultural evolution should focus on behavior, with cultural evolution viewed as more or less synonymous with change in the variety and frequency of behaviors in a given society. The analogy with biological evolution with its focus on change in the variety and frequency of alleles in a species immediately comes to mind. The other position implies that cultural evolution needs to be understood in terms of the structuring processes for cultural phenomena where those structuring processes cannot be reduced to patterns of behavior alone. Culture, in this view, is in some fundamental way extrinsic to the individual even though the locus of culture is in the minds of individuals. Culture, it is argued, is composed of conceptual systems that share with language the property of being grounded in commonly understood and shared symbolic systems that

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provides the basis for inter-individual comprehensibility of the social meaning of individual actions. Whereas the first position lends itself to modeling cultural evolution in analogy with Darwinian evolution, the second position leads to modeling culture and cultural evolution in analogy with linguistic theories of syntax and semantics and changes in syntax and semantics. In this article I discuss a way to resolve this dichotomy about the relationship between culture and behavior by formulating a more comprehensive view of their relationship and examining the implications this has for modeling the evolution of culture.

The article is divided into two parts. In the first part I critique three current approaches to modeling cultural evolution derived from Darwinian evolution: sociobiology, dual inheritance, and memes. I argue that these each of these approaches uses an incomplete view of what constitutes culture as all three ignore the way in which anthropologists have argued that a "*human group creates its own reality, a shared culture*" and so "we live in created worlds of culture" [6, p. 6, emphasis in the original]. This perspective implies that culture is not part of the phenomenological domain to which Darwinian evolution refers. Instead, culture is "a picture of the ideational world of a people" [7] and "we are thus speaking not of 'material culture' or 'human behavior' but about the *ideas* behind such events and manifestations" [8, p. 24, emphasis in the original], for "human beings are *not* simply instruments for the replication of culture; rather they *use* their culture. . .as a vehicle for living, for the mutual creation of themselves" [9, p. 319, emphasis in the original]. I end the first part of this article by introducing a culturally constructed reality—kinship systems—fundamental to the interaction of individuals in human societies and even to the formation of human societies.

. . . cultural evolution has to be considered in terms of at least three dimensions, each with a different time scale: evolution of a system of symbols, evolution in the instantiation of a system of symbols, and evolution of behavior framed by a system of symbols and its instantiation. The complexity of human societies lies in the interrelationship of these three dimensions.

In the second part of the article I consider the symbolic basis of human kinship as it is culturally constituted in the form of a kinship terminology and outline current work on formally modeling the underlying logic of the kinship distinctions embedded in a kinship terminology. The modeling makes evident three components that need to be taken into account in a theory of cultural evolution: (1) culture as an abstract, the conceptual system, (2) cultural rules for linking that conceptual system to individuals and their behavior through instantiation of the underlying abstract conceptual system, and (3) behavior viewed both as action taken in accord with one's cultural domain and its instantiation and as action arising from propensities that owe their origin to the biological evolution of our species, *Homo sapiens*. Corresponding to these three components are three distinct modes of evolution, each with a different time scale. The complexity of human societies is due, I argue, not just to the number and variety of the constituent elements of human societies, but to this multilayered interrelationship of dimensions ranging from the abstract to the concrete. Any satisfactory theory of cultural and social evolution must explicitly address and take into account this multilayeredness of human societies. B2

PART I

Sociobiology

What constitutes cultural evolution depends on claims made about what constitutes culture. Although anthropologists have long considered culture to be an information system distinct from the genomic information system [10], sociobiological arguments view culture differently and have framed arguments about cultural evolution using two assumptions: (1) culture is indexed by human behavior and (2) cultural evolution can be subsumed under the basic paradigm for biological evolution with only minor modification. With regard to the first assumption, culture is sometimes seen as another way that the environment affects the expression of behavior. For example, Flinn and Alexander argued that "No rationale has ever been advanced for regarding the influence of culture on the development and expression of behavior as other than a *special subset of the environment*" ([11, p. 391, emphasis added]. Others related culture directly to behavior. As noted by Durham ". . .culture has been viewed as [a] set of specific behaviors or 'traits' of a population" [12, p. 18] by sociobiologists. Yet others considered culture to simply be the outward manifestation of "whisperings within" [13] or the "self-interpretation" of biological propensities [14, p. 29]. But whether it is aspects of the environment influencing behavior, specific behaviors, or a more conscious expression of propensities, culture in this framework is considered to be an aspect of the genotypically constructed phenotype observed through a trait called behavior.

The linkage of cultural evolution to the paradigm for biological evolution immediately follows once behavior is included as part of the phenotype that develops from the genotype of an organism. As an aspect of the phenotype, cultural viewed as traits/behaviors/outward manifestations would be as subject to modification through genetic fitness as is the case for any other aspect of the phenotype that

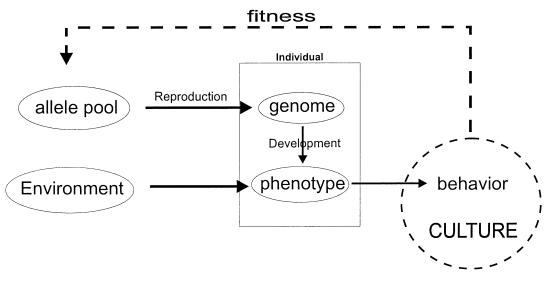
develops from the genotype. Although the extent and degree to which human behaviors are directed by the genome are debatable, common to these arguments is the presumption that models of behavioral evolution (hence by extension models of cultural evolution) differ from models of morphological evolution mainly in the details and not in the underlying paradigm used to account for changes in allelic frequencies through differential fitness values of unlike phenotypes across generations. Whether the genome directs behaviors or merely provides propensities for behaviors as argued by Wilson [15], the underlying assumption is that behaviors arising through culture are of the same order as behaviors arising through other aspects of the phenotype more obviously linked to the genotype, hence equally amenable to explanatory arguments derived directly from the paradigm for biological evolution.

Two of the key elements in the biological evolution paradigm are an allele pool from which the genotype of a zygote is constructed via reproduction and a development process that links the genotypic information contained within the zygote to the adult phenotype expressed as the outward manifestation of the genomic information contained within the individual organism. The latter introduces the environment as a third, key element because the developmental process is affected by the developing organism's interaction with its environment. Feedback from the phenotype to the allele pool arises through fitness measured as relative reproductive success because it is through reproduction that a phenotype is able to contribute its genomic content to the allele pool from which zygotes are formed. These elements and their linkages are shown in Figure 1 with culture, via behavior, considered to be a subset of all behaviors. Figure 1 is not a complete model of the process of biological evolution as a number of effects that come into play are not shown,

F1

FIGURE 1

GENETIC MODEL OF CULTURAL EVOLUTION



Schematic diagram relating culture understood as behavior to a fitness model for genetic change.

such as feedback that may occur between the phenotype and the environment, epistatic effects among traits that make it difficult to treat any single trait in isolation from other traits [16], and so on. Nor does Figure 1 take into account heritability measures based on the relative importance of environmental effects versus genetic endowment on the phenotypic expression. Rather, Figure 1 schematically merely identifies the core elements of a biological fitness model for evolution driven by change in allele frequencies (including mutations) in a breeding population.

As indicated in Figure 1, subsuming culture under behavior—with behavior considered to be an aspect of the phenotype that arises through genomic-environmental interaction—provides a basis for modeling culture as another instance of biological evolution. Reproductive fitness is central to this view of cultural evolution (inclusive fitness will be discussed below), and some authors have made the strong claim that not only is fitness central to understanding the frequency distribution of behavioral traits among humans, but humans are so constituted as to act in a manner that increases reproductive fitness. For example, Turke has argued that "Developments in evolutionary theory have made it reasonable to assert that humans. . .have been designed by natural selection to strive to maximize their genetic representation in future generations" ([17, p. 62]; see also Hughes [18, p. 6]).

These claims represent predictions arising from viewing cultural evolution as a subset of behavioral evolution driven by reproductive success. If we compare these predictions against data on behavior relating to fertility patterns, it is evident that the framework shown in Figure 1 is inadequate as a way to account for cultural evolution. Whatever is driving human reproductive behavior, it is not always fitness maximization as predicted. As noted by Johansson with regard to reproduction among European nobility, "on the average, the wealthiest Western European families in the 1600s had six children, reared four to adulthood, but only married off two per family (again on average). . .. By circa 1700 Western Europe's elites had begun to reduce the very high death rates from which their infants and children traditionally suffered; but as death rates for the young fell, so did birth rates. Demographic contraction [among the elites] continued throughout the 1800s despite improved survivorship" [19, p. 632]. The fitness maximization argument implies that birth rates should not decrease with a dropping death rate because the elites had the financial wherewithal for bearing the costs of larger families. The reason, however, for the demographic contraction among the elites was "a natural consequence of *socially constructed status anxiety*. Landed families in Western Europe were strongly averse to downward mobility" [19, p. 632, emphasis added]. Similarly, data on the demographic transition in modern Western countries are also inconsistent with fitness

maximization ([20] and references therein), especially in countries where reproduction rates have fallen below replacement rates.

The problem runs deeper, though, than just discordance between prediction and observation. At fault in the biological fitness maximization argument with respect to culture is a confounding of culture as both a consequence of the developing phenotype's interaction with its environment and culture as part of that environment. That is, because the phenotype arises through interaction between genomic information and the environment, the culture = behavior = phenotype assumption implies that culture must arise through interaction with the environment and thus is not a part of the environment. On the other hand, if culture is extrinsic to the phenotype as are other aspects of the physical environment and affects behavior as an aspect of the environment as argued by Flinn and Alexander, then culture is not part of whatever is evolutionarily driven by differential fitness values just as the biological evolution paradigm does not account for geological or climatic variation, both of which have an impact on the developing phenotype. Consequently, the argument that culture is seen through behavior must divide culture into two parts: environmentally and phenotypically expressed behavior.[1] The environmental component would play the same role with respect to the developing phenotype as does the noncultural aspect of the environment, whereas the behavioral component would presumably emanate from the developing phenotype. The problem with the dichotomy is that the evolutionary argument cannot account for both components simultaneously.

But even if this dichotomy is made and the sociobiological/maximization argument is only applied to cultural behavior, the argument is still faulty as it entails both unrealistic rates of cultural change and an inadequate conceptualization of culture. First, subsuming culture change under the biological model of evolution introduces the generation as the time unit for the measurement of change because evolution is measured in terms of change in allele frequencies per generation. With humans having generation times on the order of 20 years, time scales for cultural change should at least be on the order of 1,000s to 10,000s of years for substantial changes to take place via differential reproductive success. But even macro forms of cultural change take place over far shorter time periods, as shown by archaeological data that records the development of complex forms of social organization over a time scale of 100s of years, with more microcultural changes within a society taking place on a time scale of 10s of years. The latter is exemplified by the short time scale involved in the current shift in American and European culture towards the redefinition of marriage as not requiring two persons of the opposite sex. And second, even if the problem with time scales is set aside, still problematic is an unrealistic notion of culture as being equated with forms of behavior, a problem, as will be seen, that re-arises with other formulations for the process of culture change that use some aspect of the biological model of evolution.

Another problem with equating culture with behavior stems from the implication that different aspects of culture are to be distinguished in terms of the characteristics of behaviors and not through the means by which these behaviors are transmitted. Yet the domain of culture and its mode of transmission are necessarily linked insofar as the content of culture is said to be composed of knowledge or information extrinsic to the genome. If the content of culture is extrinsic to the genome there must be transmittal of content from one individual to another in a manner other than through genetic transmission. Definitions of culture in anthropology from early on recognized this linkage and considered culture to be distinguished not only by its content but also by the way transmittal of the constituent elements of culture takes place. The widely quoted definition given by Tylor of culture as "that complex whole which includes knowledge, belief, art, morals, law, custom" goes on to identify these as instances of "capabilities and habits *acquired by man as a member of society*" [21 (1871), p. 1, emphasis added]. Implicit in Tylor's definition is the role of learning in the transmission of ideas and the like from one individual to another in a social context outside of the genome.[2]

Although the biological evolution paradigm does not deny that one individual/phenotype may have an effect on another phenotype, the fundamental assumption is that traits undergoing evolution through relative fitness defined as differential reproductive success do so via biological inheritance to the exclusion of Lamarckian, or Lamarckian like, modes of trait transmission [22 (1976), p. 289]. For this reason, learning models, expressed in terms of nonbiological inheritance modes for transmission of information, would appear at first glance irrelevant to evolution of traits through fitness measured as differential reproductive success. Biological inheritance of traits, however, is not crucial to a fitness argument for change in the frequency distribution of traits in a population and the latter may arise without biological inheritance.

Relating change in phenotypic frequency to differential fitness values across phenotypic traits only requires a consistent correlation between the relative fitness value of a phenotype possessing the trait in question and the number of surviving and reproducing persons in subsequent generations to whom the trait is transmitted from that phenotype, not a particular mode for the transmission of a trait. More precisely, if the likelihood of cross-generation transmission of a trait from one phenotype to another is positively and monotonically correlated with the relative fitness value as-

sociated with a trait, T, then T will change in frequency in the population according to its relative fitness value in comparison to another trait, T', whether or not T is transmitted via biological heredity. Biological heredity simply provides a convenient, but not a necessary, way to measure the effect of differential fitness values on the frequency of traits by equating the per individual cardinality of the set of surviving and reproducing persons who receive the trait through genetic inheritance with the measure of the relative fitness value of a trait.

In general, it suffices to identify a process under which (1) a trait may be transmitted from one phenotype to another, (2) a trait can spread from one phenotype to another across generations,[3] and (3) rates of transmittal differ by trait characteristics. Examples of such processes include transmission due to "imprinting, conditioning, observation, imitation, or as a result of direct teaching" [23, p. 73]. Some authors are more restrictive in terms of the mode of nongenetic transmission considered to be of importance, as in Boyd and Richerson's statement that "culture is acquired by *directly copying* the phenotype" [24, p. 9, emphasis added]. But whether the process is limited to imitation or whether it includes all ways in which information is transmitted from one individual to another, the central concern of these authors, in contrast with the sociobiological framework, is on the consequences for the frequency distribution when there is nongenetic transmittal of phenotypic traits.

Dual Inheritance

The combination of phenotypic transmission through both the genome and through nongenetic transfer has been termed dual inheritance by Boyd and Richerson [24]. In their formulation of dual inheritance, the biological evolution of the process underlying nongenetic transmission of information from one individual/phenotype to another plays a central role in modeling nongenetic transmittal of traits. In contrast, the learning model utilized by Cavalli-Sforza and Feldman [23] is concerned only peripherally with the evolution of the learning process and focuses instead on the consequences of a phenotype to phenotype learning process represented by a modified genetic model. For example, they model vertical transmission from parent to offspring with the standard genetic model for a diploid organism (see Table 1, column 3), except that the transmission probabilities b_i, $0 \leq i \leq 3$, for passing on the trait T, given the mating type, are parameters whose value depends on the particular mode of learning that takes place between parent and offspring. This also differs from the genetic model for transmission of a phenotypic trait via transmission of the underlying alleles in that the transmission probabilities for the trait T in the genetic model are a consequence of a reproductive process, current allele frequencies, the genetic model (co-dominant, dominant-recessive, etc.) and do not depend on the characteristics of the trait (see column 3, Table 1).

The difference in the specification of the parameters is not a minor one. Whereas the genetic model is a theoretical model, their cultural model is a descriptive model (see Read [25] for a discussion of theoretical versus descriptive models). The genetic model has an underlying theory grounded in the biological process of meiosis that justifies the assumption of fixed transition probabilities that depend only on the allele frequencies in the breeding population. In contrast, although the parameters b_i of the learning model may be justified in a specific application through observation and modeling of empirical data, the absence of a theoretical basis for the transmission probabilities leaves one with a descriptive model for nongenetic transmittal of behavior, not a theoretical model that expresses the underlying process(es) by which learning takes place. The modeling of change in the frequency of traits through time using the model (genetic or cultural) in Table 1 assumes the parameters are constant through time, yet this assumption is likely to be violated in the cultural model for many traits of interest. One way these parameter values may change is through evolution of the parameter values representing the learning process.

Evolution of parameter values is a missing piece in the model proposed by Cavalli-Sforza and Feldman for process(es) underlying transmission of information across phenotypes in a manner subject to Darwinian evolution.[4] A particular mode of transmission, such as copying or learning from another phenotype, is a behavior. If it is a behavior subject to biological evolution, then it is the kind of behavior that the sociobiological models purport to address. Hence, a behavioral process underlying a nongenetic mode of transmission must ultimately have arisen through a genetically based evolutionary process, and some of its features should be predictable by simply taking into account the effect a biologically based learning process has on biological fitness. A distinction needs to be made, though, between the way biological fitness affects the properties of a learning process and the way the learning process, in turn, affects the frequency distribution of learned behaviors in a population of individuals.

Unlike the sociobiological argument, the dual inheritance model makes evident the analytical distinction between behaviors that may have a biological basis, such as a propensity to copy or imitate others under specified conditions and behaviors that are transmitted *through* that process, namely, the behaviors that are copied. Assuming imitative behavior has a biological basis, aspects of imitation such as, Who does one imitate? or Under what circumstances does one utilize imitation of another rather than direct learning? and so on, can be modeled using biological fitness. But once the "imitation mechanism" is in place, biological fitness need no longer be the arbiter of behaviors

TABLE 1

Genetic Model and Cultural Learning Model

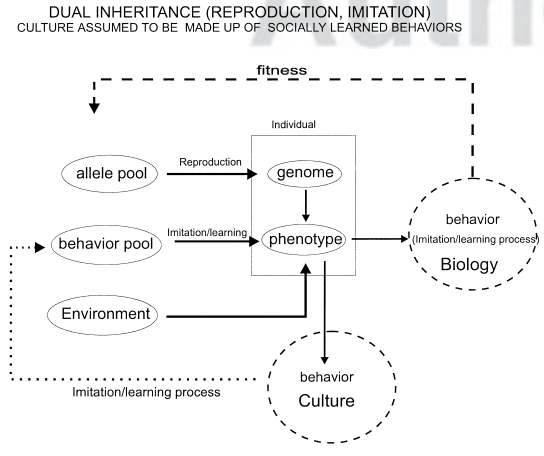
Mating Type			
Parent 1, Phenotypic Trait	Parent 2, Phenotypic Trait	Genetic Model: Probability of Offspring Having Trait T for a Dominate/Recessive Trait in Hardy-Weinberg Equilibrium	Cultural Learning Model: Probability of Offspring Having Trait T
T	T	$p^4 + 4p^3q + 3p^2q^2 = p^2(1 + 2pq)$	b_3
T	t	$p^2q^2 + pq^3 = pq^2$	b_2
t	T	$p^2q^2 + pq^3 = pq^2$	b_1
t	t	0	b_0

Modified from Cavalli-Sforza and Feldman [23], Table 2.2.1, p. 78.

that will be imitated. In effect, the evolutionary development of imitation as a behavior with a biological basis simultaneously introduces a means for transmittal of behavior from one phenotype to another outside of the framework of phenotypic change driven by change in allele frequency in a breeding population due to differential reproductive success.

F2 As shown in Figure 2, the dual inheritance model divides behaviors into two kinds: (1) biologically based behaviors that include the process by which nongenetic transmittal of behaviors from one phenotype to another takes place and (2) the (cultural) behaviors transmittable by that process. The former fits easily within the sociobiological paradigm illustrated in Figure 1 and does not require introduction of any new features into that model. One process of this kind that has been mathematically modeled is imitation of reproductively successful individuals. As demonstrated by Boyd and Richerson [24], individuals using this form of imitation can have greater reproductive success on the grounds that it is less costly to the individual to adopt behaviors that are correlated with reproductive success than to discover or learn those behaviors without input from other phenotypes.

FIGURE 2



Schematic diagram relating culture as imitated or learned behavior to a nongenetic inheritance process.

In analogy with an allele pool, the dual inheritance model posits a pool of behaviors currently exhibited by phenotypes and subject to an imitation/learning process for transmittal from one phenotype to another. Imitation/learning plays a role with regard to the behavior pool analogous to reproduction for the allele pool in the genetic model. By decoupling the transmittal of cultural behaviors to the phenotype from the allele pool as an intermediary it follows that biological fitness may play a reduced role in the change in the frequency of behaviors making up the behavior pool. Consequently there is no reason to presume that the direction of frequency change in the behavior pool is directed by biological fitness and in fact, as Boyd and Richerson [24] have shown, cultural behaviors that decrease biological fitness can increase in frequency if imitation/learning is "guided" by "successful" individuals; that is, if there is a propensity to imitate behaviors of individuals who are reproductively successful because a maladaptive behavior on the part of an otherwise reproductively successful individual can increase in frequency under imitation (see also Takahasi [26] and references therein).

The dual inheritance model is an important advance on the sociobiological model's unwarranted claim that "cultural behavior" can be subsumed within the biological evolution model. Rather than trying to force a "cultural behavior" square peg such as below replacement fertility levels into the round hole of maximizing reproductive fitness, the dual inheritance model allows more realistically for nonbiological transmission of behaviors, yet for transmission to be guided by a process that arose through natural selection.

Though more realistic, the dual inheritance model still relies on behavior and the transmittal of behavior as the

basis of culture. As criticized by Durham [12], in this framework culture is determined by what one does, not by what one conceptualizes. The centrality of behavior in the dual inheritance construal of culture is evident in the comment made by Cavalli-Sforza and Feldman: "We accept as the cultural unit, or trait, *the result of any cultural action* (by transmission from other individuals) *that can be clearly observed or measured. . .*" [23, p. 73, emphasis in the original]. Hence, in their perspective culture is at the phenomenological level of the observable and excludes the ideational level of concepts except to the extent that those concepts leave a trace at the level of what is observable. Yet consider a present-day controversy such as abortion in American society. We can identify two traits: *T* (for abortion) and *t* (against abortion) and we might model the way in which the frequencies of *T* and *t* change according to the vertical, horizontal, or oblique learning model [23] or imitation model [24] that is being invoked.[5] But even if this modeling yields a reasonable descriptive account of frequency changes through time in the two traits, it provides us with little or no information regarding either the legal or extra legal behaviors or actions that proponents of one position or the other have taken as a way to affect the frequency of *T* or *t*, let alone information on the conceptual/cultural basis underlying the two traits. Nor would it allow us to recognize that the two traits, *T* and *t*, may involve the same conceptual framework as another, seemingly different, behavior such as female infanticide among traditional Inuit groups living under Arctic conditions. It would be difficult for female infanticide to arise as a "mutation" and then spread in frequency in the context of American culture because an "infanticide trait" is defined as child murder in the American legal system. Yet female infanticide did arise and spread in frequency among the Inuit (see Balikci [27] for a discussion of female infanticide among traditional Netsilik Eskimo).

Simple comparison of the two behaviors, abortion and female infanticide, misses the culturally constructed conceptual basis underlying the behaviors in question and its effect on change in behaviors. The conceptual basis involves, first of all, a culturally specific notion for when a developing fetus takes on the status of being human, in the sense of being considered as belonging to the domain of social persons with a shared sense of morality. This change in status from being a fetus to being a human links the traits *T* and *t* in American culture and the trait of female infanticide in Inuit culture to a larger context of how humanness is conceptualized in any culture and what it means to take the life of another human. Common to the anti-abortion and pro-abortion positions in American society and to the Inuit practice of female infanticide is a conceptual framework that considers taking the life of a member of the species *Homo sapiens* to be murder when the entity in question has the status of being human. Contrariwise, extinction of the biological life of an organism not yet recognized as having (or in some important sense having lost) the status of being human is not murder, even if the organism is a member of the species *Homo sapiens*. For the anti-abortionist, humanness enters into the developing biological organism at conception; for the pro-abortionist, humanness enters in at or just prior to birth; for the Inuit, humanness enters when the newborn is given a name [27, 28]; hence, female infanticide could take place among the Inuit without it being considered child murder so long as it occurred before naming the newborn female.

Second, change in the frequency of *T* or *t* in American society due, say, to horizontal or oblique transmiss[illegible] may depend on a shift in one's belief system about humanness hence involves a complex process of relating a specific behavior to a conceptual framework and to the conditions under which an individual, or collection of individuals, is willing or able to reframe or restructure the underlying conceptual framework that gives the behavior both an individual and a shared meaning. In contrast, the dual inheritance framework assumes that the trait can be considered more-or-less in isolation and relates the change in frequency of the trait to the properties of the imitation/learning process, not to the properties of the conceptual framework in which the trait is embedded. According to Boyd and Richerson [29], behavior is the link that permits transmittal of a trait from one person to another: "Unlike genes, ideas are not transmitted intact from one brain to another. Instead the information in one brain generates some behavior, somebody else observes this behavior, and then (somehow) creates the information necessary to generate very similar behavior." [29, p. 155]. Yet if it is just the imitation/learning process that drives changes in the frequency of behavior traits, then we should see all behaviors that are part of the repertoire of the person being copied passed on to the copier. If not, then the copier, w[illegible]ust be selectively choosing which behavior to copy, hence is neither simply responding to the characteristics of the person being copied nor to the properties of the traits being copied but, as argued by Durham, to the "socially conveyed information behind them" [12, p. 167]; that is, to culture as part of the ideational context of individuals as discussed by Keesing [30] among many others.[6] AQ: 3

Meme Theory

Shifting to the ideational domain as the locus for the transmission of a trait from one individual to another has been central to the notion of memes introduced by Dawkins [22 (1976)], where a meme is supposed to be the cultural equivalent of the gene viewed as a biological unit. The unit of culture supposedly identified by memes was not made explicit by Dawkins and subsequent writers have offered various definitions, such as Blackmore's eclectic and unconstrained view of memes as "information in any of its many

forms; including ideas, the brain structures that instantiate those ideas, the behaviours these brain structures produce, and their versions in books, recipes, maps and written music" [31] or Durham's more constrained notion of a meme as "units of socially transmitted information, regardless of their form, size, and internal organization" ([12], p. 189; see also Aoki [32]). Lynch has proposed a formal definition of a meme as "A memory item, or portion of an organism's neurally-stored information, identified using the abstraction system of the observer, whose instantiation depended critically on causation by prior instantiation of the same memory item in one or more other organisms' nervous systems. ("Sameness" of memory items is determined with respect to the above-mentioned abstraction system of the observer.)" [33, ¶ 10]. For others the notion of a meme involves an active aspect on the part of the meme aimed at its propagation [34, p. 224]. For example, in a Web-based publication titled *Memetic Lexicon,* a meme is defined as "A contagious information pattern that replicates by parasitically infecting human minds and altering their behavior, *causing them to propagate the pattern.*" [35]. Some anthropologists, however, have been less sanguine about the utility of trying to identify a cultural unit, in some cases viewing the enterprise as pointless because "culture traits are distributionally unstable, i.e., for any such 'unit of culture,' variability is the norm rather than the exception," ([35, p. 235]; see also Klüver [4, p. 26–27]) or that the units must be something like the terms of a Natural Semantic Metalanguage [37] and so are at an analytical level where "knowing the basic units does not answer questions about how to classify the many things that ethnographers see and write about" [10, p. 249]. Clearly, the concept of a meme is not yet well defined and more often than not it "is suggested terminologically, rather than by careful definition and empirical demonstration [38, p. 310, quoted in Klüver [4]).

Although definitions of what a meme is supposed to represent are highly variable and even inconsistent, it is evident that information, rather than behavior, is the domain of memes. This shift to information and hence to the ideational domain brings us closer to cultural constructs than does a focus on behavior alone, but, as will be discussed below, the focus of memes on transmitting units of culture reduces culture to a trait list such as Durham's notion of culture as "a population of individual cultural items" [39, p. 196] and fails to come to grips with the far more extensive role of culture in constructing a framework within which humans operate.[7]

B3

Memes, viewed as cultural replicators in analogy with genes as genetic replicators, must have the distinguishing characteristics of a replicator [34, p. 8]. According to Dawkins [40] a replicator must have three crucial properties: (1) replicative fidelity (to make identical copies), (2) fecundity (to ensure that at least some memes replicate), and (3) sufficient longevity (to ensure that a meme survives long enough to replicate). These three properties provide the basis for some form of natural selection to be invoked as the criterion for change in the frequency of memes. The empirical measure underlying natural selection is fitness—the differential likelihood that a trait will be expressed in future generations according to the properties of the trait and the context in which the trait is found and expressed. For biological units such as genes, fitness, as is well known, is measured through reproductive success because reproduction is the underlying process for the duplication and transmittal of genes. However, fitness, from the perspective of natural selection, need not be linked to reproductive success; rather, fitness need only be measured in accordance with whatever is the process for the duplication and transmittal of the unit in question. For memes, the process is generally considered to be some form of direct transmittal, such as imitation or learning, from one phenotype to another.[8]

As noted by Cavalli-Sforza and Feldman, transmittal of information, whether by imitation, learning or some other means, involves at least two steps: awareness of the information and adoption of the information [23, p. 34]. Awareness of the information can be subdivided into four steps. First, a phenotype that currently has the information must enter or be among the collection of phenotypes that potentially or actually interact; second, the phenotype with the information must come into the vicinity of a phenotype that currently does not have the information; third, the phenotype currently having the information must broadcast the information (by passive or active means); and fourth, the broadcasted information must intersect the sensory apparatus(es) of another phenotype. Adoption of information can be broken down into two steps: sensory receipt of the information and transmittal of the sensory information to, and processing by, the cognitive apparatus of the brain.[9]

This sequence of events leading to transfer of knowledge from one phenotype to another is roughly analogous to the sequence of events involved in biological evolution. Analogous to awareness and adoption of information, in genetic evolution, is analogous to sexual contact between a male and a female leading to the production of a new phenotype. The biological event analogous to "enter the collection of phenotypes that potentially or actually interact" is being born, or migrating, into a breeding population, the collection of organisms amongst whom biological reproduction takes place. The biological event analogous to "come within the vicinity of the phenotype that currently does not have the information" is

Although definitions of what a meme is supposed to represent are highly variable and even inconsistent, it is evident that information, rather than behavior, is the domain of memes.

the selection of a partner for purposes of mating [23]. The genetic event analogous to broadcast of information would be ejaculation (including ejaculation due to masturbation) by the male and intersection of broadcasted information with the sensory apparatus(es) would be copulation. The analogy with sensory receipt and transmittal of sensory input to the cognitive aspects of the brain would be, for biological evolution, ejaculation by the male into an ovulating female and movement of the ejaculated sperm to, and fertilization of, an ovum. In other words, despite the obvious differences between the kind of information, the mode of transmission, and the transmission of information at the zygotic level for biological traits versus transmission at the phenotypic level for cultural information, the two processes are similar with respect to the sequence of events taking place. We can use this analogy in the sequence of events to define the analog of biological fitness for memes.

Biological evolution has focused on fitness defined through *reproductive success* considered as the extent to which the zygotes one has produced actually reach maturity and become reproducing members of a breeding population. Fitness is not just differential reproduction because time dependencies in changes in allele frequencies when going from a parental to a filial breeding population must be taken into account. Excluding factors such as meiotic drive and mutation, a panmictic breeding population will have an expected change of zero when going from the parental allele frequency to the expected allele frequency computed at the level of zygotic production. Evolution measured as change in expected values of allele frequencies in a panmictic population is thus largely a postzygotic event driven by differential mortality rates among developing phenotypes and fecundity rates among sexually mature phenotypes in accordance with the zygote's initial genotypic and subsequent phenotypic makeup. Consistency in generational changes in expected values of allelic frequencies through time depends on consistency through time in the correlation between aspects of the genotypic/phenotypic structure and reproductive success per generation. Reproductive success, then, is the minimal measure that must be satisfied for there to be a consistent pattern of evolutionary change through time for alleles, hence its use as a measure of fitness for biological traits. For memes, however, a different fitness definition is required. The definition will highlight the way in which a shift to memes from dual inheritance introduces the important feature of the agent as an active, rather than a passive, aspect of change.

Fitness of Memes

For the postulated memes, using biological fitness as the measure for meme fitness assumes that the analogy between the two processes for transmittal, one for biological traits and the other for information, is an identity. But this places form above substance. Instead, the analogy to time dependency for change in expected value of allele frequencies in a breeding populations is time dependency between receipt of information and broadcasting of that information (cf. Durham [12, p. 196]). Only for information transmitted vertically from parent to offspring and by no other means would biological fitness be a plausible measure of meme fitness (cf. Cavalli-Sforza and Feldman [23]). But even in this case it is defective. Whereas one of the pair of alleles a parent has at each locus on a chromosome must of necessity be transmitted from parent to offspring (unless there is chromosomal mutation), information known to a parent may or may not be passed on to an offspring and possibly transmitted to some offspring and not to other offspring.[10] Further, whereas the offspring must receive the alleles transmitted by the parent, the offspring may or may not accept the information transmitted by the parent.[11] Consequently, meme fitness must have its own definition.

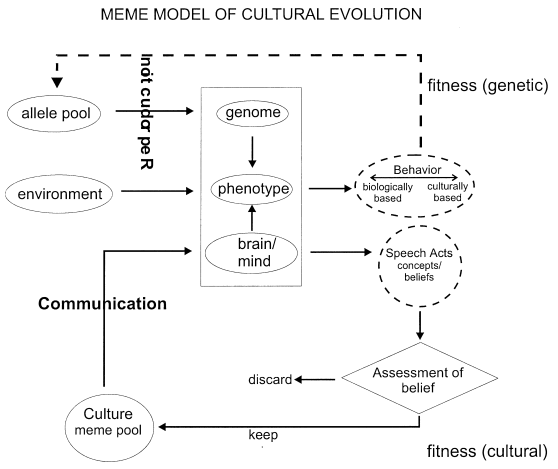
To do so we first need a reference population for measurement of change in the frequency of memes analogous to the breeding population that is used to measure change in the frequency of alleles. We can define a *communication population* to be the population of individuals among whom communication takes place in analogy with a breeding population as the population among whom mating takes place. The aspect of information transfer that seems to be closest to the concept behind reproductive fitness would be something like:

> Fitness of a Meme: The relative number of persons in a communication population (of persons) to whom the meme is transmitted by an individual already having the meme, where each recipient accepts the information and includes it within one's repertoire of information that may then be transmitted to other individuals in the communication population.

This captures the key aspects of the linkage between the measure of biological fitness via reproductive success and the outcome of fitness difference in the form of change in allele frequency in a breeding population. Note that for biological fitness, the number of offspring produced is simply a proxy measure for the number of alleles that will be contributed by an individual to the allele pool for the breeding population of the next generation.

The definition given here agrees with the "social transmission" part of Durham's [12] definition of cultural fitness as a meme's "relative empirical rate of social transmission and use within a subpopulation" (p. 194), but diverges from his inclusion of the *rate of usage* of the meme as part of the definition of meme fitness.[12] In a biological context the latter would require one to define the fitness of a biological trait both by the rate of transmittal of a trait and by how often the trait is used or "activated" in some environment. But it is not the rate of activation that determines biological

FIGURE 3



Schematic diagram for memes viewed in analogy with genes and having a process of transmission from one brain/mind to another brain/mind with fitness determined by the likelihood of a meme not being discarded.

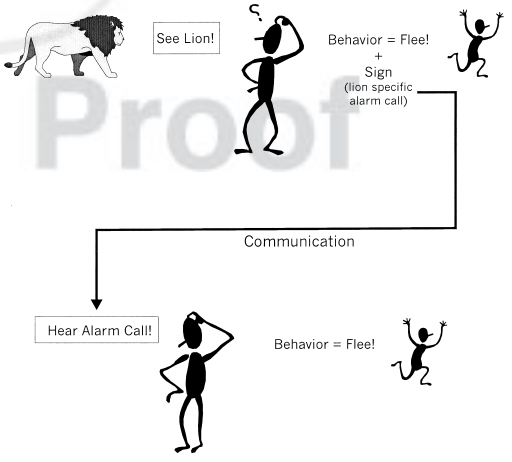
fitness; rather, it is the consequence of activation in terms of the organism's ability to develop from a zygote to a mature phenotype and to successfully engage in reproduction. High rates of the use of information can lead to its demise rather than to its propagation. The Nazi "meme" had a high rate of use within a subpopulation for a period of time, but the consequences of that usage was to cause the demise of that "meme." One might attempt to patch up Durham's definition by requiring "continued use through time," but patching up quickly leads to the circularity he wants to avoid [12, p. 194, no. 29]. Nonetheless, despite the differences in these two definitions of cultural fitness, in both cases the active role of the agent in accepting and transmitting information is central.

Agents and Signs in the Meme Approach to Cultural Evolution

The active role of the agent in accepting and transmitting information distinguishes the memetic approach in a significant way from the framework developed under the rubric of dual inheritance. In dual inheritance the agent is less of an evaluating agent and more of a device that responds to behaviors in accordance with built-in prescriptions such as "imitate successful individuals." The information behind the behavior does not play a direct role either on the side of the organism producing the behavior or on the side of the organism imitating the behavior. The built-in prescriptions are assumed to have arisen through natural selection acting on the allele pool of a breeding population as indicated in the right side of Figure 3. Although the range of behaviors that may be introduced through imitation once imitation is in place is far greater than could arise through the sociobiology paradigm (compare Figure 3 with Figure 2), agents, nonetheless, are imitating (or not imitating) according to a biological predisposition toward, and mode of, imitation. Once the characteristics of that predisposition are determined, evaluation of information on the part of an agent is no longer germane in the dual inheritance framework.[13] We can illustrate this difference between dual inheritance and meme theory in the role that evaluation plays in the transmittal of information through a pattern of sign usage among vervet monkeys.

A sign is a good candidate for a meme because it is a "unit" at the ideational level by virtue of the relationship between the signifier (such as a particular sound) and the signified. A sign satisfies Dawkins' three criteria for a replicator. A sign and its signification must be replicable as a sign would be meaningless unless there is identity in the relationship between signifier and signified in all copies of the sign. It must have fecundity, else it would be individually idiosyncratic. And clearly signs can have longevity. A "classic" example of nonhuman use of signs is the alarm calls of vervet monkeys [42], as the alarm calls are predator specific. When one monkey sees a predator (eagle, leopard, or snake), it gives out an alarm call specific to that kind of predator and the monkeys who hear the alarm call respond in a manner appropriate for escaping from that kind of predator (see Figure 4). In addition, the receiving monkey will also issue an alarm call, thereby extending the effective range of the initial alarm call. In effect, it appears that the

FIGURE 4



Behavior Transmittal via Signs and Communication

Schematic diagram illustrating how a sign can be used to communicate predator information to another person, thereby engendering in the second person the action s(he) would have taken had s(he) directly observed the predator.

alarm call replaces the actual predator as the stimulus for an internal representation of a predator by a signal receiving vervet monkey and thereby induces, indirectly, the behavior that would have occurred had the monkey directly encountered the predator.

Up to this point the scenario just described could be encompassed within the dual inheritance framework because one could posit that the transmittal of the sign from one vervet monkey to another is through imitation of a "successful" monkey, namely a monkey that learned to respond to an alarm call in the appropriate manner for that alarm call. No evaluation of the efficacy of the sign need be made by the imitating monkeys, hence the sign would spread among the vervet monkeys through the imitation process identified in the dual inheritance framework. However, another aspect of the sign system is less easily accommodated within the dual inheritance framework.

Apparently vervet monkeys are also prone to occasionally giving false alarm calls during intergroup encounters. According to Cheney and Seyfarth [42], in one instance a vervet monkey gave false alarm calls when a new male tried to transfer to his group. However, if a vervet monkey repeatedly gives false signals of the same type, other monkeys learn to ignore the false signal. Important here is the fact that it is not the monkey giving the false signal that is ignored because a signal from that monkey for a different kind of predator would be heeded. Nor is the signal ignored because the same signal from a different monkey is heeded. It appears as if the monkeys have made an evaluation of a specific signal from a specific individual within the context of a communicating population and thereby reduced the average fitness of that signal. Presumably, if the errant monkey were the only monkey that produced the false predator alarm in the communicating population, the alarm for that kind of predator would eventually be lost to that population. This kind of evaluation of information as part of the process of information transmittal is excluded, or at least reduced to limited and very specific modalities in the dual inheritance model only when they are expressible in terms of patterns for imitation of behavior. Yet evaluation does occur outside of the context of behavior and so cultural transmission, as will now be argued, can neither be reduced to transmittal of behaviors nor of memes through imitation.

Culture as Incorporating Symbol Systems

Although signs may well fit the criterion of a meme and though the transmittal of signs introduces the agent as an active participant in the transmittal process, the concept of memes nonetheless suffers from a crucial defect as a way to provide the basis for a theory for cultural evolution. Culture is not a collection of memes, each taken as some kind of cultural unit; hence cultural evolution cannot be reduced to a form of natural selection of memes. In his definition of culture Tylor [21] used the phrase "that complex *whole*" (emphasis added), not "that collection of traits." The distinction is crucial. Culture is no more the sum of its units than an organism is the sum of its alleles or biological evolution simply the sum of instances of natural selection acting on alleles. Evolution of organisms and the pattern of evolutionary change at the level of species involves processes that cannot be reduced to just natural selection acting on alleles. In response to Dennett's [43] metaphor of evolution produced by cranes versus skyhooks, Gould [44] comments:

> "the platform of evolutionary explanation houses an assortment of basic cranes, all helping to build the edifice of life's history in its full grandeur (not only the architecture of well-engineered organisms). Natural selection may be the biggest crane with the largest set of auxiliaries, but Kimura's theory of neutralism is also a crane; so is punctuated equilibrium; so is the channelling of evolutionary change by developmental constraints."

The complexity of an organism, for example, is not specified through merely listing the alleles encoded in its DNA. The famous 2–5% difference in DNA between *Homo sapiens* and the species included within the genus *Pan* does not capture the way in which developmental sequences in *H. sapiens* differ from those in *Pan*, hence does not, by itself, account for the differences in brain size and its structure and organization between *H. sapiens* and species making up the genus *Pan*. The brain's organization is vastly underspecified at an allelic level [16, p. 124] and synaptic connections are constructed during an individual's growth and development. Simply knowing the list of alleles that produce the proteins involved in the development of the brain would not suffice to understand the range of behaviors that can be produced.

Similarly, knowing the cultural units (whatever they may be) and their transmission alone is not sufficient for understanding the way a cultural system operates. The structure or system for which the units are a part, the structure or system that the units produce, and how this structure or system is produced or generated is central to our understanding of how human collectivities define themselves and how individual behavior relates to properties at the level of the collectivity. As noted by biologists Gatherer and McEwan: "Culture has its nucleotides but its phenotypic manifestation is complex and its units of selection are therefore large" [45, p. 412]. Or, in the words of a psycholinguist, culture "captures the thematic unity of a symbolic system—the conceptual unity across domains. . . [and] the functional fit between elements across different domains" [46, p. 189].

If there are units of culture, symbols are a likely candidate.[14] But symbols in isolation do not have meaning. It is through the symbol system in which a symbol is embedded

that the semantic content of a symbol has its origin. The importance of a symbol system for understanding human behavior has been noted by the anthropologist Clifford Geertz who comments that although "the dominant concept of culture in American social science identified culture with learned behavior," nonetheless "it is now clear to virtually everyone whose interests extend any distance beyond the descriptive that it is very difficult to generate analysis of much theoretical power from such a diffuse, empiricist notion" [48, p. 249], a viewpoint echoed more recently by a cognitive anthropologist, Roy D'Andrade [10]. Geertz attributes the demise of the culture = learned behavior paradigm to Talcott Parsons and comments: "In [illegible]e of this near-idea [culture as socially learned behaviors], Parsons . . . has elaborated a concept of culture as a system of symbols by which man confers significance on his own experience.

Symbol systems, man-created, shared, conventional, ordered, and indeed learned, provide human beings with a meaningful framework for orienting themselves to one another, to the world around them and to themselves. . . . *The symbol system is the information source that, to some measurable extent, gives shape, direction, particularity, and point to an ongoing flow of activity*" [48, p. 250, emphasis added]. In a similar vein, the cultural anthropologist David Schneider has noted that "The first task of anthropology, ***prerequisite to all others***, is to understand, and formulate the symbols and meanings and &beginunderscore;their configuration&endunderscore; that a particular culture consists of." [49, p. 196, italics and bold in the original, emphatic underlining added]. More recently the anthropologist Marshall Sahlins has observed that "human existence is symbolically constituted, which is to say, culturally ordered" [50, p. 400]. In brief, the underlying assertion is that culture is not simply composed of a collection or population of units as is assumed in meme theory, but is a far more complex phenomenon consisting, in part, of interconnected structural wholes each of which transcends the sum total of the parts in the structure. Nor, from this perspective, can a structural whole be accounted for by the behaviors that are produced in accordance with it as is assumed in dual inheritance theories.

The relationship between a cultural concept and behavior is complex and involves the integration of both the effects of internal conceptual systems on the meaning associated with sensory input and the various factors that affect the translation of sensory input to external behavior. There is no homomorphic, let alone isomorphic, mapping from behavior to an underlying conceptual system because the organization of the conceptual system underlying behavior need not be recoverable in any straightforward manner through behavior.[15]

As problematic as this view of culture may be for meme theory, dual inheritance and sociobiology, its legitimacy as a critique of those approaches depends on being able to implement this vision. Geertz notes that "The [illegible]ability of the Parsonian concept of culture rests almost entirely on the degree to which such a model can be constructed—on the degree to which the relationship between the development of symbol systems and the dynamics of social process can be circumstantially exposed, thereby rendering the depiction of technologies, rituals, myths, and **kinship terminologies** as *man-made information sources for the directive ordering of human conduct* more than a metaphor" [48, p. 250–251, bold and italics added].

In Part II I develop the kind of model asked for by Geertz through consideration of kinship terminologies viewed as [illegible] symbol systems, with the American/English kinship terminology used as a case study. The construction of a model for a kinship terminology viewed as a symbol system will illustrate the way in which culture is both far more complex than envisaged in the sociobiology, dual inheritance, or meme theory frameworks. Further, it will become evident that culture is composed of distinct constructs that operate at, and connect, levels in the continuum going from empirical behavior to abstract conceptualization. One of the critical implications of this analysis is that cultural evolution is not a single process but several processes, each of which has a different modality depending on the aspect of culture being considered. The analytic framework developed for the analysis of the American Kinship Terminology (AKT) as a conceptual/symbolic system also opens the possibility of resolving the dichotomy observed by James March [5], discussed above.

PART II

Before beginning the construction of a model for the underlying logic that gives a kinship terminology structure its particular form and makes it into a *system* of symbols and not just a collection of symbols, some preliminary comments about the nature of kinship terminologies are needed.

Kinship Terminologies

Kinship, as it occurs in human societies, is a cultural construct as asserted by Geertz because it cannot be reduced to biological relations.[16] That kinship is a construct in its own right and not reducible to biological distinctions can be seen through the way, in some societies, individuals with identical biological relationship to ego are not only differentiated in terms of being different kinds of kin,[17] but the organization of the society as a whole centers on that differentiation and its social implications. In addition, different societies have terminologies that make noncomparable distinctions from one society to another among one's kin, yet the underlying structure for the formation of biological kin via biological reproduction is constant, hence the variation among terminologies with regard to kin that are distinguished cannot arise from the biological domain. Nor is

biological reproduction universally recognized as relevant to the formation of kin relations. In the Amazonia region there is "absence of a notion of genetic kinship" [54, p. 354]; among Australian aboriginal groups "physical paternity is normally dismissed as being virtually of no practical importance" ([55], p. 596, as quoted in Scheffler [56]); among some Eskimo groups kinship "integrates nonbiological social relationships that are considered to be as 'real' as any biological relationship" [28, p. 34]; and among the Zumbagua of Ecuador "parenthood is restricted neither to a biological determination rooted in insemination nor to a jural or symbolic definition based on metaphor" [57, p. 695]. Kinship as it is recognized in human societies, then, is a cultural construct, not a biological given.

Kinship as it is recognized in human societies, then, is a cultural construct, not a biological given.

B4

As a cultural construct, kinship is given indigenous specification through a kinship terminology. A kinship terminology is the set of words used by the members of a given culture to refer to one's relatives. A kinship terminology is a particularly useful semantic domain for exploring the issues being examined here because it is the linguistic form through which the domain of kinship is given its primary form, thereby raising the possibility of an underlying "grammar" for the syntax of that linguistic domain. In addition, the kin terms making up a kinship terminology are a means for assessing not only the individuals making up a dyad are kin related, but also serving to define the kind of kin relationship that they share. Thus in American culture when ego refers to another person, alter, as, say, brother, ego is not only identifying that ego and alter are linked as kin, but also that they share a particular relationship, brother, out of all the kinds of kin relations identified in the kinship terminology that is an aspect of American/English culture. The importance of kinship in human societies, though, is far more pervasive, and runs far deeper, than just being a means to specify culturally defined relations between pairs of individuals. Kinship, as it is culturally constructed, has been the basis for the organization of human societies.

AQ: 6

For many human societies, and in particular the small scale societies that have characterized human existence prior to the advent of agriculture, one's identity as a member of a collectivity is in terms of a distinction between the societal members and all other persons. The term the !Kung San use for themselves, *ju hoansi*, can be translated as "we, the real people." Similar characterizations in other societies of one's group as the real people appear to be common. The boundaries of a collectivity defined as "the real people" is expressed in terms of kinship relations. The collectivity is the set of persons who can mutually identify one another as kin or kin related. One means for identifying someone as a kin person arises through whether or not one has a kin term that may be used to refer to that person; hence, one's kin may be considered to be those persons for whom one has an applicable kin term.

In societies that define the collectivity through kin relations, identification of another person as one's kin may also be prerequisite to social interaction between two individuals. This can be seen in the !Kung San expression for something bad or harmful, *ju dole*. This expression is also used for strangers [58], where strangers are conceptualized as persons for whom one does not have a kin relation. When two unacquainted persons meet each other they first must determine if they have a kin relationship, which they do by figuring out the kin terms they should use for each other. If they cannot determine their kin relationship, there will be no social interaction between them.

The centrality of kinship for establishing the boundaries of a social group is related to the fact that one's kin are not just individuals with whom a relationship can be determined through the application of a kin term, but the world of kin are also the world of persons who share a common sense of morality and share expectable kinds of behavior (on the positive side) and where it is also possible to bring sanctions, even if only through social ostracisation (on the negative side). Thus one's identity as a kin person is fundamental to knowing a person's status as a social person and whether one shares a common sense of morality and kinds of appropriate behavior with that person; that is, a kin person, unlike a stranger, is a person for whom one has a reasonable expectation about the kinds of behaviors that may occur or the sanctions that can be invoked when inappropriate behavior does take place.[19]

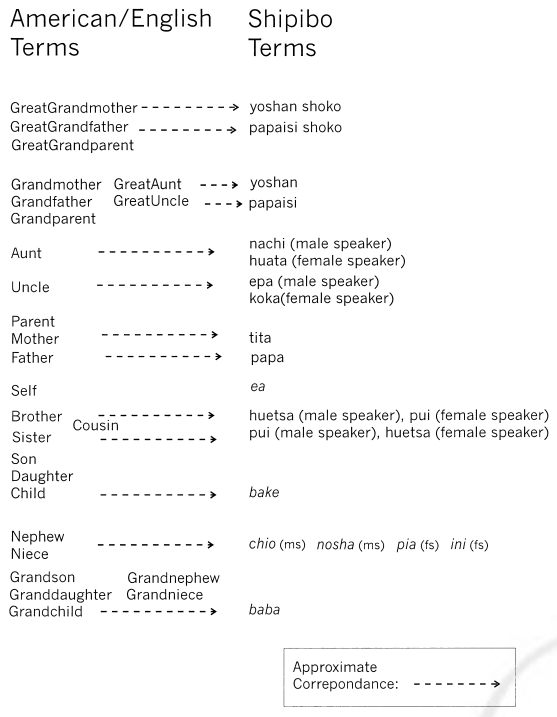
In American culture the kinship terminology is composed of the terms mother, father, brother, sister, uncle, aunt, etc. Terms may be used in address, as in a statement such as "Uncle Bill, can I use your car?" or for reference, as in statements such as "This is my Uncle Bill." The latter usage has dominated the study of kinship terminologies and will be the focus here. Other cultures have terminologies that differ from the American terminology not only by virtue of language differences, but also by different conceptualization of who are one's kin and the kind of kin relations that one may have with respect to one's kin. For example, among the Shipibo Indians—a horticultural group living in the Amazonian portion of Peru (see Behrens [60])—some of the distinctions made in the AKT kinship terminology are not made in the Shipibo terminology and some distinctions made in the Shipibo terminology are not made in the AKT. In particular, the sex of the speaker makes a difference in the kin term used for several of the terms in the Shipibo terminology, whereas this is true only for the terms husband/wife in the AKT (see Figure 5).

AQ: 7

F5

A meme theory of kinship terminologies would view these differences as arising from the addition and deletion

FIGURE 5



Comparison of American/English kin terms with kin terms from the Shipibo Indians of Peru.

of kin terms taken as cultural units based on the concept or idea expressed via the kin term and thereby directing the fate of that term/unit in the collection of kin terms for which it is a part. Whether a kinship terminology is simply a collection of t[illegible] each of which has had its own evolutionary history or whether a kinship terminology has organizational unity that determines the distinctions represented by the kin terms is central to the adequacy of the concept of culture underlying meme theory, dual inheritance theory, or sociobiology. We now consider the nature of kin terms and their relationship to kinship and a kinship terminology.

Kin Terms

When confronted with kin terms [illegible] do not have translation into the framework of American/English kinship distinctions, anthropologists have used genealogy and genealogical tracing as a way to express the meaning of a kin term take[illegible]om another culture so as to elucidate at least some of its meaning for a person outside of that culture. (Genealogical tracing, the basis of constructing family trees, appears to be very wide spread, if not universal, in human societies [61].) In addition we, as natives to our own culture, often define kin terms using genealogical criteria, such as when a parent explains to a child that "he is your Uncle Bill because he is your father's brother" and most of us can provide genealogical definitions for many of our kin terms.[20] Despite the convenience of using genealogical criteria as a way to convey at least a partial sense of the meaning of a kin term, it is evident from numerous ethnographic examples that the convenience is mainly for the anthropologist dealing with another culture and is not part of the conceptual apparatus brought to bear by culture bearers on their understanding of their kinship world.

In her ethnography on the kinship terminological system of the !Kung San, the anthropologist Lorna Marshall comments:

> The !Kung were apparently not always assiduous in teaching their children the exact biological position of their kinsmen (whether a given man was FaBr or MoBr, for instance), and a person would not always know why he applied a certain term to someone, but he would know that the term he used was proper, and he would know the proper joking status to observe; that would have been well taught him by his parents. . . . !Kung informants showed no interest in generation as such. What a !Kung says, when he associates his relatives with each other in the pattern I have called generational, is that they are 'like' each other. . . . That they are alike because they occupy the same 'step or stage in the succession of natural descent' (as Webster defines 'generation') apparently does not concern the !Kung. Instead it was the joking relationship they spoke of, and they pointed out the parallel po[illegible]sition of their kin in its terms. [58, p. 204, 208, ita[illegible] in original, underlining added].

AQ: 8

Although Marshall found it convenient to describe their kinship system in generational and genealogical terms, it is evident from her comments that the latter is not part of their conceptualization. And with their naming system the whole system of terms of reference and address changes, regardless of genealogical relationship, merely by changing one's name: "Names may be changed, and, when they are, the person is reclassified and the kin terms applied to him or her are changed accordingly" [58, p. 236]. Her observations on disinterest by the !Kung san in genealogical relationships as part of knowing the usage of one's kinship terminology are not an isolated case.

Goodale makes a similar observation about the Tiwi, a group of hunter-gatherers who lived on Melville and Bathurst Islands off the coast of northwestern Australia. Their term, *innari*, which we can transliterate as "Mother," refers to a category of women that includes the person Americans would call mother and includes other women such as the sister of the woman an American would call mother. The women in this category are not genealogically distinguished by the Tiwi. She comments: "I am fairly cer-

tain that it is completely unnecessary for Tiwi to make such [genealogical] discrimination, which is one that *they not only do not, but also cannot, ordinarily conceptualize*" [62 (1971), p. 73, emphasis added]. The failure of the Tiwi to make genealogical distinctions among the women to whom the term *innari* is applicable makes it evident that kinship concepts are not grounded in genealogical relationships; rather, kin terms have primary meaning by virtue of their position within a system of terms and not by reference to other domains.

Examples of other ethnographers who have made similar observations about kin terms include Behrens [60] for the Shipibo, Singarimbun [63, p. 147] on the Karo Batak, and Kelly [64, p. 69] for the Etoro. As noted by the anthropologist Robert Parkin [65, p. 94], "[t]he ethnographic literature is full of discussions of how, when two people meet for the first time, they set about determining their relationship to one another." The means for so doing is by using kin term calculations and not through genealogical tracing.

The anthropologist Marshall Sahlins makes explicit the way kin term calculations are used to determine kin relationships in his discussion of Moala kinship: ". . . [kin] terms permit comparative strangers to fix kinship rapidly without the necessity of elaborate genealogical reckoning—*reckoning that typically would be impossible*. With mutual relationship terms all that is required is the discovery of one common relative. Thus, if *A* is related to *B* as child to mother, *veitanani*, whereas *C* is related to *B* as *veitacini*, sibling of the same sex, then it follows that *A* is related to *C* as child to mother, although they never before met or knew it. Kin terms are predicable. If two people are each related to a third, then they are related to each other" [66, p. 155, emphasis added]. The way the Moala determine kin relationships solely through consideration of kin terms suggests that kin terms form a symbolic system of kin relationships for which calculations linking symbols are constructed through what we can call a kin term product.

Kin Term Product and Kin Term Maps

Ethnographic examples of directly determining kin relations using kin terms alone suggests that calculation with kin terms viewed as symbols is central to understanding the way the collection of kin terms in a particular terminology constitutes a symbolic system and how kin terms, as symbols, are interrelated. We may abstract from ethnographic examples of calculating kin relationships a calculation that we will call a *kin term product* [67]. We define a kin term product as follows:

> Definition: Let *K* and *L* be kin terms in a given kinship terminology, **T**. Let ego, alter$_1$, and alter$_2$ refer to three arbitrary persons each of whose cultural repertoire includes the kinship terminology, **T**. The kin term product of *K* and *L*, denoted *K o 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$_2$ (properly) uses the kin term *K* to refer to alter$_2$.

For example, in the American/English Kinship Terminology (AKT), if *K* is the kin term Mother and *L* is the kin term Father, then if ego refers to alter$_1$ as Father and alter$_1$ refers to alter$_2$ as Mother, ego (properly) refers to alter$_2$ as Grandmother; hence Mother o Father = Grandmother (read "The kin term product Mother of Father yields the kin term Grandmother" or, more simply "Mother of Father is Grandmother") (see Figure 6). (Kin terms with capital letters will be used to indicate that the term is being considered as a symbol.) Note that this is not a statement about genealogical relations because Father, Mother, and Grandmother are kin terms and no claim is being made about the genealogical relationships among ego, alter$_1$, and alter$_2$. It might be the case, for example, that alter$_1$ is the adopted mother for ego and alter$_2$ is her (biological) father. The equation simply asserts that ego would (properly) refer to alter$_2$ as Grandfather in the situation where ego (properly) refers to alter$_1$ as Mother and alter$_1$ (properly) refers to alter$_2$ as Father, a consequence consistent with the AKT when applied to adopted children. The kin term product expresses the (proper) informant response, or what Bourdieu calls the "official representation" [68, p. 167], to questions such as "If you (properly) refer to someone by the kin term *K*, and that person (properly) refers to someone by the kin term *L*, what kin term would you use to (properly) refer to this last person?" The criteria by which the informant arrives at an answer (genealogical calculation, personal experience, etc.) is not of primary concern. Rather, our concern here is with

AQ: 9

F6

FIGURE 6

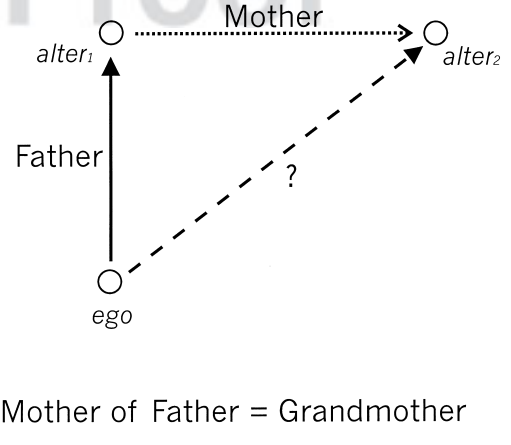


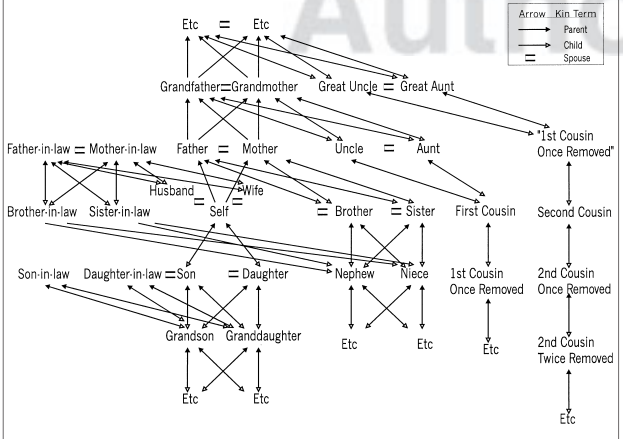
Illustration of a kin term product for users of the American/English kinship terminology.

the term(s) deemed by the informant to be the consequence of this kind of kin term calculation.

We can express informant information about the way kin terms are linked as symbols in the form of a kin term map ([69], subsequently modified by Read [67]). A kin term map provides a way to display the structural relationships among kin terms elicited from informants by focusing on taking products with a few, core kin terms. For the AKT we can construct a map showing the way kin terms are linked through taking kin term products with the kin terms Father and Mother and their reciprocal terms,[21] Son and Daughter, along with the affinal (relation by marriage) kin terms Wife and Husband. The kin term map shown in Figure 7 displays, for each kin term, the kin term that is produced via the kin term product when a product of a kin term is made with one of the above six kin terms. What the kin term map displays is the constructive and systematic nature of the kinship terminology as a conceptual domain; that is, the way in which the positions in the structure appear to be systematically linked through repeated kin term products, in this case using the "generating" reciprocal kin term pairs, Parent = Father/Mother, Child = Son/Daughter and Spouse = Husband/Wife for the AKT.

The key concern here has to do with the way one can account for the structural properties displayed in the kin term map. The "meme" notion of cultural units simply presumes that kin terms can be added or subtracted from the kin term map according to criteria that lie outside of the collection of symbols displayed in the kin term map. But if the map is the outward representation of a conceptual domain structured by an internal logic that accounts for both the form of the kin term map and the nodes displayed in the map, terms cannot simply be added or deleted in the manner suggested for memes.

FIGURE 7



Kin term map of the kin terms in the American Kinship Terminology, based on using the kin terms Parent, Child, and Spouse as generating kin terms for the kin term map.

The difference between these two perspectives can be illustrated with some of the kin terms in the AKT. The AKT appears to use a logic whereby affinal terms are linguistically marked through use of the suffix "-in-law," thereby giving rise to terms such as Mother-in-law, Sister-in-law, etc. However, this logic is violated for one pair of terms and its variants, namely Aunt and Uncle. In American culture the same term, Aunt, is used for both "blood" relations—father's sister and mother's sister—and "relations by marriage"—father's brother's wife and mother's brother's wife. The anthropologist David Schneider has claimed that the failure to use the -in-law suffix in the case of Aunt and Uncle by marriage is an anomaly in what otherwise appears to be logic underlying the lexemic form of the affinal terms in the AKT. The reason for the anomaly, he argued, stems from the way "-in-laws" are conceptualized in American culture as distant and reserved, whereas one's (genealogical) aunts and uncles, whether by blood or by marriage, have a close and warm relationship to their nephews and nieces [70, p. 107, no. 7]. Hence, according to his argument (which fits easily within the meme paradigm), we have dropped what otherwise would be Aunt-in-law and Uncle-in-law terms and substituted the terms Aunt and Uncle in their place in order that the kind of emotion associated with terms that identify "blood" kin relations would be consistent with the affect that actual aunts and uncles feel and express towards their nephews and nieces whether or not the relationship of the former to the latter is by blood or by marriage. From this perspective, and consistent with cultural evolution as it is expressed in meme theory, terms can be added to a terminology or dropped from it without considering the logic underlying the terminology as a structurally organized collection of symbols. If, however, features of the kin term map, such as the lack of an "-in-law" suffix on the aunt and uncle terms, are the consequence of an underlying logic guiding the generation of a symbolic structure from atomic symbols using the kin term product, then the meme theory is fundamentally misguided.

We now show that there is an underlying logic to the structure of the AKT that does account for the apparent anomaly of not using a suffix when referring to aunts and uncles by marriage. When we make this logic explicit, we also find that the kin term map structure can be generated through the working out of an underlying grammar for the terminology. To see this, suppose we begin with the set of kin terms, A = {Father, Mother, Son, Daughter, Wife, Husband}, and start constructing kin term products in accordance with native knowledge about the AKT. Consider, for example, the kin term product "Father of Father." This product yields, from our informants, a new symbol not yet in A and known to the users of the AKT as Grandfather. Add this symbol to the set A so that we now have the set of

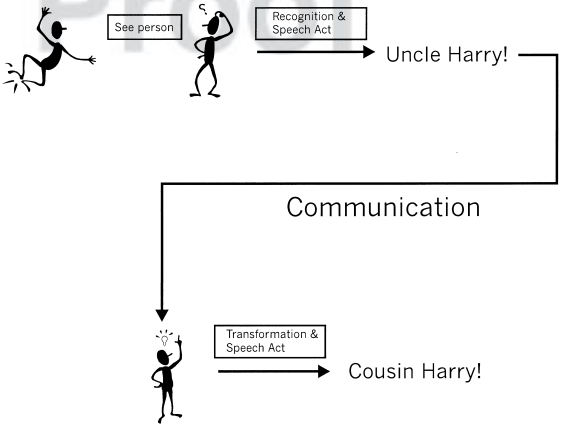
symbols A' = {Father, Mother, Son, Daughter, Wife, Husband, Grandfather}. Note that in some cases when we take a product of kin terms already in our set of kin terms we do not get a new kin term. For example, the product Wife of Father yields a kin term (in this case, Mother) already in A and so no additional kin term is added to the set. In other cases the kin term product does not yield a kin term; e.g., Father of Father-in-law does not correspond to a kin term in the AKT.

We continue taking products in this manner until for all possible products either (1) no new kin term is elicited, (2) a product does not yield a kin term, or (3) a repetitive pattern ensues (such as the sequence Father, Grandfather, Great-grandfather, etc.). The question now becomes twofold. Is there a set of atomic symbols from which the kin term map can be generated using the kin term product in accordance with a small set of structural equations and possibly a few structural rules relating to structural features such as sex marking of kin terms? If so, does the logic of that system account for the structural form of the kin term map and specific features such as Wife of Uncle = Aunt and Husband of Aunt = Uncle in the case of the AKT?

An affirmative answer has several crucial implications for the argument being made here about the nature and form of cultural constructs. First, it would establish that the terms of the terminology are *not* each a unit, as would be assumed in a meme theory for the transmission of a kinship terminology.[22] Instead, there is a subset of terms that constitute units from which the other terms can be generated. Second, the relevant cultural information is not exhausted by the list of kin terms but must include the structural equations satisfied by the products formed with the cultural units. Third, any additional rules regarding the form of the structure produced from the units and the structural equations are also part of the cultural information embedded within the terminology. Fourth, the process by which a structure is generated and structural properties that it must display for a kinship terminology structure to be distinguishable from the structure for other cultural constructs is also part of the cultural information embedded into the kinship terminology. Fifth, the structural properties that make it possible for substructures of the terminology to be used culturally by analogy or by metaphorical extension as a way to structure the content in other domains is also part of the cultural information included with the kinship terminology. Sixth, constraints on any change or evolution in the structure arising from the logic of how the terminology is generated as a structure must also be considered as part of the cultural knowledge that is conveyed when the terminology is transmitted from one person to the next. And seventh, the process by which a terminology is transmitted must also be included because it is the underlying logic of the terminology that must be transmitted in the same way that it is the underlying grammar of a language that must be transmitted to another individual for that individual to be a competent user of a language. It is this logic that makes one person's expression of a kin relationship not only intelligible to, but also capable of being transformed by, the recipient of that expression (see Figure 8). F8

The answer to the two questions expressed above is in the affirmative. The kin term map for the AKT can be generated by making use of the structural information presented in Figure 9 (see Read and Behrens [71] for details). F9 The atomic symbols for the AKT are the member of the set A = {Parent, Child, Self}. The structural equation responsible for the structure of the consanguineal terms (relations by blood) of the AKT is the kin term equation, Parent of Child = Self. The affinal portion of the structure is generated by the addition of the atomic symbol, Spouse, along with several equations that relate it to the other atomic symbols (such as Spouse of Parent = Parent) and limit the extent to which taking a product with the symbol, Spouse, leads to a new symbol in the terminology (such as Parent of Parent of Spouse is undefined). The sex marking of kin terms for the AKT is accounted for by a simple rule that reserves sex marking of a kin term to the case where either "Spouse of K" is a kin term or "Spouse of (reciprocal of K)" is a kin term; e.g., Parent is bifurcated into a pair of sex marked symbols, Mother and Father, by virtue of the fact that Spouse of Parent = Parent (hence Spouse of Parent is a kin term) and reciprocally, Child is bifurcated into the pair of terms, Son and Daughter. Contrariwise Cousin is not sex marked because in proper usage of the AKT the kin term product, Spouse of Cousin, does not yield a kin term. Further, because Cousin is self-reciprocal, the other means by which a kin term becomes sex marked does not apply. Finally, the full Cousin terminology expressed using terms of the form,

FIGURE 8



Recognition of a person as kin related, communication of kin information to another person, and transformation of kin information from the other person's perspective to one's own perspective.

FIGURE 9

Outline of a Grammar for the American Kinship Terminology

Let $S = <S, o>$ be a semigroup; that is, S is a set of symbols and o is an associative binary product defined for all pairs of symbols from S. A set $G \subseteq S$ is said to generate the semigroup S if S is the smallest semigroup containing G. In this case we call G a generating set for S. (Convention: We write xy in place of x o y.)

Definition of Reciprocal Elements:

If $x, y \in S$, then x is a reciprocal for y if, and only if, xy is an idempotent: $(xy)(xy) = xy$

An element $f \in G$, the generating set for S, is called a *focal element* if (1) every element in S can be reached from f; that is, if $x \in S$ then there is a $y \in S$ with $yf = x$ and (2) there is a $g \in G$ such that for all $x \in S$, $gx \neq f$.

If S is a semigroup with a single focal element, f, then a *spouse* element is an element s such that $ss = f$.

Algebraic Model for the American/English Kin Term Map

(1) Generators: $G = \{i, p, c\}$, where i is an identity element for the binary operation o.
(2) Associative binary operation: o
(3) Structural Equation: p o $c = i$

Properties (1) - (3) generate a semigroup S known as the bicyclic semigroup.

Theorem: p and c are reciprocal elements.
Proof: $(pc)(pc) = ii = i = pc$. $(cp)(cp) = c(pc)p = cp$.

Theorem: i is a focal element for S.
Proof: This follows from the fact that i is an identity element and the equation $cp = i$ is not valid in S.

The semigroup S is the *base algebra* for the AKT structure.

A spouse element s is added to the semigroup with s satisfying:
(1) $ss = i$ (Spouse of Spouse is Self)
(2) $sp=p$ $(cs = c)$ (Spouse of Parent is Parent; Child of Spouse is Child)
(3) $pps = 0$ $(scc = 0)$ (Grandparent of Spouse is not a kin term; Spouse of Grandchild is not a kin term)
(4) $psc = 0$ (Parent of Spouse of Child is not a kin term)
(5) $spc = pcs$ (Spouse of Sibling is Sibling of Spouse)

Let S^* be the semigroup with the element s added to the base algebra for the AKT; that is, S^* is generated by $G \cup \{s\}$.

AKT Sex Marking Rule: (1) if $x \in S$ and sx is a kin term, then replace x by a pair of symbols, x_f and x_m and (2) if x' is the reciprocal of x then replace x' by a pair of symbols, x'_f and x'_m. (That is, when Spouse of a Kin Term is a Kin Term then the Kin Term will be marked as a male or a female kin term and so will its reciprocal term).

Ith cousin j-times removed rule: The cousin elements (elements of the form $c^i p^j$, where $i, j \geq 2$, are labeled in a manner such that the labeled cousin terms are self-reciprocal and a maximum number of cousin elements are distinguished by different labels.

Grammar for the American Kinship Terminology.

"Ith cousin J times removed," determined by requiring that all Cousin terms be self-reciprocal and that a maximal number of Cousin terms is distinguished. The structure generated according to this construction process (see Figure 10) is isomorphic to the kin term map for the AKT [71].

F10

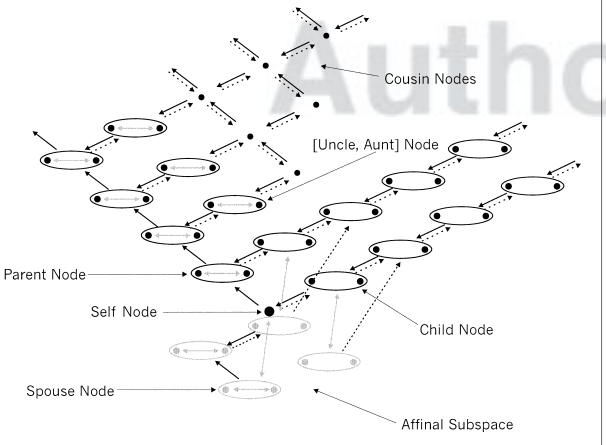
One of the implications of the logic underlying the generation of a structure isomorphic to the kin term map is the presumed anomaly of not using an "-in-law" suffix for the Aunt and Uncle terms. The graph of the algebraic structure that has been generated makes it evident that the terms with an "-in-law" suffix form are in a third dimension with respect to the rest of the structure (see lower left portion of Figure 10). In contrast the equations Spouse of Aunt = Uncle and Spouse of Uncle = Aunt are a logical consequence of generating a structure in accordance with the structural information given in Figure 9 (see [Uncle, Aunt] node in Figure 10 bifurcated into two nodes connected by a double-headed arrow that represents taking a product with the Spouse element, thus indicating that Spouse of Aunt = Uncle and Spouse of Uncle = Aunt since in the algebra $scpp = cpp$, where s, c, and p are generating elements corresponding to Spouse, Child, and Parent, respectively, and cpp is the algebraic element corresponding to the [Uncle, Aunt] node).

Kin Term Grammar

The underlying logic of a kinship terminology can be modeled using algebraic structures known as *semigroups* (see Read [67], Read and Behrens [71], and Read [72]).[23] Here it suffices to note that the symbolic system displayed in the kin term map (Figure 7) is linked to an algebraic structure as a model for that structure (Figure 10) by virtue of two features abstracted from the kinship terminology: (1) a set of symbols, S, corresponding to the kin terms and (2) a binary product defined over ordered pairs of symbols from S via the kin term product. The underlying theory behind the construction of a semigroup (modified by the Sex Marking Rule and the Cousin Rule) isomorphic to the kin term map relates to both the structural criteria that distinguish a kinship terminology structure from other cultural constructs and the process for the construction of a kinship terminology. Despite the radical differences among kinship terminologies with respect to the genealogical relations that are either grouped together under the same kin term or distinguished by different kin terms, there appears to be an underlying logic for the generation of the structure of a kinship terminology that is highly similar across terminologies. This theory is potentially falsifiable.[24] One simply needs to find a kin term map that is not isomorphic to a semigroup structure produced in accordance with this theory of kinship terminology structures.

The algebraic modeling of the kin term map provides us with a syntactic account of the structure of the kin term map in the form of a grammar (displayed in Figure 9), but only a partial semantic account. The additional ways in which the syntactic and semantic aspects of the kinship terminology are interrelated will now be considered because this will introduce another, central aspect of what is involved with cultural constructs.

FIGURE 10



Algebraic model isomorphic to the kin terms map shown in Figure 8. The model illustrates the way the affinal kin terms of the AKT form a distinct subspace (lower center) of the kin term structure and the fact that Spouse of Aunt = Uncle and Spouse of Uncle = Aunt is a logical consequence of the

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Semantic Content of a Kinship Terminology

The algebraic modeling of the kin term map treats the kin terms as abstract symbols without content. What a kin term "means" or to whom a kin term may be properly applied is unneeded information in the algebraic modeling and so the algebraic modeling is silent on the question of the application of the kinship terminology to empirical egos and alters. In addition to the syntactic argument we also need a means to instantiate the abstract symbols of the kinship terminology; that is, we need a set of cultural rules that determine the individuals to whom the abstract symbols of a kinship terminology may be properly applied. We model these cultural rules (for the AKT) by mapping the atomic kin terms to sets of genealogical relations as follows: Parent → {genealogical mother, genealogical father}, Child → {genealogical daughter, genealogical son} and Spouse → {genealogical wife, genealogical husband}.[25] We will use the term *instantiation* for this process of linking symbols with categories. The special term, Self, we map to the reference person from whom genealogical tracing will carried out: Self → {myself} (or, Self → {ego}, to use the technical term, ego). These mappings are consistent with what users of the AKT say about the use of the terminology with respect to the genealogical relatives that are used for genealogical tracing. We now construct the mapping of the other kin terms to sets of

genealogical relatives using the following definition of a set product:

> Definition: If $A = \{a_1, a_2, \ldots, a_n\}$ and $B = \{b_1, b_2, \ldots, b_m\}$ are two finite sets, define the set product $A \times B$ as follows: $A \times B = \{a_1b_1, a_1b_2, \ldots, a_1b_m, a_2b_1, a_2b_2, \ldots, a_2b_m, \ldots, a_nb_1, a_nb_2, \ldots, a_nb_m\}$.[26]

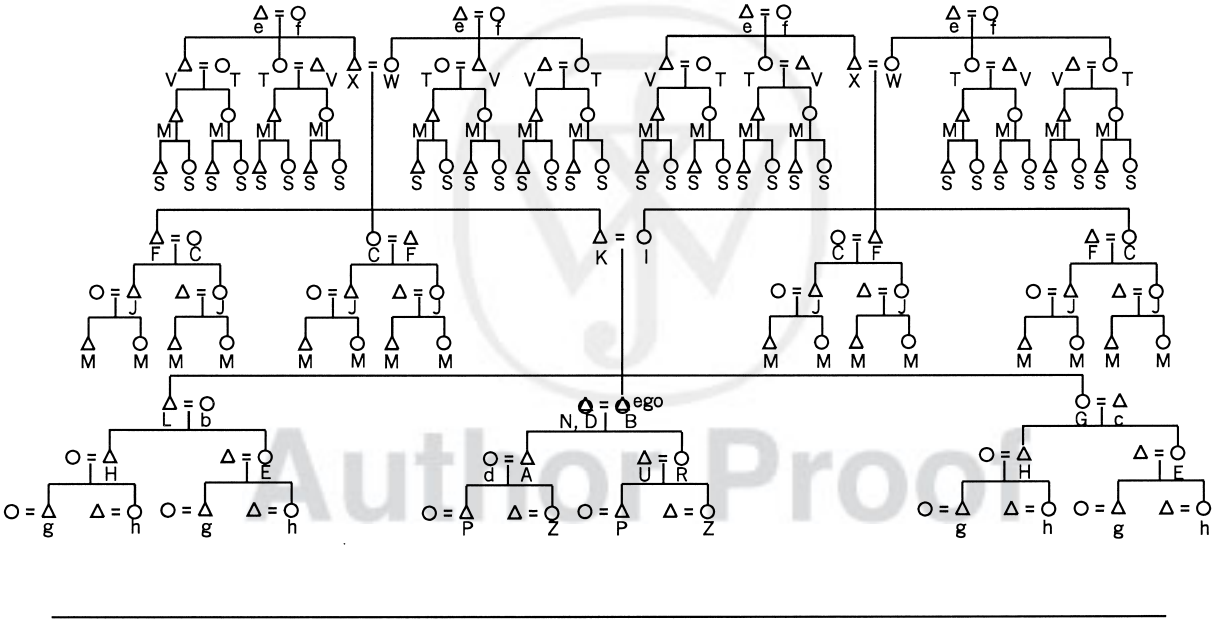
We use the algebraic model of the kin term map and this definition of a set product to generate the set of genealogical kin to whom any kin term can be applied by using the above mapping of the atomic terms to sets of genealogical kin and the translation of the binary product of kin terms into the product of the corresponding sets of genealogical kin. For example, the term Grandfather = Father of Parent = {father} × {mother, father} = {father of mother, father of father} = {mother's father, father's father}. Figure 11 displays the mapping of kin terms onto genealogical kin predicted by the algebraic model for the kin term map using the above instantiation of the atomic kin terms with regard to genealogical kin. Figure 11 is in complete accord with the proper usage of kin terms in the AKT expressed in terms of genealogical kin. This result also demonstrates that definitions of kin terms via sets of genealogical kin are derived and not primary constructs, as was mistakenly assumed in many previous formal accounts of kinship terminologies.

F11

Instantiation of Kin Terms

There is no formal reason to limit the instantiation of the atomic kin terms to genealogical kin. Other instantiations of the atomic kin terms can also give rise to consistent usage of kin terms. The instantiation of kin terms in a genealogical idiom serves to link one conceptual system kin relations to another conceptual system of genealogical relations (or "family trees"), but is not logically necessary. In the context of American culture an additional instantiation of the

FIGURE 11



A - Son
B - Self
C - Aunt
D - Wife
E - Niece
F - Uncle

G - Sister
H - Nephew
I - Mother
J - Cousin
K - Father
L - Brother

M - 1st Cousin Once Removed
N - Husband
O - 2nd Cousin Once Removed
P - Grandson
Q - 2nd Cousin Twice Removed
R - Daughter

S - 2nd Cousin
T - Great Aunt
U - Son-in-law
V - Great Uncle
W - Grandmother
X - Grandfather

Y - Mother-in-law
Z - Granddaughter
a - Father-in-law
b - Sister-in-law
c - Brother-in-law
d - Daughter-in-law

e - Etc. 1
f - Etc. 2
g - Etc. 3
h - Etc. 4
i - Etc. 5
j - Etc. 6

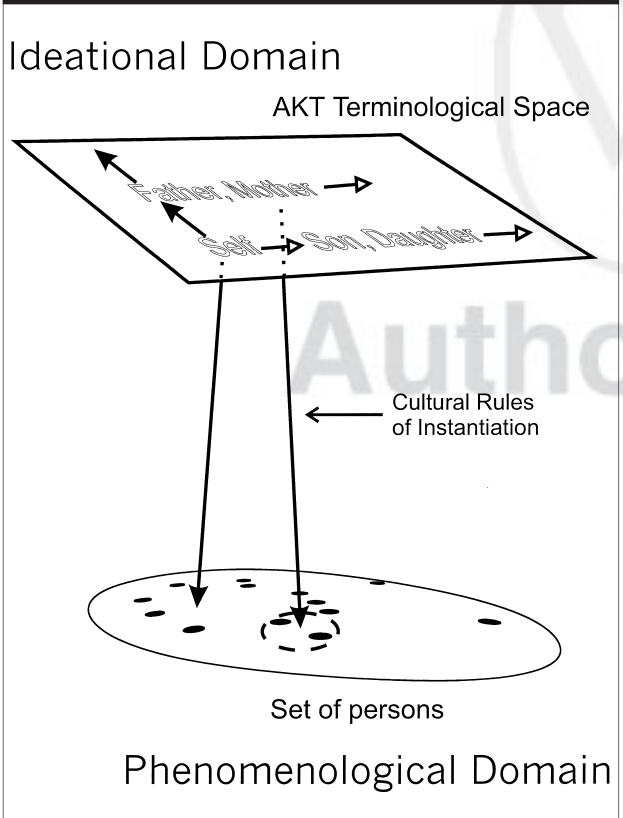
Female Person | Parent-Child Link
Male Person — Sibling Link
= Marriage Link

Predicted distribution of kin terms onto a genealogical grid.

atomic kin terms occurs through adoption because kin terms are applied to the adopted child in a manner no different than is the case for one's "natural" children. Another way in which the genealogical instantiation might be modified occurs when a previous instantiation is erased, such as has happened to the concept of an "illegitimate child." The "illegitimate child" concept formerly had instantiation in American culture, for example, through being an expression applied to the child of a woman who is not married. Today we accept the concept of a single parent family and a single woman may bear a child without the child being considered illegitimate by her relatives.

More broadly, by instantiation I refer to cultural rules that link the ideational domain with the phenomenological domain (see Figure 12). The mappings discussed above from kin terms to genealogical relations and from genealogical relations to actual individuals who are part of one's family tree is but one example of the process of instantiation. Other examples include the concept of "humanness" discussed previously. More generally, instantiation is a fundamental way whereby abstract, cultural concepts and constructs are given content and thereby linked to the phenomenological domain. In Table 2 are listed a variety of kinds of cultural constructs, their instantiation, and relevant patterns of behavior.

FIGURE 12



Associated with abstract, cultural symbols are rules of instantiation that link these symbols with persons.

Dual inheritance, with its focus on behavior, addresses primarily the right side of the table and presumes that an adequate accounting of patterning at the level of behaviors can be achieved through identifying structuring processes such as imitation and/or learning and the modality through which these processes operate, where that modality is understood as a consequence of natural selection. That imitation of behaviors takes place to some degree in this manner is undoubtedly correct; less obvious is the claim that all behaviors are a consequence of the structuring processes identified through dual inheritance and even less obvious is the presumption that these structuring processes are the basis for the properties in the left side of the table. Meme theory, in contrast, is either too powerful a theory by virtue of including everything listed in the table that is not behavior as a meme, or is inadequate as it only addresses "Unstructured Concepts, Ideas" [Item (3) in the first column of Table 2]. By atomizing all cultural phenomena as units to be included under meme theory, structure cannot be accounted for, just as gene theory does not, by itself, account for structure in the biological domain. Biological structures arise through a developmental process that cannot be reduced to merely specifying the genes involved in the developmental process. Further, the relationship between concept and behavior is only poorly addressed in meme theory, because behavior is not predictable just by knowing the concepts and ideas an individual may have stored in one's brain.

Similarly, a purely cultural theory that only addresses the leftmost column is inadequate for much the same reason. What people say they should do and what they actually do range from highly concordant in some cases to wide disparity in other cases. A theory of culture can encompass the structural aspects that are excluded in meme theory, but it is as problematic for addressing the full range of behaviors as dual inheritance is problematic for addressing the full range of what comes under the rubric of culture. In both cases the linkage between the domains of culture and behavior is not addressed even though, in many ways, this linkage, identified as Instantiation in Table 2, may be the most critical—and most difficult—part to understand. It is here that resolution of the conflict that inevitably occurs between behaviors arising out of one's identity versus behaviors arising out of one's assessment of the consequences of actions (as March [5] expresses it) must be adjudicated, both in terms of the interests of the individual and in terms of the interests of other individuals with whom one interacts. Adjudication can take place at the level of individuals and their behavior; it can take place at the level of instantiation through changes that take place in terms of rules of instantiation; or it can take place at the level of cultural constructs.

TABLE 2

Examples of Cultural Constructs, Instantiation, and Behavior

Cultural Constructs	Instantiation	Behavior
Abstract symbol systems	Rules giving content to abstract symbols	What individuals do or say
(1) Structures with an internal logic		
(a) Kinship terminology structures [67, 71, 72]	Rules for: Who is a parent? Who is a child?	Sperm donation; in vivo fertilization; surrogate mothers
(b) Primary genealogical space [61]	Genealogical tracing from ego to alter	Construct a family tree
(c) Binary Opposition	Concepts of Friend and Enemy[27]	Networks of friends and enemies
(d) Mediation Structures [76]	Zapotec wedding ritual [77]	Ritual activities
(e) Prescriptive marriage structures [78]	Australian section systems	Marriage networks; "corrections" made when marriages are of the right category
(2) Structures with an external constraint color categories [79]	Rules for order of appearance of color terms	Color distinctions made by individuals
(3) Concepts		
(a) Concept of human	Fetus becomes human at birth	Pro-choice activism
(b) Concept of genealogical father	Father is husband of mother	"Dreaming" by Australian aborigines; "Male sperm has no role in reproduction"
	Time Scale for Change	
Hundreds of years	Tens of years	Years

The time scales for these adjutications are of different orders of magnitude. Roughly speaking, adjudication at the level of behaviors has a time scale of years; adjudication at the level of instantiation a time scale on the order of tens of years and adjudication at the level of cultural constructs at the level of hundreds of years. If we apply the term evolution to the outcomes of these adjutications, then we must recognize that "cultural evolution" is not a single phenomenon and cannot be circumscribed by notions such as change in the phenotypic makeup of a population with behavior included as part of the phenotype of individuals. Instead, we need to distinguish among change at the level of cultural constructs, change at the level of instantiation of cultural constructs, and change at the level patterns of behavior, where the latter includes both behaviors arising out of ones identity as a cultural person and the actions one engages in as a biological person. In brief, human societies are complex, not so much because any single system within a human society is complex, but because we are capable of operating at levels ranging from purely individual to social and we draw on both our biological background that arose through genetic fitness and natural selection and our cultural background that we have constructed in terms of how we formulate the behaviors in which we engage. Our modeling of this complexity cannot be reduced to any single aspect of these different dimensions, but must take into account the way in which we are capable of shifting between very different modalities—biological and cultural—that affect and frame our experiences and behaviors as social organisms.

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ENDNOTES

1. If it is argued that the phenotypic expression of culture by some of the phenotypes becomes part of the environment of the other phenotypes and the first set of phenotypes affect the behavior and expression of cultural traits in the other phenotypes, then a Lamarckian, direct effect of one phenotype affecting the trait exhibited by another has been introduced, contrary to the sociobiology paradigm.
2. This view of culture also implies that culture is not unique to humans because transmittal of behaviors through a social context outside of the genome does occur with other organisms [16, p. 63].
3. Absence of cross-generation transmission also leads to evolutionary demise of the trait in the following generation. The interest, here, though is on processes that affect the frequency of a trait across generations.
4. Cavalli-Sforza and Feldman [23] recognize the importance of biological evolution on the form of the learning process they model (p. 74), though natural selection, according to them, only "*indirectly* controls the scope of choices made" (p. 342, emphasis added).
5. Yet even at the level of behavior there is ambiguity. Should a person be considered as "for abortion" on the basis of her/his stated beliefs about abortion, or should the classification of an individual be based on actions taken by the individual? What one believes and what one does need not be identical, especially with regard to matters as emotionally and psychologically charged as abortion.
6. Although the proponents of dual inheritance recognize the ideational level as well as the behavioral level, it plays a secondary role to behavior. In Cavalli-Sforza and Feldman's framework it is part of the process by which an individual is first aware of, and then accepts, a behavior to whom (s)he is exposed [23, p. 62], but for modeling purposes the ideational level is subsumed in the transmission probabilities for the nongenetic transmission of a trait. Though Boyd and Richerson are more explicit about culture as information stored in the brain and the way groups may differ because of differences in culturally transmitted ideas giving rise to different behaviors [29], nonetheless they fall back on behavior as the primary means by which a trait is passed from one individual to another.
7. The "population of units" view of culture is comparable to defining a language to be a population of words and to define change in language as change in frequency of words but ignoring the syntactic and semantic aspects of language. Both are inadequate.
8. Some authors (e.g., Blackmore [31, p. 27] and Higgs [41]) have focused on imitation in exclusion of other processes such as learning.
9. Two steps are postulated because one can "receive" external phenomena through the senses but not cognize what has been received, such as when one listens politely but one's mind is on other matters.
10. The latter feature occurs approximately with biological reproduction because only one of a pair of alleles at a locus is transmitted to an offspring. However, the biological feature is due to sexual reproduction and a closer analogy would be between a homozygous trait and a meme. For a homozygous trait every offspring must receive the homozygous allele from each locus associated with the trait.
11. Imitation could circumvent the problem identified here if one assumes that imitation only occurs between offspring and parent, but such a highly constrained form of imitation for human societies is not realistic.
12. Blackmore [31, p. 38] incorrectly asserts that Durham [12] uses the same fitness criterion for both biological and cultural traits.
13. One of the rationales for imitative behavior is that it shortcuts the cost of individual learning because the imitator need not evaluate the behavior in question, only the source of the behavior.
14. Though Durham [12] considered symbols in the sense "defined. . .by Gerhard and Lenski [47], to be any vehicle for the transmission of socially meaningful information" [12, p. 188] to be an alternative to a meme for a unit of culture, he rejected calling a cultural unit a symbol because of that term having substantial prior connotation. However, Durham's willingness to associate the term meme with, for example, milk-processing methods in different societies—what he calls "milk-processing memes" [12, p. 246]—suggests that the term, symbol, may also have been too confining for him.
15. One example of the problem with trying to recover the conceptual basis from behavior can be seen with kinship systems. Anthropologists have examined the relationship between differentiation expressed in kinship terms and in behavior. In commenting on this literature, Murdock concludes "all kinship terms are independent words, and as such are completely and thus equally different from one another. . .. The application of completely differentiated terms to incompletely and variably differentiated phenomena [i.e., behavior] results inevitably in a lack of strict comparability" [51, p. 109].
16. Although anthropologists have had variable views on the relationship of kinship as it is expressed in human societies to biological kinship, there appears to be a consensus view that kinship as it is expressed in human societies differs in some fundamental way from biological kinship. For example, a recent text comments "All human societies have kinship, that is, they all impose some *privileged cultural order* over the biological universals of sexual relations and continuous human reproduction through birth" ([52, p. 3, emphasis added]; see also Keesing [53] for a similar definition).
17. The cultural distinction being considered here is between what anthropologists call parallel cousins (cousins where the siblings in the parental generation are of the same sex) and cross cousins (cousins where the siblings in the parental generation are of the opposite sex). In a number of societies the persons the anthropologist designates as parallel cousins are not distinguished from siblings, whereas the persons designated as cross cousins may be central to prescriptive marriage rules regarding the appropriate kin relationship between two persons who are to be married. A further distinction is sometimes made between the two possible kinds of cross cousins (a cross cousin through one's mother's brother versus a cross cousin through one's father's sister), with the marriage rule linking a male ego to his mother's brother's daughter, whereas marriage with his father's sister's daughter would be considered incestuous. (Although it is convenient for a person outside of the culture to express the marriage rule in terms of genealogical connections, at a cultural level the rules are expressed using a kin term

for the category of kin for whom marriage is prescribed, not in terms of genealogy, and from one instance of marriage to another may involve spouses with very different genealogical connection.) The "mirror image" of this rule, namely prescribed marriage with the father's sister's daughter where the mother's brother's daughter would be considered incestuous, does not occur in any society. None of these distinctions among kinds of cousins has a counterpart with regard to genetic "cousins."

18. The use of ethnic distinctions in which one group identifies its place in the context of other group is relatively recent in human history (and a subject of interest in its own right as an example of cultural evolution).
19. Although modern state systems such as the United States are not defined in terms of kin groups, nonetheless one's identity as a citizen in the United States is determined primarily through the American cultural notion that there is a substance passed between parent and child [59], in this case "citizenship." Being born of an American citizen suffices to establish one as a citizen. The criterion for citizenship has been extended to persons born within the boundaries of the United States, but this appears to be a secondary and not a primary notion of citizenship as it is hedged by the means through which a woman happens to be on U.S. soil at the time of giving birth.
20. Although some terms such as Uncle can be given a definition such as {father's brother, mother's brother, father's sister's husband, mother's sister's husband} by most persons for whom the American/English kinship terminology is part of their cultural repertoire, it is less evident that we can easily give a complete, genealogical definition to a term such as cousin, especially when the term "cousin" is used for any kind of cousin and further distinctions such as first cousin, second cousin, and so on are not made. Nonetheless, as culture bearers, we know how to use the term, cousin, even if we are not able to provide a complete, genealogical definition of the term.
21. If ego (properly) refers to alter by a kin term K and alter (properly) refers to ego by a kin term L, then K and L are said to be reciprocal kin terms. For example, in the American kinship terminology if a man refers to a male child as son, then the male child refers to the man as father and so father and son are reciprocal kin terms for male speakers.
22. In view of the ambiguity surrounding the definition of a meme, it is not clear what would necessarily be considered a meme. On the one hand Durham [12] considered a symbol as a possible candidate for a "cultural unit" (p. 188), which suggests that each kin term is a "cultural unit" = meme, but on the other hand he considers a meme to include any "socially transmitted information, regardless of their form, size, and internal organization" (p. 189), which suggests that the entire kinship terminology could be a meme. However, calling the entire kinship terminology a meme contradicts the idea of memes as a construct analogous to a gene.
23. A semigroup consists of a set of symbols, S, and an associative binary product, o, defined over the symbols in S.
24. Other formalisms that have been used in the study of kinship terminologies are based on the assumption that kin terms are labels for already determined categories of genealogical kin (but the basis for determining those categories is not specified). These formalisms, such as componential analysis and rewrite rules, are descriptive formalisms and produce descriptive models, not theoretical models [23]. Rewrite rules are an example of what Chomsky [73] calls an unrestricted writing system and hence are not falsifiable.
25. By "genealogical father" and "genealogical mother" is meant the male person and the female person through whom one does genealogical tracing. In some cultures genealogical father may be the person purported to be the physical father of ego, but in other cultures the genealogical father may simply be the man currently married to the genealogical mother. In most, but not all, cultures the genealogical mother is the physical mother. Buchler and Selby [74] provide an example where the genealogical mother is not the physical mother.
26. In terms of matrices, if A is a row matrix and B is a row matrix, the $A \times B$ is the set of elements in the matrix product, $A^{\mathrm{T}}B$, where A^{T} is the transpose of the matrix A.
27. The concepts of Friend and Enemy are linked by the following rules": a Friend of a Friend is a Friend; a Friend of an Enemy is an Enemy; an Enemy of a Friend is a Friend; an Enemy of an Enemy is an Enemy. See Read [75] for a discussion of the alfebraic structure determined by these four rules.