CULTURAL CONSTRUCT + INSTANTIATION =

CONSTRUCTED REALITY

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Abstract: Standard scientific modeling uses a conceptual framework inadequate for modeling that is intended to take into account the implications of the capacity of individuals in human societies to reflexively assess goals, interests, statuses and the like. Standard scientific modeling is also insufficient for representing the shared, constructed universe -- which we subsume under the term culture -- within which individuals operate and the way individuals are capable of changing and restructuring their constructed universe. Standard scientific modeling partitions the modeling enterprise into a theoretic component (theory driven models) and an empirical component (data driven models), both assumed to be embedded within a single, fixed empirical universe. But the notion of a "constructed reality" implies that in addition to the external, empirical universe there is an internal, constructed universe within which behavior is both formulated and becomes the instrument of change. A new modeling paradigm is needed that takes into account these different dimensions of what constitutes behavior. In this paper I suggest that such a paradigm is provided through making a distinction between formal models of the logic of cultural constructs and the logic of the instantiation of the symbolic/abstract elements of those cultural constructs. An example illustrating this paradigm, based on the logic of a kinship terminology structure in comparison with the logic of the instantiation of a kinship terminology structure, will be discussed.

Figure 1 provides a schematic diagram of the basic elements that comprise scientific argumentation in the physical sciences. The bottom part of the figure (labeled "phenomenological") identifies the target of an argument to be phenomena whose existence neither depends on the observer nor on conceptualizations made about those phenomena. The conceptualizations made by the observer are part of the ideational domain as indicated in the top part of the figure. The underlying presumption is that phenomena consist of "stuff" (made up of natural units such as subatomic particles, atoms, molecules and so on) that has both form (the characteristics and properties of a unit) and pattern (the relationship of units to one another). Further, it is assumed that form and patterning arise through process(es) whose operation is extrinsic to, and independent of, the conceptual domain of the observer. At the phenomenological level the observer constructs data models ($Model_D$), which are part of the conceptual domain, to represent form and pattern as it is perceived by the observer. The confirmation of a $Model_D$ arises through public comparison of the patterning expressed in the model with the patterning observed in phenomena. That is, confirmation is subject to critique and disconfirmation by other observers. At the ideational level we hypothesize processes that could account for the form and pattern observed in phenomena and construct a theory that works out the expected form and pattern that would occur in a universe governed by the hypothesized process(es). In parallel with a $Model_D$ at the phenomenological level, we have a $Model_T$ at the ideational level that expresses the expected patterning as derived from the theory based upon the hypothesized process. Explanation can be viewed as a match (or isomorphism) between $Model_D$ and $Model_T$ (with the caveat that explanation dependents upon confirmation of the $Model_D$ as a representation of the patterning and form observed in phenomena) (Read 1992).

The first modification that we need to make of this basic schema for it to be applicable to human societies takes into account the fact that life forms have the property of reproduction, hence there is a feedback loop from the "natural units" back to the "natural units" based upon reproduction (lower left of Figure 2). Reproduction introduces yet another kind of structuring process that leads to patterning expressible via the frequency of units with specified traits. A $Model_D$ might be a frequency distribution table or a histogram of different traits in a specified population of "natural units." The usual hypothesized

structuring process for this pattern is natural selection and one way that process may be given a theoretical basis for producing patterning is through a theory of fitness maximization. One predicted pattern from fitness maximization are strategies called Evolutionary Stable Strategies (ESS) and a $Model_T$ for an ESS might be expressed as fixation of an ESS in a population, so that all "natural units" in that population would use an ESS. Comparison of the predicted frequency of the ESS trait against the observed frequency would be the basis for making an explanatory argument regarding the presence of a particular strategy such as an ESS in the population of "natural units."

This characterization of patterning at the phenomenological level can be represented schematically for the case of genetically based behaviors exhibited by the "natural units" as shown in Figure 3. Figure 3 identifies the main components that make up an evolutionary argument: first, an allele pool from which new individuals are formed via reproduction and to which they contribute via reproduction; second, a phenotype arising from the genetic makeup of the individual; third, the fact that the phenotype is affected by developmental and other processes that reflect environmental conditions; fourth, a feedback loop via fitness that affects the frequency of alleles in the allele pool, and fifth, a claim that many, if not all, behaviors can be accounted for within this framework, hence these behaviors are expressions of the phenotype. For those who take a behavioral definition of culture, cultural phenomena can be embedded in this schema as a particular class of behaviors that, allegedly, make up culture, thus are accounted for in the same manner as any other kind of behavior. This view of culture as having a fundamentally biological basis has sometimes been referred to as a sociobiology (Durham 1991:18-19).

Biological kin are introduced into this schema via inclusive fitness (see Figure 4). Assume individual 1 (phenotype 1) and individual 2 (phenotype 2) are related to each other as biological kin, hence have a common genetic ancestor. Inclusive fitness measures the incremental change in fitness (Δ fitness2) that occurs in phenotype 2 by virtue of a behavior done by phenotype 1 directed towards phenotype 2. From the perspective of phenotype 1, the fitness associated with the behavior is the sum of the fitness phenotype 1 directly accrues from doing the behavior plus a weighted contribution $w(\Delta$

fitness2) due to the incremental fitness that accrues to phenotype 2 through the behavior engaged in by phenotype 1. The weighting is usually assumed to be proportional to the genetic closeness of phenotype 1 and phenotype 2 (e.g., $w = 1/2$ in the case of full siblings). Inclusive fitness has been invoked to account for behaviors that reduce the fitness of the acting individual (phenotype 1) by seeing these as genetically based behaviors where the weighted, incremental change in fitness of phenotype 2 outweighs the fitness reduction phenotype 1 obtained from doing the behavior; that is, from the perspective of the allele(s) responsible for the behavior the net fitness of the allele(s) passed on by genetic descent from a common genetic ancestor for phenotype 1 and phenotype2 is positive. We can call this the primary form of inclusive fitness. The primary form of inclusive fitness addresses directly change in allele frequencies that underlie the posited behavior, such as altruistic behavior. Those who invoke inclusive fitness to account for social behavior sometimes use a secondary form of inclusive fitness wherein it is presumed that individuals are predisposed to act in a manner that increases inclusive fitness. The secondary form of inclusive fitness does not presume a specific allele underlying the behavior in question, but simply assumes that there is selection for behaviors that maximize inclusive fitness.

One aspect of behavior not accounted for within the genetic model of behavior is the transmission of a behavior from one individual to another through mechanisms such as learning or imitation (see Figure 5). The term *dual inheritance* has been used when transmission of behaviors is posited to occur in both a genetic manner and directly from one person to another (Cavalli-Sforza and Feldman 1981; Boyd and Richerson 1985). In this framework culture consists of those behaviors transmitted directly from one individual to another without recourse first to any supposed genetic underpinnings of a behavior; i.e., culture consists of socially learned behaviors (see Figure 6). The learning/imitation process is itself a behavior, but one that is presumed to be subject to modification via the basic genetic schema outlined in Figure 2. For example, imitation directed towards successful persons may increase one's fitness in a Darwinian sense by virtue of the fact that successful individuals have arrived at behaviors that do accrue greater fitness. But once the imitation mechanism is in place there is no reason to assume that imitation will only lead to imitation of behaviors that increase individual fitness. Instead, it is possible that

successful individuals may engage in behaviors that are not fitness maximizing and if the imitation process merely uses success in a general sense as a marker of a person who should be imitated, imitating the non-fitness maximizing behavior can increase the frequency of behaviors that reduce individual fitness (Boyd and Richerson 1985).

One of the important aspects of the dual inheritance models is the explicit introduction of social interaction as a critical process leading to the patterning seen in the kinds and frequency of behaviors. As illustrated in Figure 5, dual inheritance models would account for a second person exhibiting a behavior without the behavior arising through the conceptual apparatus that leads from stimuli by external phenomena to behavior of the second individual considered in isolation. By its definition, dual inheritance presumes that there must be at least dyadic interaction of individuals and the pattern of dyadic interaction will also affect the frequency distribution of traits passed from one individual to another through imitation. While the dual inheritance models use a notion of culture within the range of definitions that have been given by anthropologists as to what constitutes culture, the framework nonetheless focuses on what individuals actually do with imitation and/or learning the mechanism for direct transmittal of a behavior from one individual to another (Durham 1991:181). Absent from this framework is any form of communication that cannot be accounted for simply as an instance of a learning/imitation phenomenon. An example would be communication based on signs wherein it is the meaning of the sign that is being communicated and not the behavior associated with the act of signing.

Introduction of the idea of a sign also requires introduction of a cognitive apparatus that is both capable of encoding cognized information as a sign and decoding a sign that has been received as equivalent to what would have been the cognized information leading to the production of that sign (see Figure 7). The classical example of communication using signs among non-human primates is vervet monkeys calls that are not simply generalized warning cries but are specific to the kind of threat. Vervet monkeys who hear a threat-cry respond in a manner appropriate to the particular kind of threat. As illustrated in Figure 8, the process entails one individual encountering a threat, cognizing an appropriate behavior in response, such as fleeing, and simultaneously generating a warning cry, or sign, that in turn

signals to other individuals not merely that there is a threat but a specific kind of threat. In this case the second individual responds as if s(he) had seen the threat directly, hence the transmission is of a sign (which involves both encoding via the transmitter and decoding by the recipient) and behavior is transmitted indirectly.

Much of the scenario discussed so far could be encompassed within dual inheritance theory as learning is central to the vervet monkey behavior. But fitness, as discussed by Durham (1991) using the notion of memes, arises for the case of signs in a different manner than illustrated in Figure 6. While the concept of memes is vague and has been said to encompass virtually all concepts and ideas (Durham 1991, Blackmore 19xx), a more limited notion of memes as equated approximately with signs will be used here.

Durham attempts to address directly, following arguments by Keesing (1974), the notion that whatever is culture, it occurs at the ideational and not the phenomenological level. Durham argues for a process of cultural selection in analogy with biological selection and the mechanism he proposes is the evaluation of a meme by the recipient that leads to a decision either to "keep" the meme or to "discard" it (see Figure 9). The evaluation introduces what Durham calls cultural fitness via the person who is the potential recipient of the meme. Whereas dual inheritance would look to characteristics of the transmitter as an indicator of whether or not the potential recipient will receive the meme or not, the source of the meme is not critical under cultural fitness as it is the evaluation made by the recipient that determines whether the meme will be kept. To the extent that the recipient uses attributes of the transmitter to decide whether or not to accept the meme the argument is similar to dual inheritance. But cultural fitness need not be driven by transmitter features as the evaluation made by an individual need not be in reference to others who currently have the meme, but can be an evaluation made in terms of the individual's perception of the value of the meme to her(him) self. This can be seen in the way in which the response to a sign sent by a vervet monkey can shift when an individual repeatedly sends false signals; that is, other vervet monkeys learn to ignore the sign sent by the false signaler (Cheney and Seyfarth 1990). The imitation argument would require that the false signaler also be a non-successful individual, whereas the

evaluation argument only requires that potential recipients evaluate the sign being received and then decide to reject it based on prior experience with signs from that individual.

Although Durham recognizes the importance of the ideational/phenomenological distinction for cultural constructs discussed by Keesing (1974), Durham treats the notion of a cultural construct as if it can be treated as a single entity -- a meme -- and transmitted as a unit to be evaluated by the recipient for acceptance or rejection. This simplification ignores the fact that a cultural construct is not a "unit" but may well be a symbolic system with a structural form for the system arising out of the logic underlying the formation of the cultural construct. Further, the idea that cultural constructs are selectively evaluated by the recipient as to whether the cultural construct will be "received" ignores the whole process of enculturation as a way of ensuring that newly born individuals will become "culture bearing" members of the social group into which the newly born individual is being incorporated.

We can illustrate the problem identified here with the cultural construct known as a kinship terminology. This will lead to hypothesizing yet another aspect of the mental features of modern *Homo sapiens* that fundamentally restructures the relationship between an individual and his/her social, cultural and material environments. The argument will draw heavily upon prior research by the author (Read 1984, 1990, 1999, 2001a, 2001b, 2001c, Read and Behrens 1990) on the structural form of kinship terminologies viewed as a symbolic system.

A key concept is the notion of a kinship terminology as a symbolic structure whose structural form can be generated from a core set of symbols, structural equations, and various rules for introducing particular features into the symbolic structure. This differs from the received view of kinship as genealogical with a terminology providing a classification of possible genealogical positions. The notion of kinship as genealogical in origin goes back to Morgan in terms of kinship theory and explicit identification of kin terms as being secondary to genealogy goes back to Rivers (1924). Rivers rejected the possibility of kin terms as delineating one's kin on the grounds that kin terms are definable genealogically as in statements such as "an uncle is either a mother's brother or a father's brother or the husband of a mother's sister of the husband of a father's sister". Not realized by Rivers (and by

subsequent theorizing that has presumed genealogy expressed in the form of the genealogical grid to be the primary definition of what constitutes kinship) is the fact that these are not primary definitions of kin terms but the consequence of mapping kin terms viewed as an abstract symbol system onto the genealogical dimension that Rivers took as the primary dimension of kinship.

Distinguishing a cultural construct as an abstract symbol system requires that the abstract symbols and the structural relations in the symbol system be given concrete content in the usage of the abstract symbol system. The term *instantiation* has been introduced by Read (Read and Behrens 1990; Read 2000, 2001a) to identify the logic and process of providing content to an abstract symbol system so as to make it possible to move from the conceptual domain of culture to the phenomenological level of behavior. Instantiation is very similar to Bourdieu's notion of the logic of practice, but differs by making it explicit that instantiation is part of an overall framework consisting of three essential components: cultural constructs (ideational/conceptual domain), behavior (phenomenological domain) and linkages between cultural constructs and behavior (instantiation rules). The linkages among these three components are shown in Figure 10 for the simple behavior act of one individual (ego) identifying another individual (alter) as one's grandfather. Three components involved are (1) the cultural construct known as a kinship terminology, (2) a behavior ("He is my grandfather") and (3) instantiation that links the world of concrete individuals to the abstract symbols of a kinship terminology via (in this example) instantiation of the primary symbols of the kinship terminology using the concepts of genealogical father, genealogical mother, genealogical son and genealogical daughter (Lehman 2001, Read 2001a) that are the basis of genealogical tracing. It should be noted that genealogical parent (mother or father) and genealogical child (son or daughter) are not the genitor and genetrix used as the basis of the genealogical grid, but are culturally specified persons through whom genealogical tracing is recursively used by cultural bearers to construct a linkage from one person to another. Although in some cultures genealogical tracing may be based upon genitor and genetrix viewed as the presumed physical father and physical mother, this is not a universal property of cultures and requires confirmation for a specific culture as argued by Schneider (1984). Other cultures do not make a distinction between presumed

genitor and genetrix and other relations such as *pater* and *mater*; e.g. for the Inuit of Repulse Bay Maxwell (19xx:nn) has argued that for them “adoptive relationships are considered both ‘real’ and genealogical”.

In Figure 10 these components appear as (1) a $Model_T$ for a kinship terminology (in this case, the American/English Kinship Terminology, or AKT -- left side boxes and bottom center boxes in Figure 10), (2) the conceptual basis for genealogical tracing (middle box, Figure 10), (3) instantiation between the generating terms of the AKT and the basis for genealogical tracing (horizontal arrows marked "instantiation" going from the center box) and (4) a group of persons that includes ego and alter (rightmost collection of dots). It should be noted that there are two forms of instantiation involved in this example. First there is the instantiation of the generating terms for the AKT, which are symbolic symbols, in the form of the basic concepts upon which genealogical tracing is based (namely genealogical parent, genealogical child, spouse) and second there is the instantiation of those concepts in terms of actual persons (namely a person is identified as ego, another person identified as alter and a genealogical path from ego to alter constructed based on recursive use of the concepts of genealogical parent). Each of these components will now be discussed in more detail.

First, genealogical tracing. The output of genealogical tracing is a genealogical diagram of individuals showing how they are linked through recursive identification of an ego's genealogical father, genealogical mother, etc. The genealogical diagram is a $Model_D$ and displays the pattern of linkages among individuals based on the culturally specified notion of who is considered to be a genealogical parent, child or spouse. It differs from a pedigree as the latter represents the genetic connections among individuals and a genealogical diagram has no necessary relationship to a pedigree. While the form of the genealogical diagram arises from phenomenological events of reproduction, it is based upon a logic of tracing that specifies what kinds of tracing are permissible and what kinds are not, hence has associated with it a conceptual basis for its implementation as discussed by Lehman and Witz 1974. The recursive application of genealogical tracing from a person to that person's genealogical father and genealogical mother is shown in the boxed set of dots in the upper right of Figure 10. In this example the boxed set of

dots indicates that one has traced from ego (open circle) to alter (open circle) via two steps of genealogical tracing.

The second component, and the more complex one, consists of the kinship terminology viewed as an abstract system of symbols. The symbols are the kin terms elicited from informants and the "system" part of the set of symbols is the way that the kin terms are linked to each other as symbols. The linkages among symbols is established by the way culture bearers determine kinship relationships through constructing an argument of the form "If I call X by such and such a kin term and you call X by such and such a kin term then you are my ____", where the blank would be the kin term used by one person for the other person. For example, Sahlins (1962:155) in his discussion of Moala kinship notes that "… [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*, while 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" (emphasis added). Parkin (1996: 94) comments that "[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" and a partial list of examples of this kind includes the Shipibo (Behrens 1984), the !Kung san (Marshall 1976), the Karo Batak (Sigarimbun 1975: 147) and the Etoro (Kelly 1974: 69).

In effect, culture bearers are using kin terms as a kind of kinship calculation in which kin terms have understood relationships to other kin terms as kin terms and without recourse, first of all, to genealogical specification of the linkage of ego to alter (let alone a specification based upon a presumed, universal, genealogical grid with an underlying logic (Andrade 1970, Read 2000) assumed to be universal). The calculation may be expressed more formally as a product of symbols via the following definition of a *kin term product*:

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 Mother and alter$_1$ refers to alter$_2$ as Father, ego (properly) refers to alter$_2$ as Grandfather, hence Father o Mother = Grandfather (read "Father of Mother is Grandfather"). Note that this is not a statement about genealogical relations as Father, Mother and Grandfather are kin terms and no statement 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" (1990: 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, only the term(s) that is deemed by the informant to be the consequence of this kind of kin term calculation.

A kin term map (Leaf 1971, Read 1984) is constructed that displays the linkages among kin terms established via taking kin term products with a set of kin terms that are the atomic (irreducible) kin terms for the kin term map. More than one kin term map can be constructed for the same terminology, depending upon the choice of the atomic terms. For example, one might use the kin terms Mother, Father, Son, Daughter, Husband and Wife as the atomic terms for the AKT, or alternatively one might use the kin terms Parent, Child, and Spouse as the atomic terms. A kin term map for the AKT based upon the

latter choice of atomic terms is shown in Figure 11. The motivation for this choice of atomic terms arises out of a $Model_T$ for the kin term map viewed as a $Model_D$ (see below).

The kin term map expresses informant cultural knowledge. The kin term map is bounded in that repeated queries based on the above definition of a kin term product will either result in another kin term, the reply that there is no kin term (such as would occur if one were to ask someone for whom the AKT is part of one's cultural repertoire about the kin term used by ego for $alter_2$ when ego refers to $alter_1$ as parent-in-law and $alter_1$ refers to $alter_2$ as parent) or a pattern of repeating kin terms would be elicited and the form of the kin term map is terminology specific. No universal form of a kin term map is presumed and in fact different terminologies have different structures as illustrated by the kin term maps for the AKT, the Punjabi (Leaf 1974), the Shipibo (Read and Behrens 1990; Read 2000), the Trobriand (Read and Behrens 1990), among others.

The kin term map is a $Model_D$ as it represents the cultural knowledge of a culture bearer and displays the pattern implicit in that cultural knowledge and drawn upon when responding to questions about kin term products. A natural question to ask is whether or not the structure displayed in a kin term map has an underlying logic that permits it to be generated from a few, atomic symbols, structural equations that indicate when certain kin term products can be reduced to other kin terms (such as the kin term product Spouse of Parent can be reduced to the kin term Parent in the AKT) and rules about structural properties; that is, to ask if a $Model_T$ can be constructed isomorphic to the $Model_D$ represented in the form of a kin term map?

The answer to this question is critical to our understanding of what constitutes a cultural construct such as a kinship terminology. If the kin term map can be isomorphically represented as a $Model_T$ then the kinship terminology has a structure that must be considered as a whole and not as an historic accumulation of terms as has been implicitly, if not explicitly assumed in most theorizing about kinship terminologies. In these arguments some features of a terminology are isolated and a claim is made about those features without considering how the isolated features are part of, and embedded in, a structure with an underlying logic to its form. For example, Schneider (1980) considered the "in-law" suffix that

appears on some of the kin terms in the AKT and presumed the lack of terms such as "Uncle-in-law" for a person related to ego by marriage to a consanguineal Aunt to be an inconsistency in the AKT that required explanation by reference to properties from outside of the terminology. Similarly, arguments about conjunctive versus disjunctive definitions of kin terms based on genealogical definitions of kin terms have presumed that kin terms can individually, or perhaps in sets such as sibling terms, be formulated as part of a terminology without considering the terminology to be a logically integrated system of symbols through which features of particular terms, such as sibling terms, arise.

The systemic character of a kinship terminology can be identified by determining whether or not it is possible to model the kin term map as a structure composed of related symbols (kin terms) comprising a structural form that can be generated from a few, non-reducible symbols based on a binary product of symbols (the kin term product) and structural equations satisfied by the binary product, and rules that introduce locally defined, but globally expressed, structural features. Unlike formalisms such as componential analysis and rewrite rules that relate features of kin terms to a presumed, universal genealogical grid and for which the formalism is descriptive, hence always applicable regardless of the structural form (see Read 2000 for a detailed critique of rewrite rule analysis), not all structural forms can be modeled in the form of a generative structure. In other words, the claim that a kin term map has a structural form that can be generated is falsifiable. On the other hand, success in modeling the kin term map as a generative structure identifies the kin term map as a system of symbols for which local properties need to be considered as arising through the logic underlying the structural form and not as properties introduced independently of their implications for the overall system of which they are a part

The formalism of a binary product defined over a set of (abstract) symbols captures the sense of the kin term product applied to a set of symbols taken to be the kin terms of the kinship terminology. The kin term product is associative, hence the appropriate formalism for modeling the kin term map is that of an algebraic construct known as a semigroup. A semigroup is based on (1) a set, *S*, of symbols, (2) an associative, binary product, o, defined over the set *S* of symbols (that is, for each pair of symbols, *s*, *t* $\hat{I}$ *S*, the binary product maps the pair of symbols *(s, t)* to another symbol in *S* that can be denoted by the

expression *s* o *t*, where the order of the symbols in the binary product is important) and (3) structural equations satisfied by the binary product that give the resulting structure its particular form. For the case of the AKT, the set of symbols are the kin terms of the AKT, the binary product is the kin term product, and the structural equations are determined through analysis of the kin term map.

Work to date on a variety of terminologies (American/English, Shipibo, Trobriand, Punjabi, Fanti, Read 1984, Read and Behrens 1990, Read nd) strongly suggests that the form of a kinship terminology structure is based on a relatively limited number of procedures for building more complex structures from simpler structures. Accordingly, the analysis of a kin term map proceeds by first reducing the map to a simpler form that can be modeled isomorphically as a semigroup (the *base algebra* for the terminology) and then expanding the base algebra by reversing the structural modifications made during the simplification procedure. The reduction step is based first on removing affinal terms (defined as terms that can only be reached from the focal term(s) for a kinship terminology (see Figure 12 and Read n.d. for a definition of a focal term) by use of a kin term product based on a spouse term). This reduced kin term map is further simplified either through use of the concept of structural equivalence (two nodes in a kin term map are structurally equivalent if the pattern of arrows arriving at or leaving one of the nodes is matched by the pattern of arrows arriving at or leaving the other node, hence the two nodes can be "collapsed together" in a manner consistent with the pattern of arrows in the kin term map for these two nodes) or through separating out the kin terms of a single sex, including terms without sex marking.

For the AKT, the reduced kin term map is obtained through structural equivalence that collapses together Father with Mother, Grandfather with Grandmother, etc; Aunt with Uncle, GreatAunt with Great Uncle, etc; Son with Daughter, Grandson with GrandDaughter, etc.; Brother with Sister, Nephew with Niece, etc. The structure of this simplified kin term map can be generated from a semigroup based on two atomic symbols (call them *p* and *c*), an identity symbol (call it *i*) and a structural equation $pc = i$. This structural equation also causes the symbol *c* structurally to be the reciprocal of the element *p* and vice versa (see Figure 12). Affinal symbols are introduced through adding another symbol, call it *s*, and structural equations that give s the properties of an affinal term (such as $ss = i$, or in interpreted form

"spouse of spouse is self", where "self" is the term ego would use to refer to him/herself) and the equations satisfied by *s* when products are taken with *s* and other symbols, such as $sp = p$ (see Figure 12). Sex marking of symbols is introduced via a rule stipulating when a symbol will be bifurcated into a pair of sex marked symbols (see Figure 12). Lastly, the cousin terminology for the AKT in the form of an "*i*th cousin *j* times removed" is introduced via a rule stipulating which of the cousin terms will be made identical to each other (see Figure 12).

The algebraic structure generated by the grammar for the AKT given in Figure x is shown in Figure 13. This structure is isomorphic with the kin term map for the AKT (Read 1984, Read and Behrens 1990), hence the kin term map for the AKT is a structure that can be generated. The complete specification of the way the kin term map can be generated, that is, the grammar for the AKT, is given in Figure 12. Some of the nodes in Figure 13 are marked with their isomorphic kin term equivalents. Of particular note is the affinal subspace determined by the grammar (lower left part of Figure 13) which corresponds precisely to the kin terms with an "-in-law" suffix and the "uncle/aunt node." Separated from this affinal subspace and part of the "consanguineal" structure are the "Uncle/Aunt" nodes. The latter shows the same pattern for linking the pair of sex marked nodes (pair of nodes within the ellipse encompassing this pair of nodes) as is true for the "parent node"; that is, the algebraic analysis demonstrates that "spouse of uncle is aunt" and "spouse of aunt is uncle" in parallel with the fact that "spouse of father is mother" and "spouse of mother is father". In other words, the fact that the AKT does not use an "-in-law" suffix to produce terms such as "uncle -in-law" or "aunt-in-law" is not the anomaly presumed by Schneider and others, but simply demonstrates the way in which the kinship terminology is consistent with the logic expressed in the grammar for the kinship terminology.

The symbols of the algebraic analysis do not contain within themselves the information needed to apply them to concrete instances. The structure shown in Figure 13 is abstract, hence there must be instantiation of the abstract symbols for this symbolic structure for it to have semantic content, as discussed above. Whereas the logic of the grammar cannot be modified without affecting the associated structure, rules of instantiation can be modified or changed without modification of the structure of

abstract symbols for which the rules provide semantic content. Further, there may be more than one instantiation that is possible and any instantiation is subject to cultural change.

Formalisms such as componential analysis and rewrite rules have implicitly used an instantiation of kin terms based upon a genealogical grid. These formalisms have erroneously taken the instantiation of kin terms via kin type definitions as if the genealogical instantiation of a symbol embedded in the structure generated in accordance with a kinship terminology grammar *is* both the definition of the meaning of a kin term and provides the basis for understanding how one kin term is related to other kin terms. In effect, these formalisms have confounded syntax with semantics and have assumed that there is a single, universal instantiation in the form of kin types applicable to all kinship terminologies. But there is no reason to presume, as argued by Schneider (1984), that the genealogical grid is a universal conceptual structure that is part of the cultural repertoire of all societies. The genealogical grid of kin types is not "natural" and does not represent the process of genealogical tracing whereby one individual may construct a genealogical linkage between him/herself and another person based upon recursive use of a culturally specified genealogical father and genealogical mother (see Lehman 2001, Read 2001). Nor is the genealogical grid consistent with terminologies for which kin terms include an "older"/"younger" distinction such as *tuwa* and xxx in the Trobriand terminology, where the latter are terms that may be glossed as "older same sex sibling" and "younger same sex sibling."

What does appear to be universal (Lehman 19xx) is the process of genealogical tracing. Genealogical tracing only depends upon recursive use of the concept of genealogical father and genealogical mother (in the ancestral direction), genealogical son and genealogical daughter (in the descendant direction) and genealogical brother and genealogical sister (in the horizontal direction, including a possible relative age distinction such as genealogical older brother versus genealogical younger brother). Genealogical tracing, however, does not allow for unconstrained recursion in that genealogical tracing allows for tracing upward, or tracing downward, or tracing upward and then downward, but not tracing downward and then upward (see Lehman and Witz 1974).

The instantiation of the generating symbols in the algebraic structure produced via the grammar

given in Figure 12 may be extended, via the binary product, to the other symbols in the structure shown in Figure 13 (see Read 2000 for details). When the generating symbols are given instantiation in terms of kin types and the logic of this instantiation is then carried out for the other symbols, a "definition" of each symbol in the form of kin types is produced. The consequence of this particular instantiation of the generating symbols may be displayed with the usual kind of genealogical diagram used to display the usage of kin terms as elicited from informants. The result of so doing is shown in Figure 14 for the AKT. Figure 14 is a *predicted* mapping of kin terms onto the genealogical structure. The mapping is based on the algebraic structure given in Figure 13 and the instantiation of the symbols *i*, *p*, *c* and *s* via $i \rightarrow$ {ego}, $p \rightarrow$ {*fa*, *mo*}, $c \rightarrow$ {*so*, *da*} and $s \rightarrow$ {*hu*, wi}, where *fa*, *mo*, *so*, *da*, *hu* and *wi* are the kin types father, mother, son, daughter, husband and wife, respectively. It may be seen by inspection of Figure 14 that the predicted "definitions" of kin terms in the language of kin types is precisely the set of genealogical definitions that have been assumed by theorists from Rivers on to be irreducible and primary. Figure 14 makes it evident that these definitions are neither irreducible nor primary but derivative, hence formalisms such as componential analysis and rewrite rules (and variants on these) that have assumed a genealogical definition of kin terms as the primary data upon which analysis of a kinship terminology should proceed are based on an erroneous assumption.

Rather than presuming that a genealogical specification of kin terms are the primary data and the kinship terminology a derivative phenomena (in the sense that the terminology is assumed to provide semantic labels for already existing classes of kin types), we can allow instead for two separate, but interrelated conceptual structures. One is the kinship terminology, a cultural construct based upon its own logic expressed, in the case of the AKT, by the grammar presented in Figure 12. The other is genealogical tracing based upon a cultural specification of who is identified as genealogical father, genealogical mother, genealogical son, genealogical daughter, etc. and a logic of tracing as outlined by Lehman and Witz (1974). Identification of two constructs provides us with a more complete understanding, as outlined in Figure 10, of the way a cultural construct such as a kinship terminology provides not only the basis for conceptualization by individuals of their relatedness as kin, but also the

means for transforming one person's conceptualization into another person's conceptualization (see Figure 15). In Figure 10 two instantiations are involved. First, the instantiation of genealogical tracing as the way to determine a genealogical connection between the person identified as ego and the person identified as alter. Second, instantiation of the kin terms using the concepts involved in genealogical tracing. The connection between these two conceptual systems, illustrated in the genealogical diagram in Figure 10, enables a specification using one conceptual system to be translated into a specification using the other conceptual system. Thus if alter is ego's father's father, the logic of the terminological structure when instantiated using genealogical tracing identifies the proper kin term to be used by ego for alter is the kin term, Grandfather. Conversely, if one knows that the kin term Grandfather is used by ego for alter, then a potential genealogical tracing from ego to alter would be that alter is ego's father's father. The term "potential" is used here purposefully since the calculations of the kinship terminology structure can be carried out without first using the genealogical tracing construct, as illustrated by the quotation from Sahlins given above. Similarly, one can construct genealogical tracings without involving kin terms. This implies that the instantiation of kin terms using the concepts upon which genealogical tracing is based only partially expresses the manner in which kin terms may be instantiated. Instantiation of kin terms can involve sets of persons outside of genealogical tracing; e.g., adopted children, or persons inconsistent with genealogical tracing, such as same sex marriages in which one person is identified as the "wife" and the other as the "husband". Instantiation of kin terms is neither determined by features of genealogical tracing nor limited to properties that can be expressed within the conceptual structure of genealogical tracing. Instead, instantiation is by cultural consensus as to who is encompassed within the range of a kin term when it is applied to concrete individuals.

Whereas signs primarily enable one individual to convey to another individual information specific to a sign by means of transmitting the sign, the kinship terminology not only determines the culturally constructed kin relations of different alters to ego, but also makes it possible to transform the kin relation recognized by one ego for an alter into the kin relation that would be recognized by a different ego solely by reference to the conceptual structure and the relationship of the two ego's to each

other (see Figure 15). In effect, the terminology structure not only constructs a world of kin from the viewpoint of each person, but worlds of kin that are mutually translatable from one to another, hence constructs both a global and a local reality of how the domain of kin relations is constituted. Instantiation represents the ways in which the abstract symbols of this structure are given content.

Unlike a genetic system the cultural system and its instantiation is changeable by the cultural bearers. Both a cultural construct and its instantiation are subject to modification by the cultural bearers, though modification has different constraints in the two cases. Modification of a cultural construct made in accordance with an internal logic or grammar is constrained by changes consistent with that logic (such as the introduction of the "ith cousin j times removed" terminology or its later reduction to a simplified form) or by reformulation of that logic or grammar. Modification of instantiation can be term specific, hence is amenable to local changes within the structure that need not have global ramifications. Change of a cultural construct or of its instantiation is endogenous and can be purposeful (such as the push for same sex marriages as a new kind of instantiation of the American cultural construct of marriage), hence is similar to the Lamarckian notion of change in order to be better adapted, whereas genetic change is exogenous and is not purposeful. This implies that fitness, whether genetic or cultural, is insufficient as a mechanism for understanding cultural change. Change must also take into account purposeful change directed towards achieving specific goals. In Figure 16 change in cultural constructs and/or instantiation of cultural constructs through behavior is included explicitly as a means by which cultural constructs and/or instantiation may change.

Figure 17 illustrates changes that need to be made in Figure 2 to accommodate the notion of cultural constructs and instantiation. Hypothesized processes at an ideational level now include both processes that relate to instantiation and to the form of cultural constructs. At the phenomenological level, the additional complication is introduced that the ideational level of culture is also part of the phenomenological level in that the individuals of a society are culture bearers, hence their ideational/cultural world is part of the phenomenological domain from the viewpoint of scientific theorizing. Both instantiation and modification of a cultural/conceptual system occur at the

phenomenological level, hence the "units" of the phenomenological domain are much more complex in human cultural systems as the units of the cultural/conceptual domain must be included and these are subject to modification either in consequence of conditions external to individuals or in consequence of the interrelationship among cultural constructs. For example, the shift from a primarily kinship terminology based marriage system among native Australians to a marriage section system in which the kinship system is no longer needed for its ongoing operation involved change in conceptual units at the phenomenological level. Figure 17 provides a way to resolve the problem posed by the sociologist James March in a lecture given as the 1999 Jacob Marschak Memorial Lecture, UCLA. Prof. March summarized contemporary theories, models and analyses of human groups by observing that

> "There are two great contending visions of how human action is to be interpreted. The first vision sees action as driven by a logic of consequences in which alternatives are assessed in terms of two guesses - a guess about the probable future consequences of action and a guess about the probable future feelings an actor will have about those consequences when they occur. The second vision sees action as driven by a logic of appropriateness in which actors seek to fulfill identities by matching actions to situations in ways that are appropriate for an identity that the actor accepts."

Under his first vision would come models that focus on conditions external to the individual and take the individual as a constant, such as occurs with rational choice and optimization models. Under his second vision modeling must accommodate both the internal, underlying conceptual structures for the identities the actor can take on and the process by which identities are taken on. Prof. March did not resolve the contrast he posed. The features of the phenomenological level in Figure 17 suggest that the contrast is real and relates to a basic aspect of human societies, namely that the phenomena to be explained are simultaneously phenomenological and ideational.

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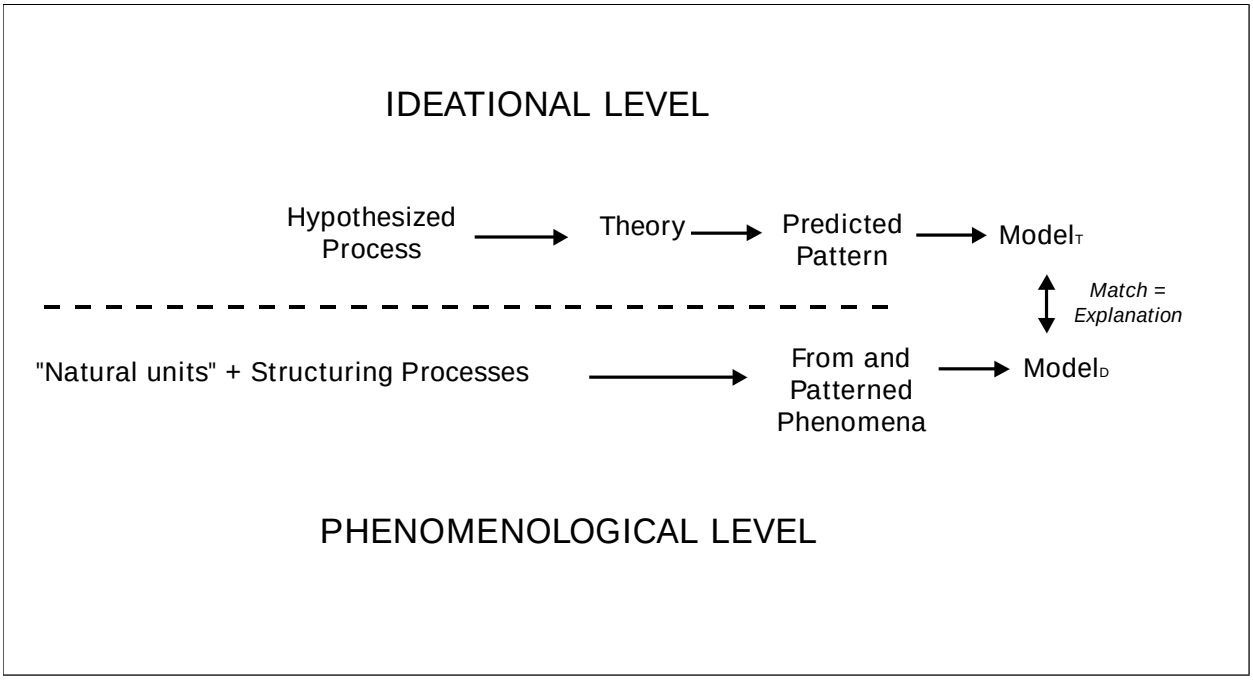


Figure 1: Schematic diagram of scientific discourse. Discourse occurs at two levels: phenomenological/descriptive and ideational/theory directed.

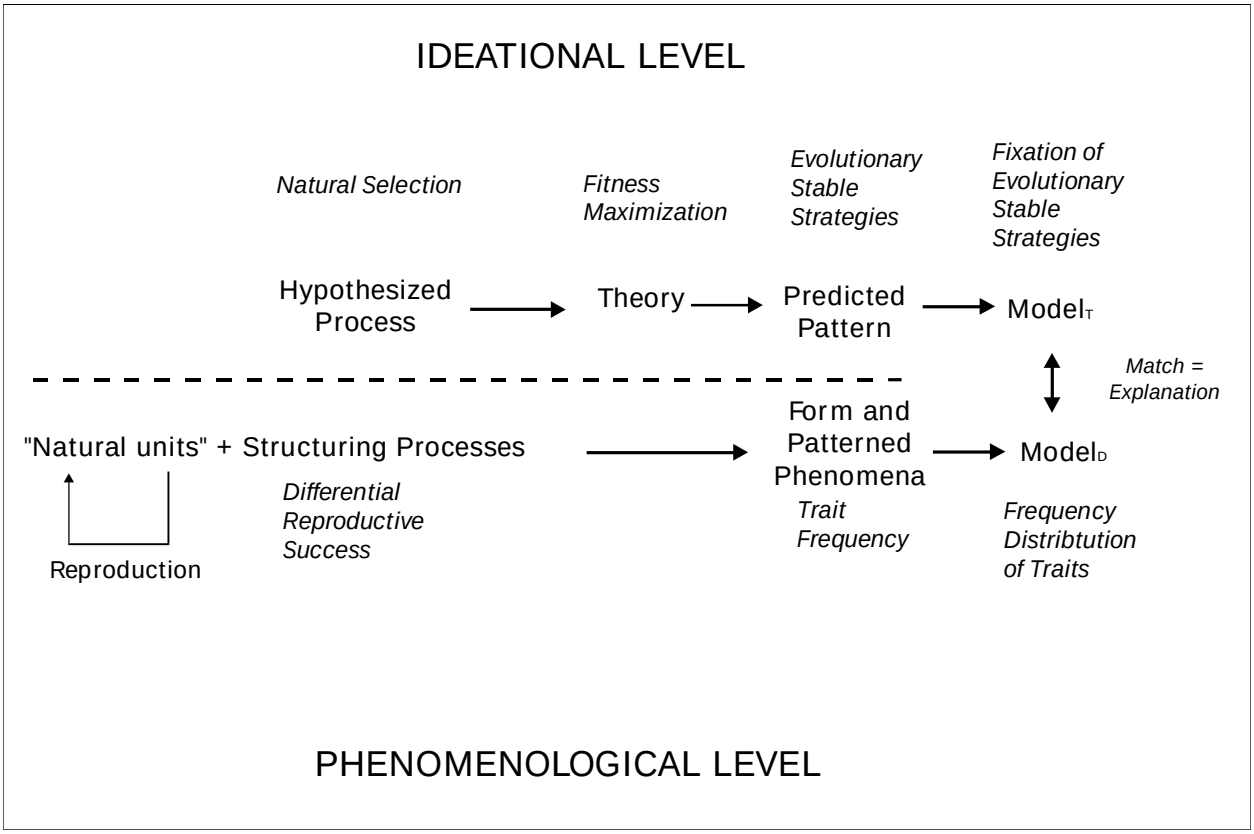


Figure 2: Addition of biological reproduction scientific discourse to include living organisms in the domain of discourse. Differential reproductive success a primary phenomenological process and fitness maximization as an illustration of theory construction.

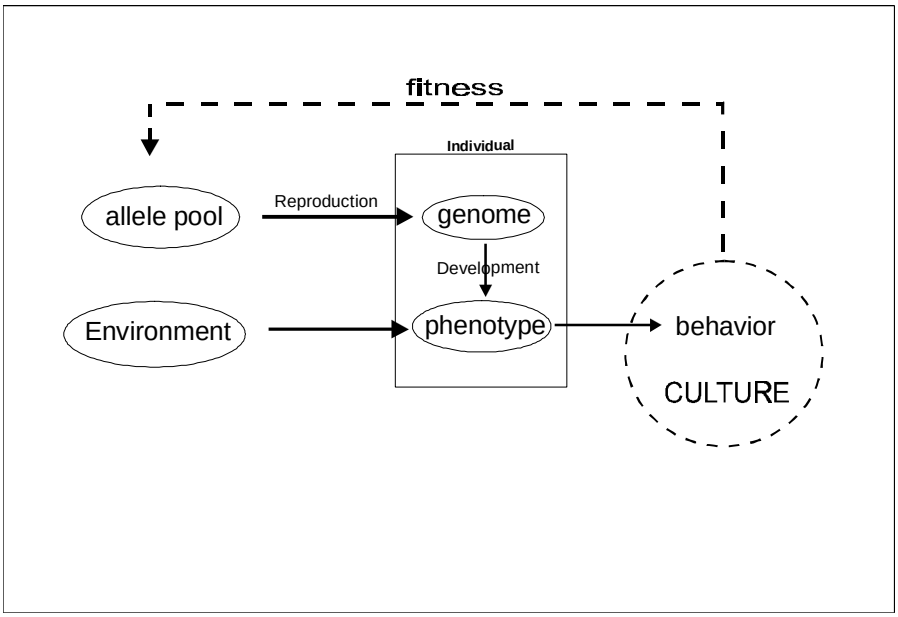


Figure 3: Schematic diagram of the relationship between individual/phenotype and behavior with the latter assumed to encompass the domain of culture.

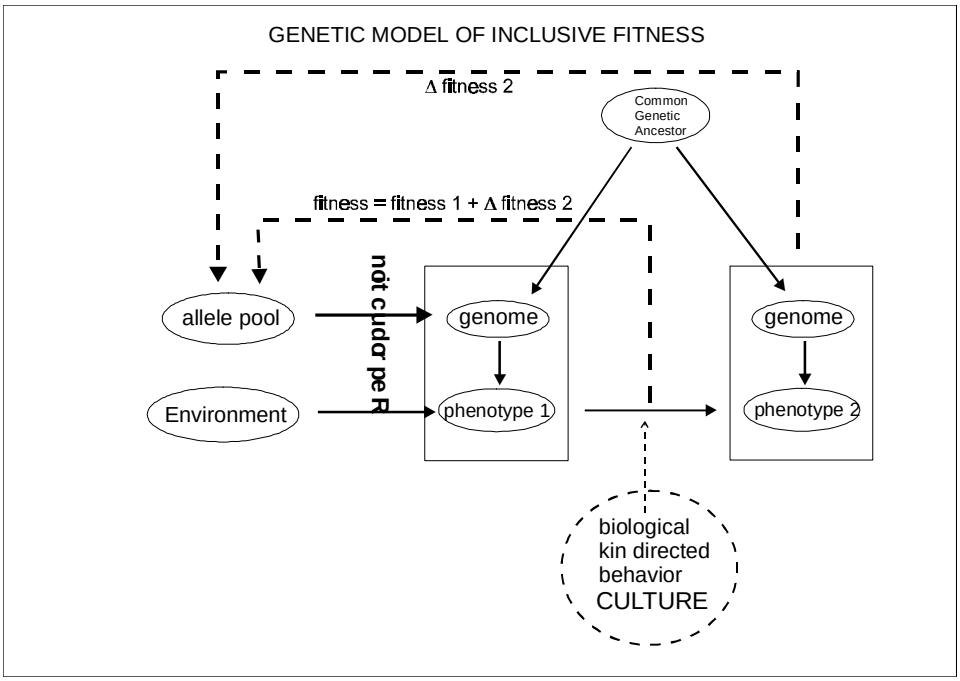


Figure 4: Expansion of Darwinian fitness to inclusive fitness introduces genetic relatedness as a component of the schematic diagram.

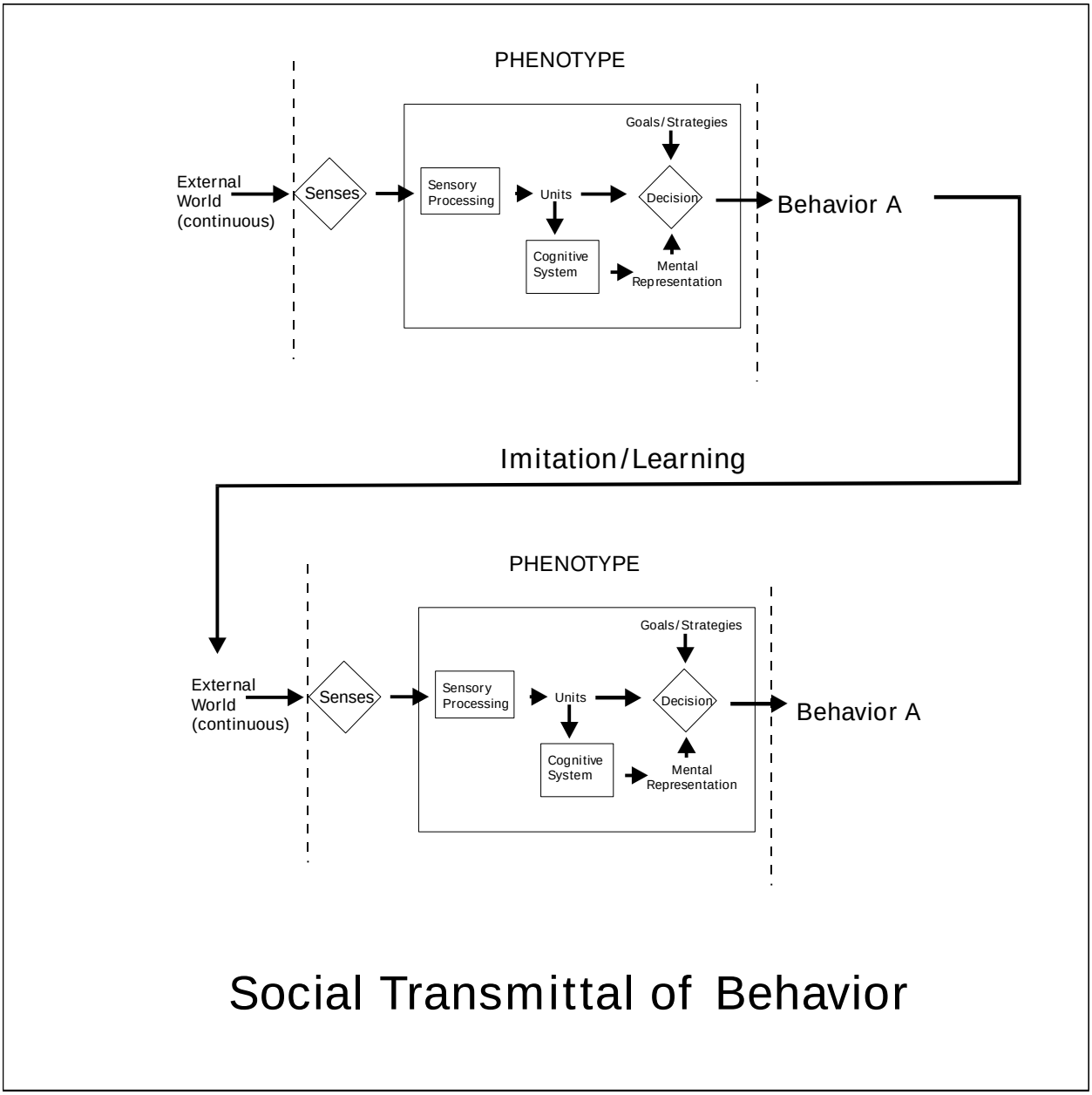


Figure 5: Schematic illustration of non-genetic transmittal of a phenotypic characteristic via imitation/learning.

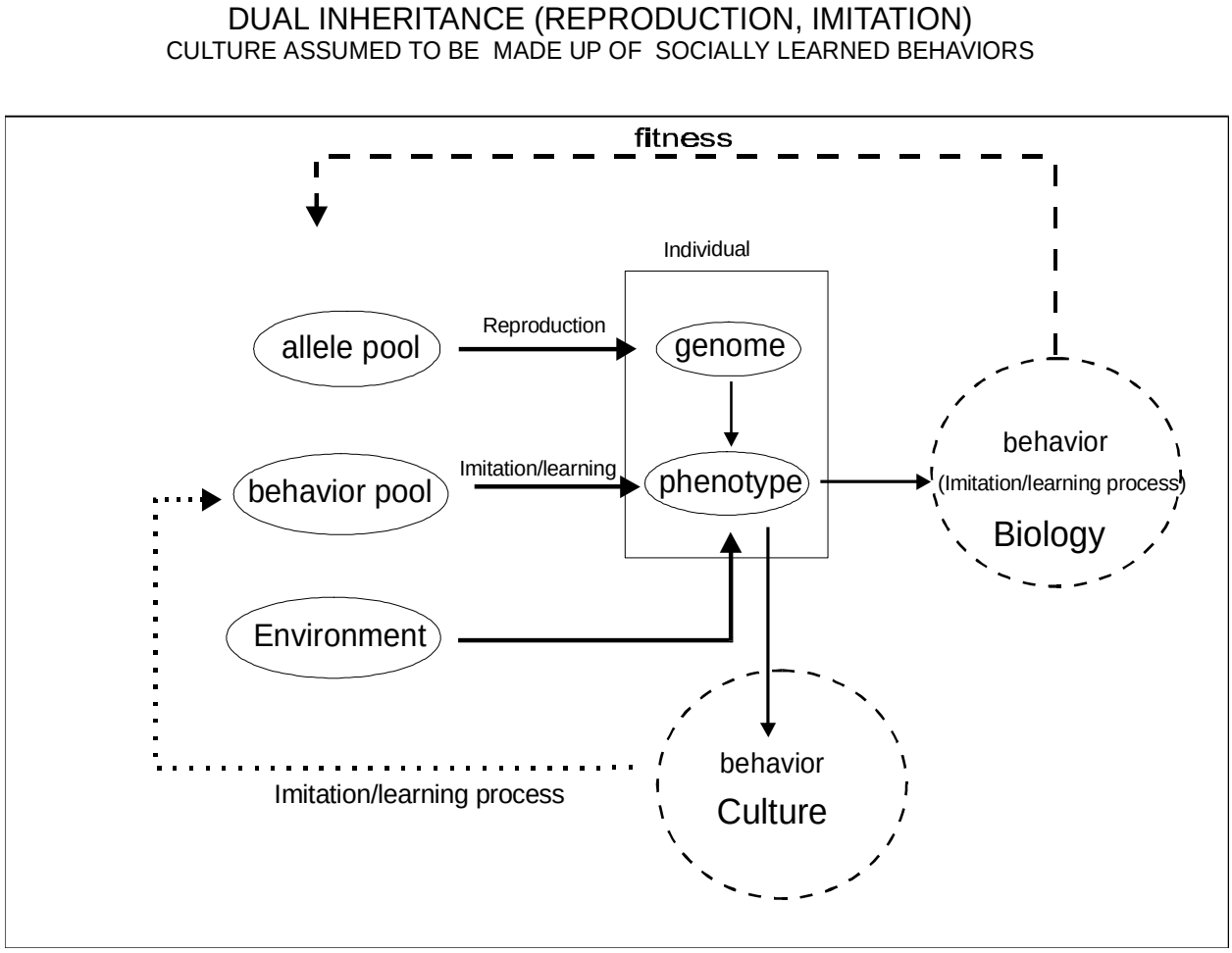


Figure 6: Schematic diagram with a distinction between culture as behaviors that are transmitted via learning/imitation and behaviors with a biological basis (dual inheritance model).

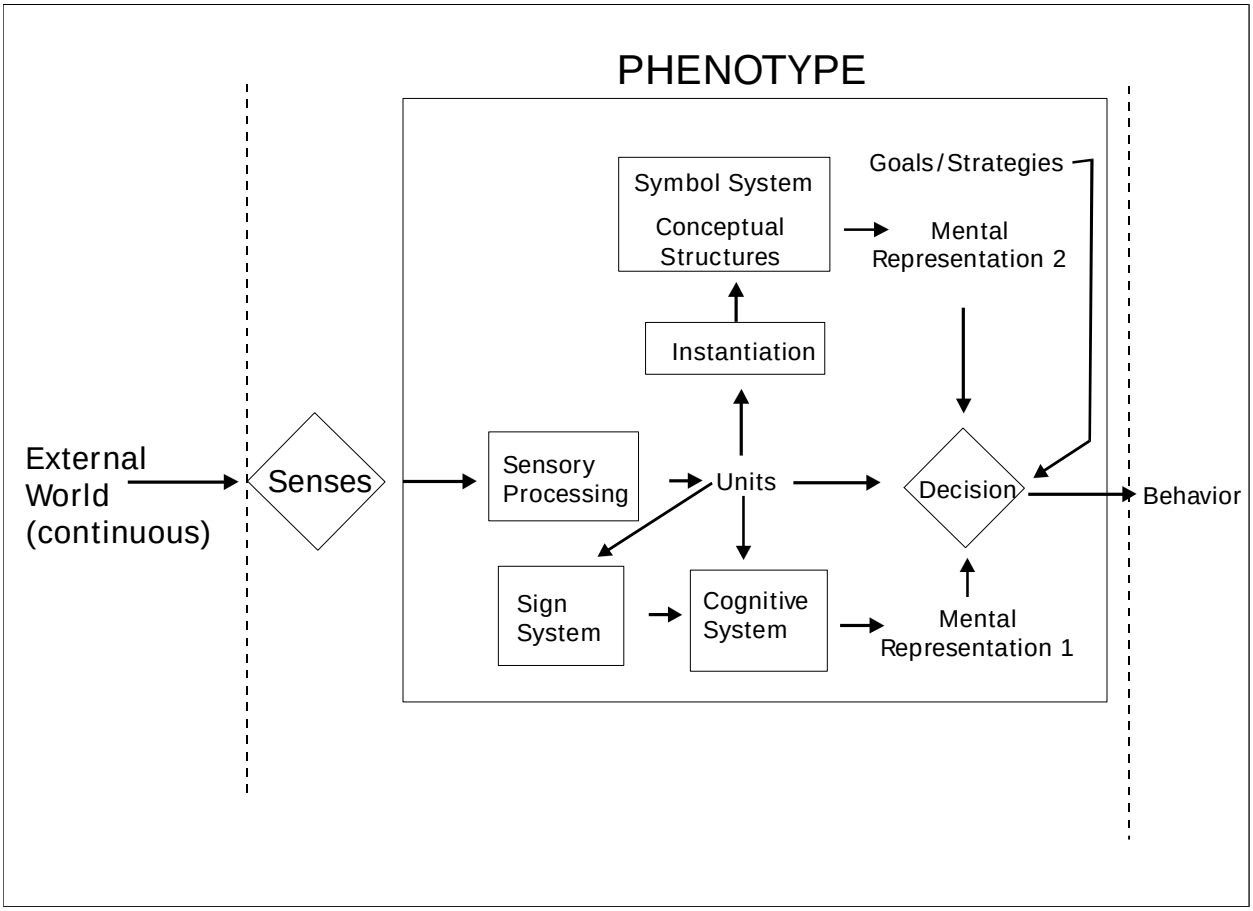


Figure 7: Schematic diagram of cognitive processes beginning with stimuli from the external world that are input versus an organism's senses and ending with behavior as an output of the phenotype. The cognitive system includes the capacity to generate and to make sense of signs as inputs to and from the external world.

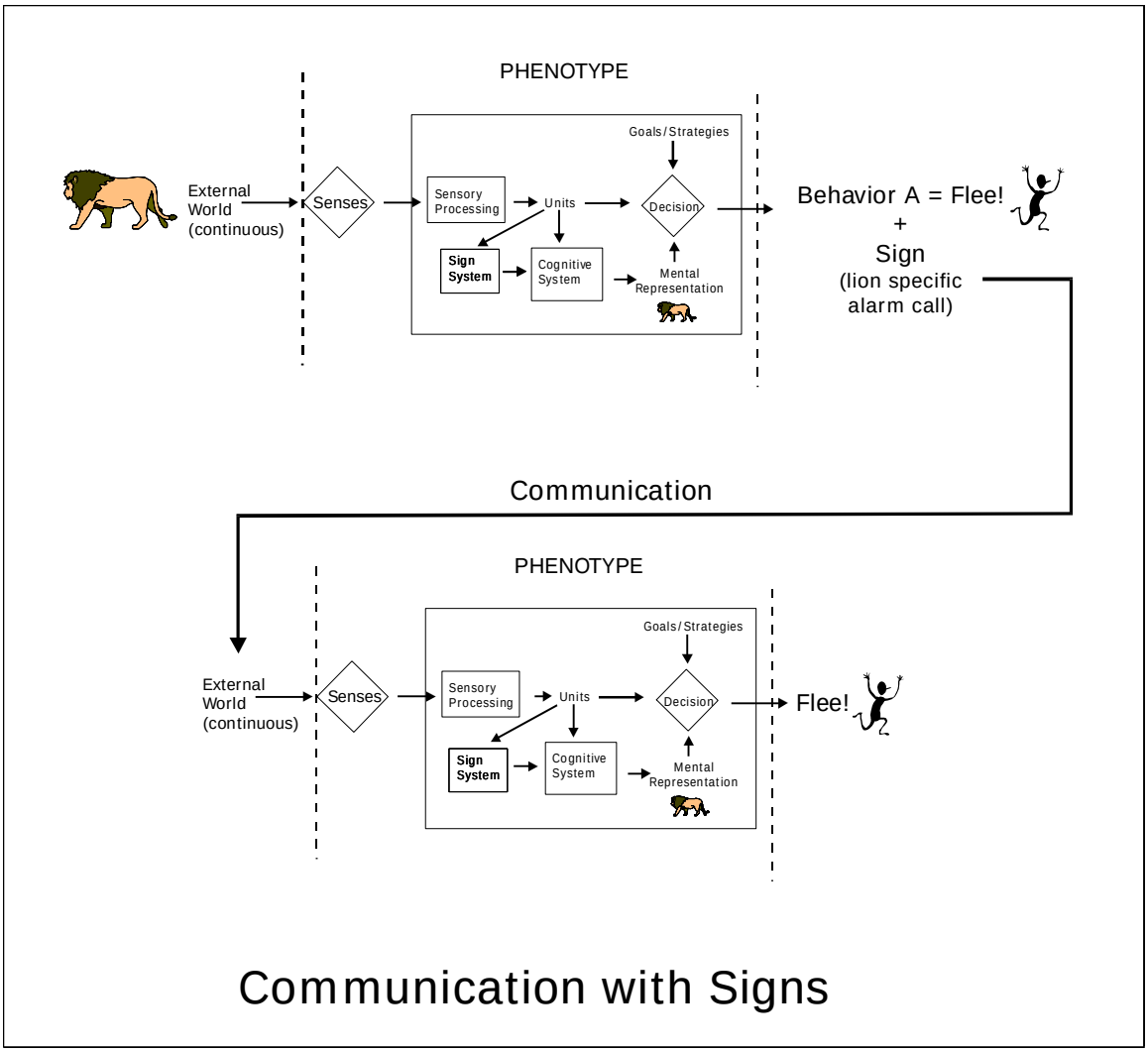


Figure 8: Schematic diagram illustrating the way in which communication with signs introduces a level of communication from one phenotype to another that is not easily accommodated within the dual inheritance model of imitation/learning. The image of the lion in the cognitive processes is merely intended to be a shortcut way of indicating that the external image of a lion has an internal representation based upon the way the brain processes visual imagery. Individual one (top phenotype) induces in individual two (bottom phenotype) a behavior appropriate for the stimuli seen by individual one but for which individual two only has the sign "sent" from individual one to individual two.

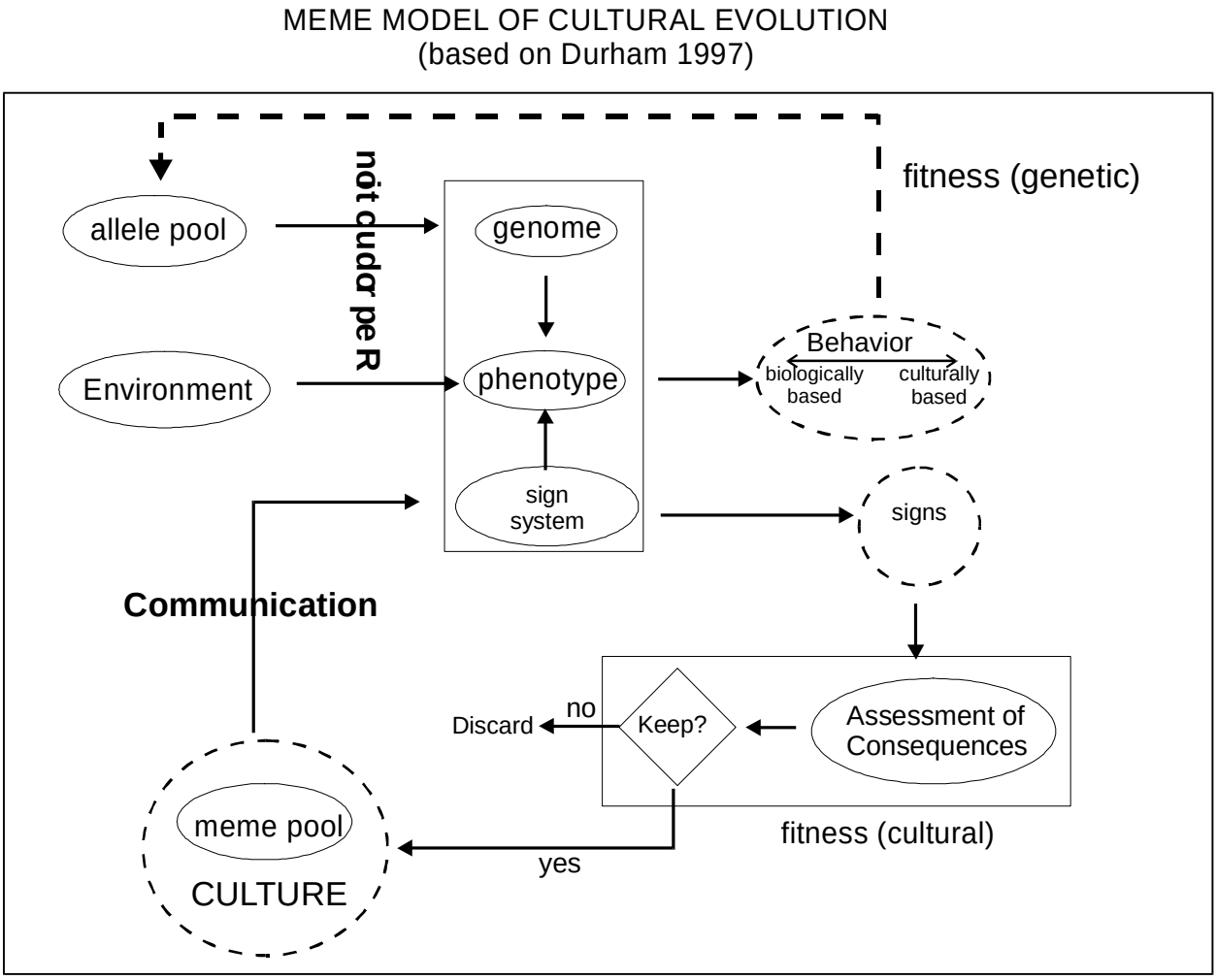


Figure 9: Schematic diagram based on the idea of memes/signs. Memes/signs can be accepted or rejected by the recipient, thereby introducing cultural fitness in parallel with biological fitness. Unlike dual inheritance, memes/signs are acted upon by the potential recipient and evaluated as to whether or not the meme/sign should be "accepted" by the potential recipient of the meme/sign.

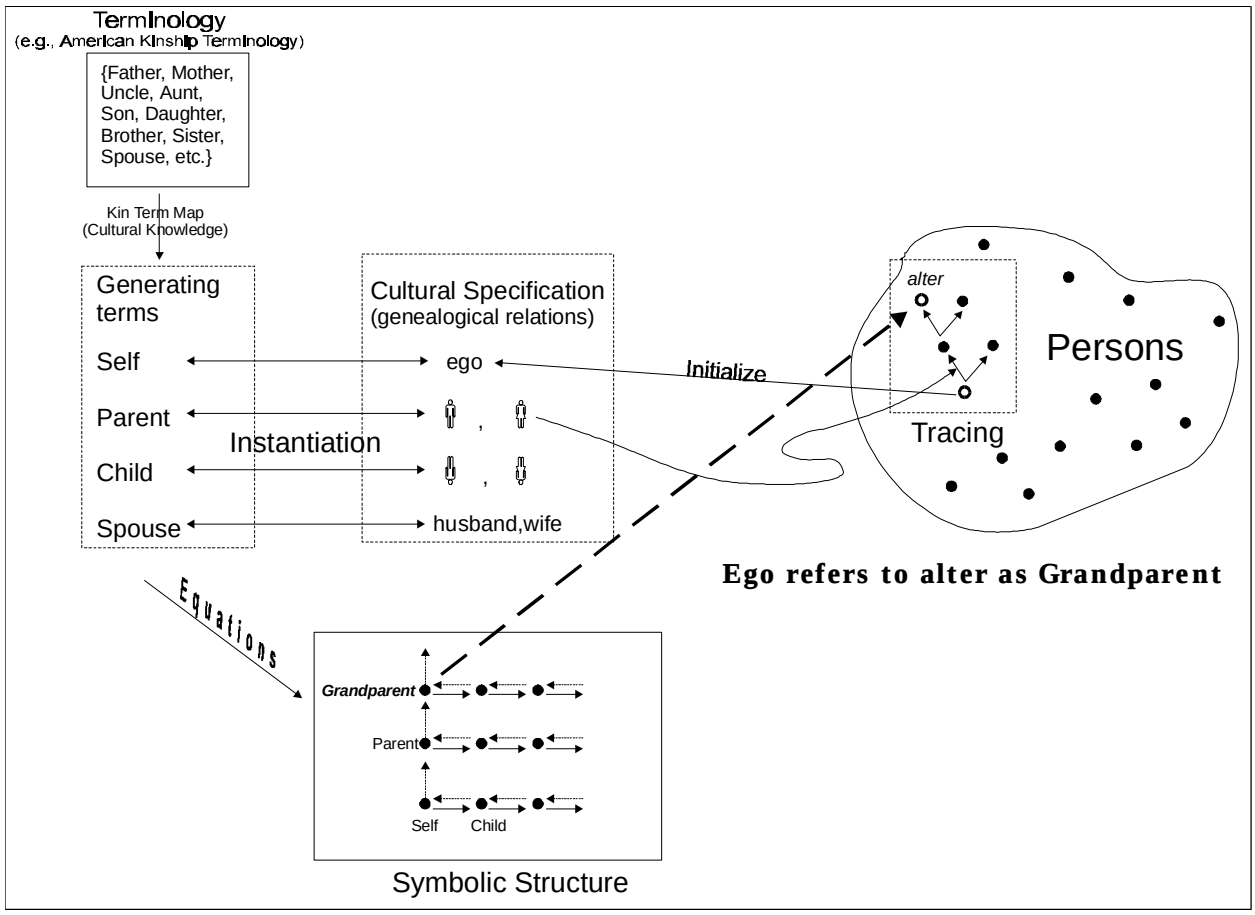


Figure 10: Schematic diagram illustrating the interconnection between two cultural constructs: (1) kinship terminology (upper left) and (2) genealogical tracing (middle). Instantiation links genealogical tracing to concrete individuals (persons identified as ego and alter). Separately, instantiation links the kinship terminology to genealogical tracing through instantiation of the generating symbols of the kinship terminology using the basic concepts (genealogical father, genealogical mother, etc.) upon which genealogical tracing is based.

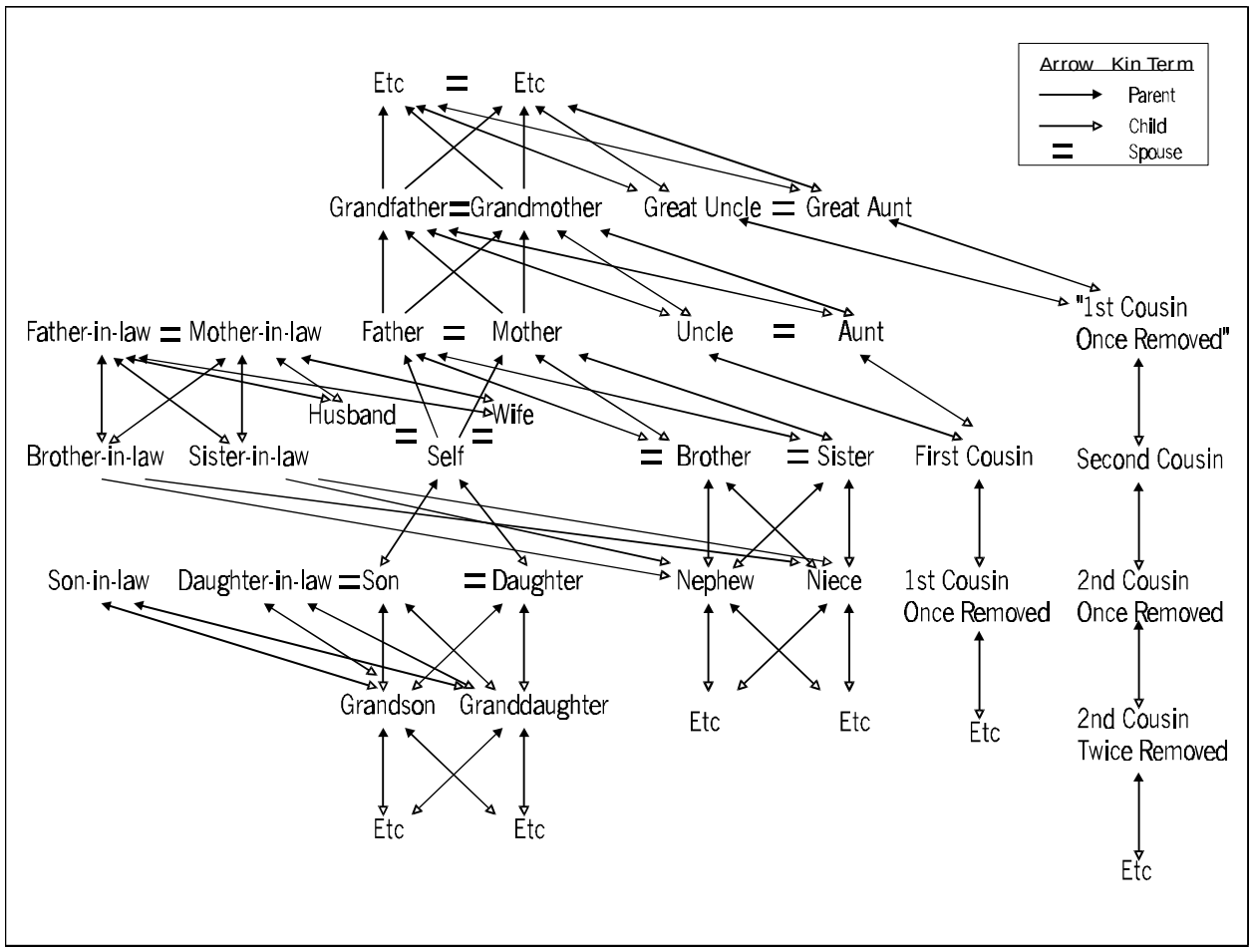


Figure 11: Kin term map for the American Kinship Terminology. Upward arrows represent the result of taking kin term products with the kin term, Parent. Downward arrows represent the result of taking kin term products with the kin term, Child. The "=" sign represents the result of taking kin term products with the kin term, Spouse. The nodes labeled with Etc. indicate that the map continues using the same pattern as displayed in the immediately preceding nodes.

Grammar for the American Kinship Terminology

Let $S = \langle S, o \rangle$ 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: $(xy)(xy) = xy$

Theorem: If S has an identity element, i and $xy = i$ then x is a reciprocal for y and y is a reciprocal for x.

Proof: First, $(xy)(xy) = (i)(i) = i = xy$ and so x is a reciprocal for y. Second, $(yx)(yx) = y(xy)x = y(i)x = yx$ and so y is a reciprocal for x.

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: The symbol p has as its reciprocal the symbol c and vice versa.

Proof: $(pc)(pc) = ii = i = pc$. $(cp)(cp) = c(pc)p = cp$.

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)
(4) $sp = p$ ($cs = c$) (Spouse of Parent is Parent; Child of Spouse is Child)
(5) $pps = 0$ ($scc = 0$) (Grandparent of Spouse is not a kin term; Spouse of Grandchild is not a kin term)
(6) $psc = 0$ (Parent of Spouse of Child is not a kin term)
(7) $scp = cps$ (Spouse of Sibling is Sibling of Spouse)

Let S^* be the semigroup with the element s added to the base algebra for the AKT.

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.

Figure 12: Grammar for the American Kinship Terminology (AKT).

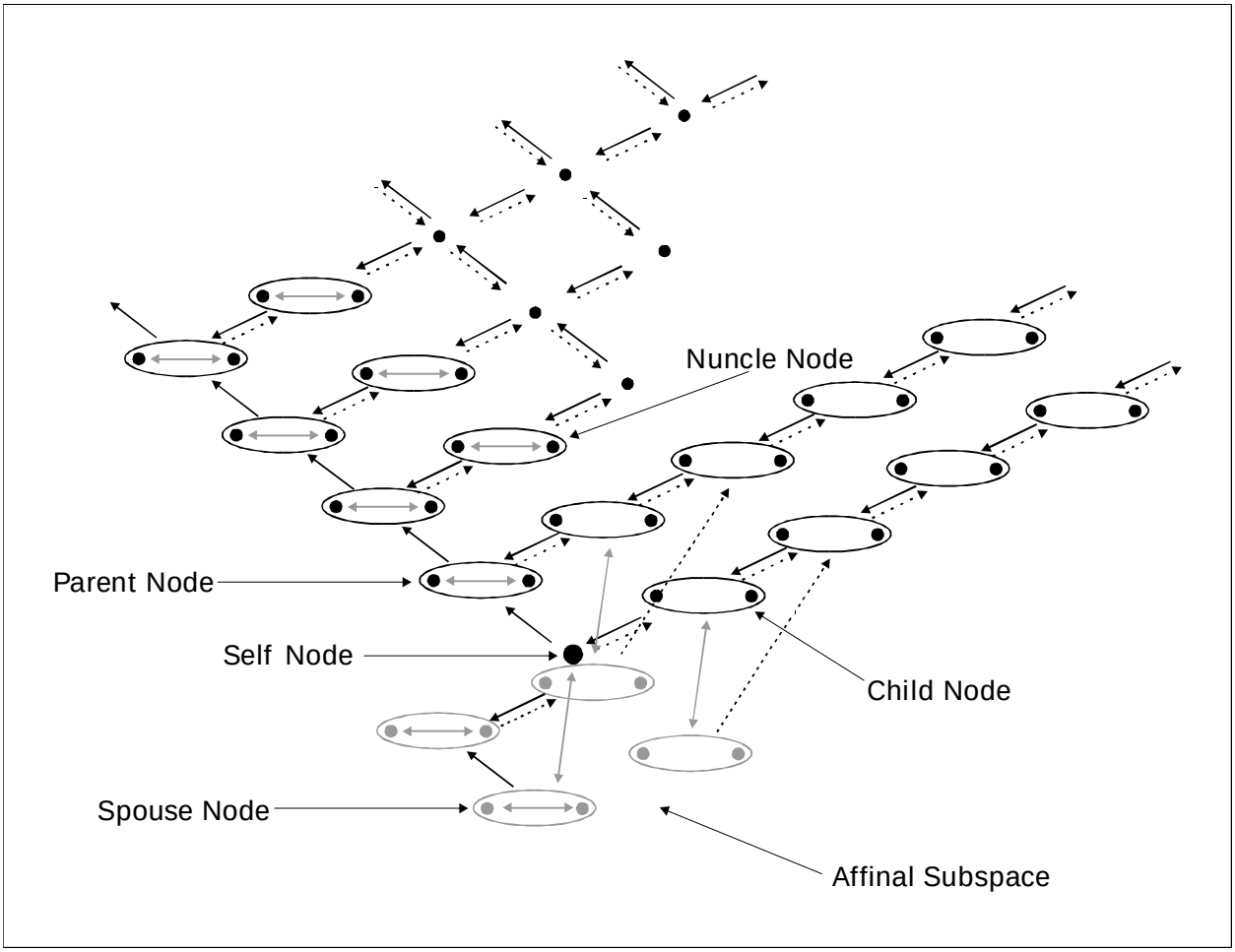


Figure 13: Graph of the algebraic structure isomorphic to the kin term map for the AKT. The nodes for the generating symbols, Self, Parent, Child and Spouse are indicated with arrows. The latter three nodes are bifurcated into two nodes due to the rule for sex marking of symbols. The gray nodes in the bottom part of the graph form the affinal subspace and are precisely the nodes marked with an "-in-law" suffix when the algebraic structure is mapped to the kin term map.

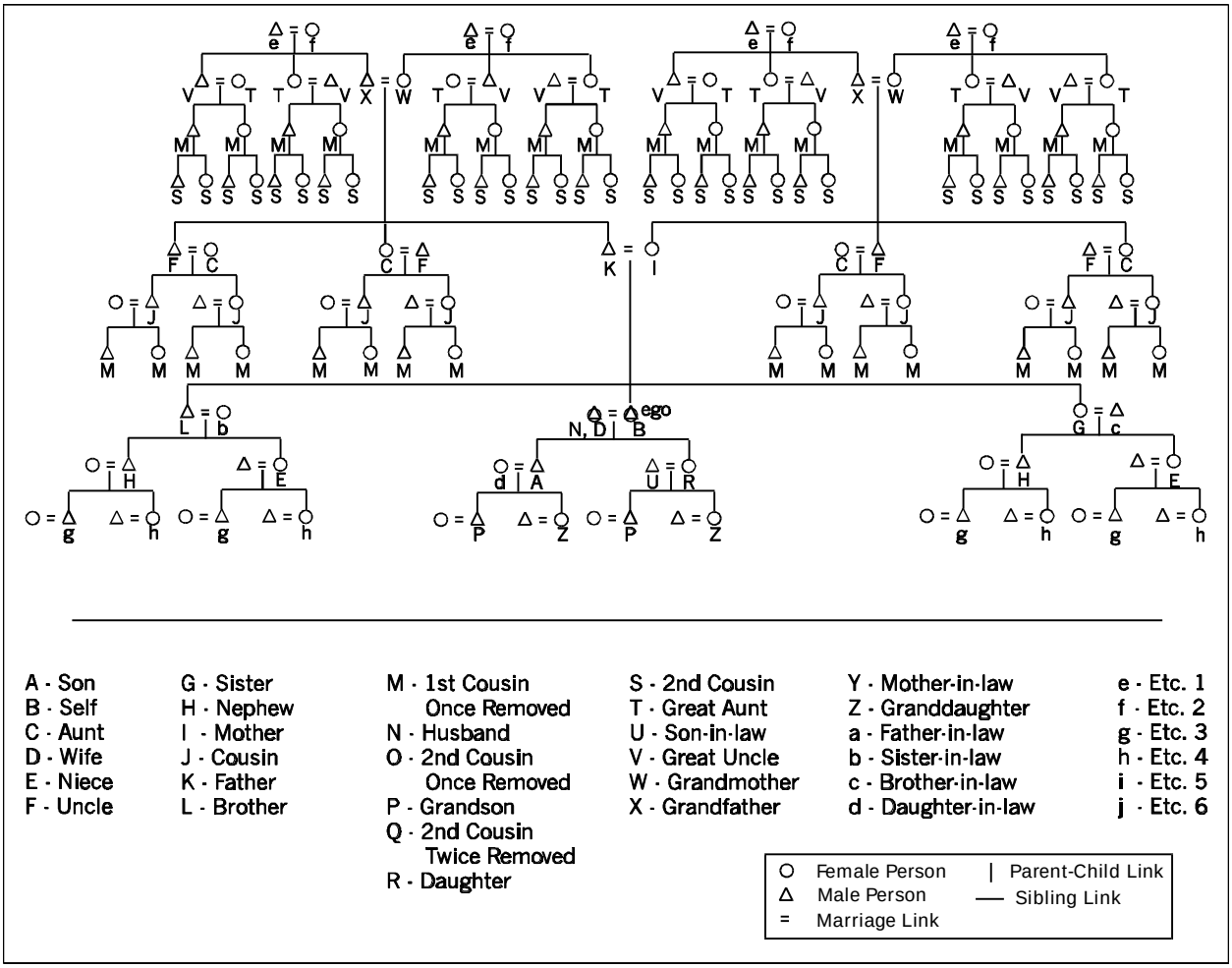


Figure 14: Genealogical diagram for the AKT as predicted from the algebraic structure shown in Figure 4 and the mapping from symbols to kin types defined by Self → *{ego}*, Parent → *{mo, fa}*, Child → *{da, so}* and Spouse → *{wi, hu}*.

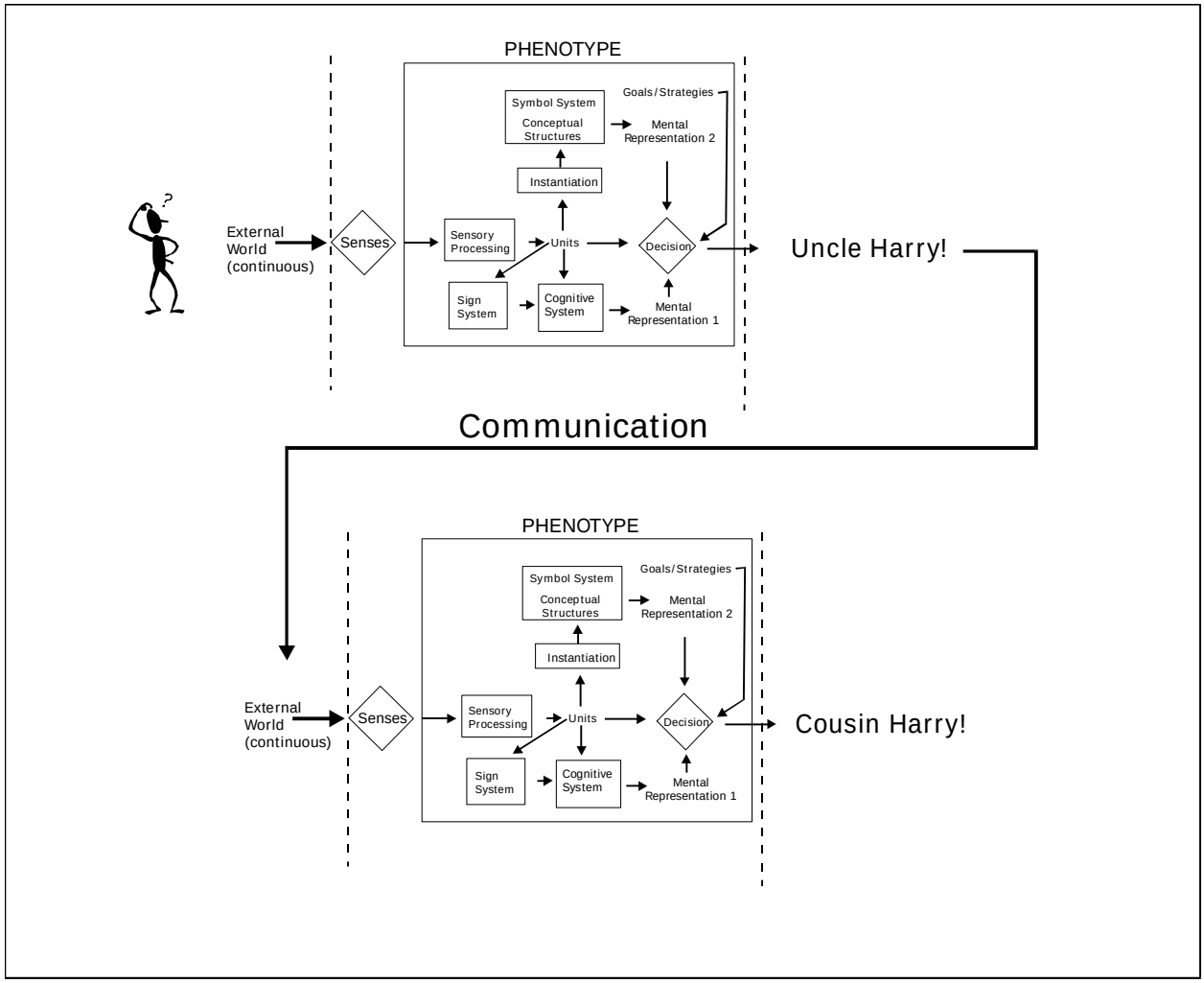
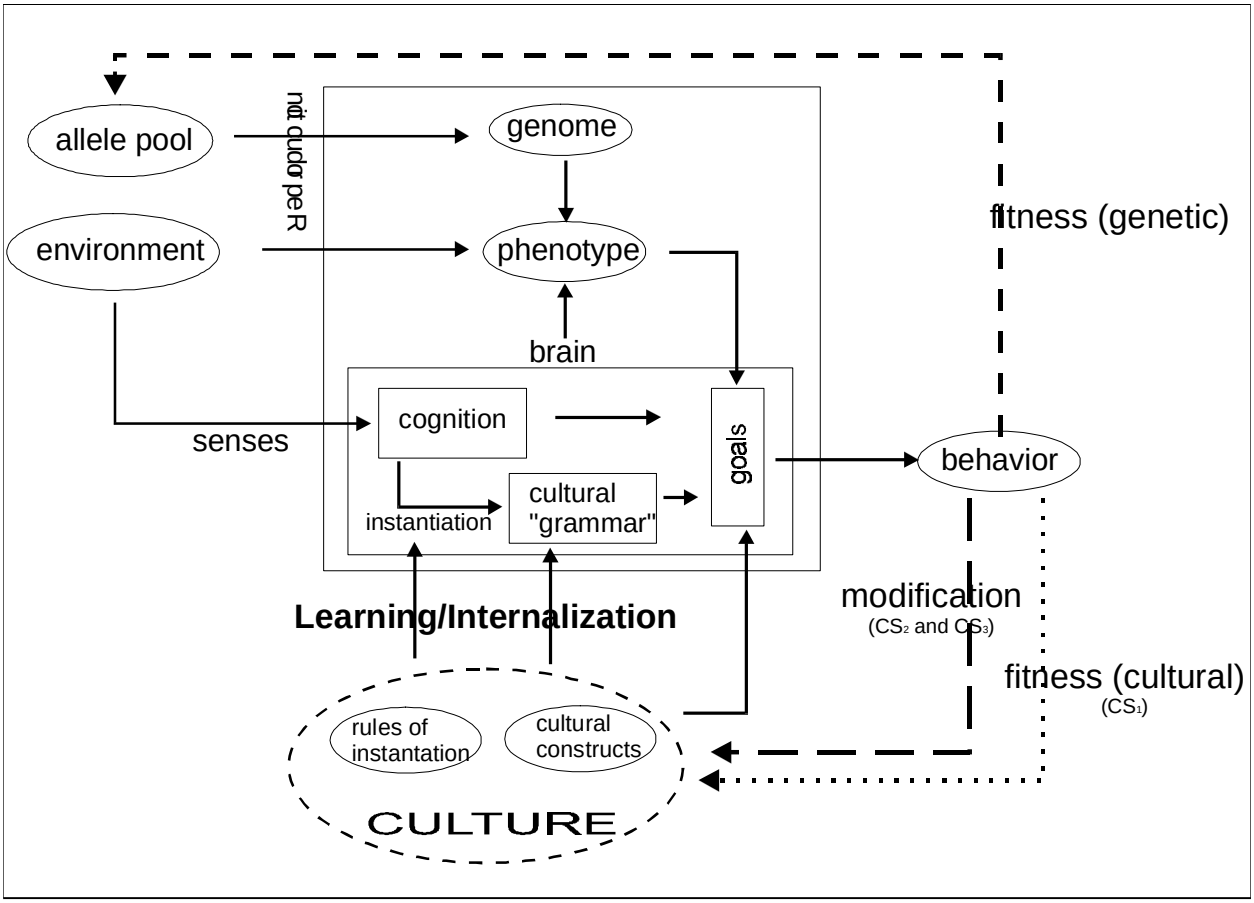


Figure 15: Schematic diagram illustrating the way a kinship terminology as a cultural construct serves to both construct a kinship domain for the first individual (top phenotype) and to provide the basis for translating that kinship domain into a kinship domain for the second individuals (lower phenotype). This translation process indicates that a shared culture is more than agreement on cultural rules and the like, but also ensures that the constructed reality for one individual can be related to the cultural reality for another individual.



CULTURE VIEWED AS IDEATIONAL CONSTRUCTS AND RULES OF INSTANTIATION

Figure 16: Modification of the schematic diagram of meme/signs to incorporate cultural constructs and their instantiation as well as modification of either a cultural construct or rules of instantiation a possible outcome of behavior. Unlike genetic modification whose origin is exogenous to the genome and random with respect to the genomic content, cultural modification may be purposeful and aimed at introducing features into the constructed reality expressed through the cultural construct and its instantiation.

"Constructed units" + Conceptual Structure + Instantiation

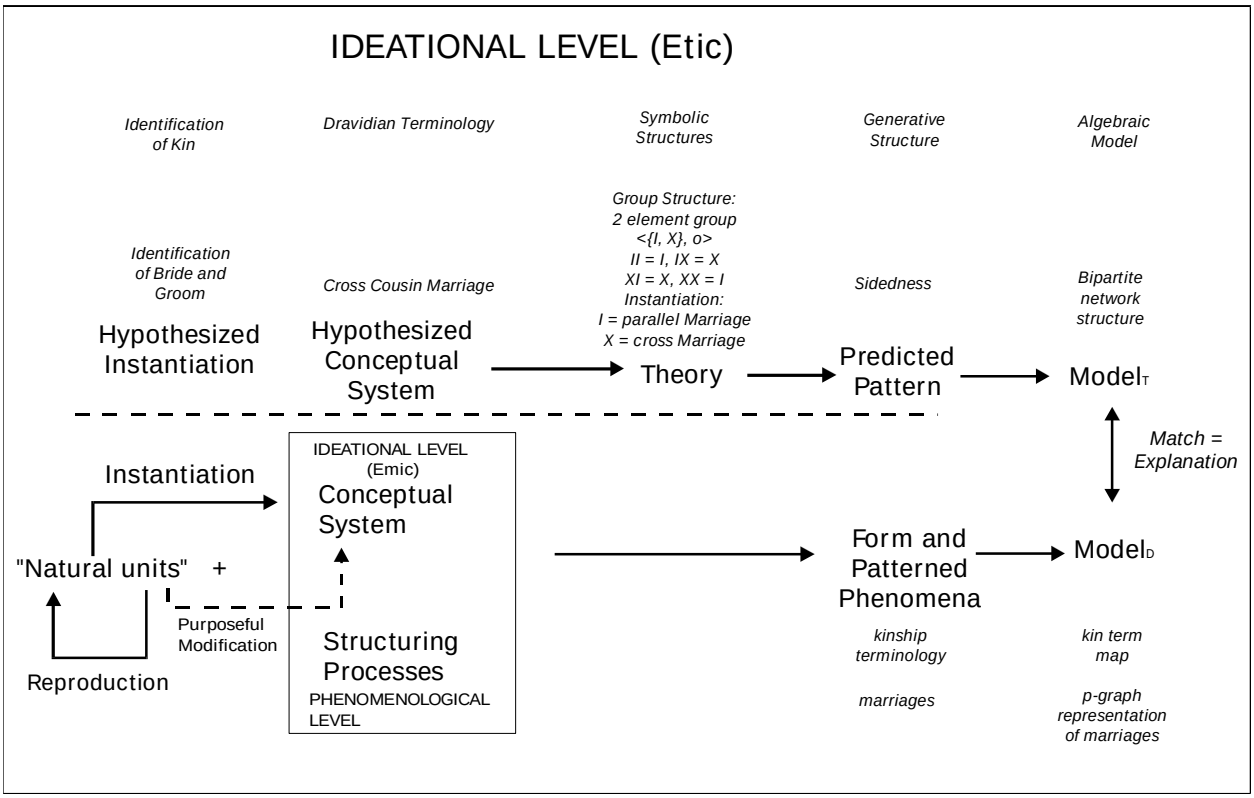


Figure 17: Modification of the scientific discourse diagram to incorporate the emic ideational level as part of the phenomenological domain of phenomena to be accounted for in scientific argumentation. Purposeful modification may act on the conceptual system directly or on its instantiation. The form and pattern of phenomena are a consequence of either structuring processes at the phenomenological level or a consequence of the conceptual system. The former leads to theorizing based on consequences of action/behavior (such as rational choice models) and the latter to theorizing about action/behavior arising out of the identity taken on as a consequence of the conceptual system (such as marriages formed in accordance with prescriptive rules about marriage partners). The diagram implies that neither perspective ("consequences of action" or "identity") is sufficient as a basis for understanding the full range of human behavior.