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# Multiple Measures of
# Alyawarra Kinship

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*A field experiment conducted in Central Australia in 1971–1972 explored differences between what Aborigines actually did and what they said they did when anthropologists interviewed them. Fieldwork entailed observing behavior and recording it in numerically coded forms; analysis entails extracting patterns computationally that would not appear in traditional ethnographic data. This article focuses on discrepancies between expected and observed with regard to descent, marriage, and kinship. First, it examines field methods and the dataset, then reviews analytical methods used to interpret the data. The alternative analytical methods serve to test "competing hypotheses" about the nature and operation of Alyawarra descent, marriage, and kinship. The cumulative result of using these diverse methods has been increasingly complex and subtle understandings of previously unknown aspects of Central Australian social organization. The data continue to repay increasingly sophisticated analyses thirty years after they were recorded, thus attesting to the success of the field experiment.*

*Keywords:*    *genealogy; marriage; kinship; Australian Aborigines; sections; sub-sections; network analysis; helical models; cohesion models; regular equivalence analysis; role; motif; axioms*

**D**enham conducted the Alyawarra project in 1971–1972. He used methods being developed for observational field studies of nonhuman primate behavior but studied people with human cognitive and linguistic capacities. A comprehensive review of the field methods appears in Denham (1978); the following paragraphs deal in greater detail with methods used to collect data related to descent, marriage, and kinship.

Denham worked for eleven months with 264 Alyawarra-speaking Aborigines at MacDonald Downs and Derry Downs (MD-DD) Stations, Australia, about 160 miles northeast of Alice Springs, Northern Territory. The Chalmers family, who operated these and adjacent cattle stations, were highly sympathetic to the Aboriginal people, whom they had known inti-

mately since homesteading there in 1923. The Chalmers served as a buffer against the encroaching white world.

The Alyawarra lived in four semipermanent camps spread over a distance of fifty-four road miles. The camp where Denham lived had a typical population of about 100 and was the most isolated. The people were not nomadic in the traditional sense but remained highly mobile within the cluster of four camps and between the cluster and other camps, cattle stations, and towns in the region. They hunted kangaroos for most of their meat but also received rations of flour, sugar, tea, bread, and fruit. Under conditions of semi-provisioning, they maintained much of their traditional lifestyle with little interference from whites or "detribalized" Aborigines. Alcohol was prohibited.

Fieldwork emphasized what people actually did in their day-to-day lives. That focus never precluded traditional ethnographic data collection but always emphasized primarily what they did and secondarily what they said they did. It used numerically coded data collection that was compatible from the outset with computer-assisted data analysis. Each component of the fieldwork was as systematic and exhaustive as possible, but some components required sampling.

The project yielded the Alyawarra Ethnographic Archive (Denham 2003). It contains 46,156 numerically coded data records in 78 files, plus 563 photographs, 37 maps and ground plans, 17 genealogical diagrams including all 377 members of the research population, 500+ pages of field notes, 77 minutes of edited audio recordings, and about 2,000 pages of published and unpublished papers in any way related to the Alyawarra project. Also derived from the Alyawarra project is the Group Compositions in Band Societies Database (Denham 2002) containing 41 numerically coded genealogical censuses from hunter-gatherer societies worldwide, including the Alyawarra. The Alyawarra project was designed initially to yield the archive, and each step in the research has presupposed the existence or development of applicable methods. These datasets, plus all of the Alyawarra papers cited in this article, are available on the Web at http://www.alc.edu/denham/index.htm.

Because this article deals specifically with genealogical, demographic, and kinship data, the remainder of this section reviews methods used to generate these datasets.

## Photodeck

Denham recorded vital statistics, genealogies, and kinship data on printed $6 \times 8$ inch cards, one card per person (Figure 1). The front upper-right corner

## FIGURE 1
### Photodeck Card

| | SX | T | X | C | IN | OUT | DOB | DP | M1 | M2 | M2D | F | S | | Id# |
|---|----|---|---|---|----|----|----|----|----|----|-----|---|---|---|-----|
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| SP1 | | | | SP2 | | | | | SP3 | | | | | | |
| CH | | | | CH | | | | | CH | | | | | | |

Mount portrait here

< Top      Bottom >

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|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
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| Id# | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
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Front

| | Census | | Id# | | Name | |
|---|--------|---|-----|---|------|---|
| Day | Camp | Res | Notes | | | |
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Back

holds a Polaroid portrait of the person to whom the card is assigned (ego), the upper-left corner holds vital statistics and genealogical data, and the lower half contains a form for recording kinship terms used by ego. The back holds census data, data from sortings discussed below, and miscellaneous notes.

Early in the project, Denham made two portraits of each of 225 Aboriginal people at MD-DD, mounted one on the card assigned to ego, gave the other to ego for his or her own use, entered a unique personal identification number (ID) on the card, and filled in the blanks. That procedure, without portraits,

was used for an additional 41 living members of the population and 113 deceased ancestors, yielding a total of 377 data cards.

## Vital Statistics

The following data were fundamental to the entire project and were coded for all 377 people:

- Sample: First of 377 Vital Statistics and Genealogical Data records
  01 0001 001 1 92 19 1 1 1 44 2 001 294 0 305 363 154 1 Jim Austin
- Key: required/*optional*/[computed]: [File#], [Record#], ID#, sex (SX), date of birth (DB), [age in years], [age cohort], language group, moiety, section (S), patrilineage or country (C); current marital status (M1); day person joined and/or left the population (IN / OUT); *nature + day of status changes: puberty(DP)*;*marital status* (M2, M2D); *date of death of parent* (P), *spouse* (S), or *self* (*OUT*); identities of father (FA), mother (MO), spouse(s) (SP1,SP2,SP3), and all known children (Ch); [kinterm data in File22]; European name.

A complete key to this and all data files appears in Denham (2003).

There are no known errors in personal identification number, sex, and section (hence, partimoiety). We believe all current marital statuses are correct, but a very few people who are coded as never married may have been widowed or permanently separated before the project began. Because of distances between camps, Denham often failed to learn immediately of in- and out-migration, so these data are accurate to +10 days. Dates of births that occurred during the fieldwork are accurate to +2 days, death dates are correct, and dates of puberty and marriage, which mark conspicuous changes in one's residence, are accurate to ±10 days.

During their half-century at MD-DD, the Chalmers family recorded the births of everyone born at MD-DD. From their records, Denham extracted birth dates (±10 days for people younger than twenty years old, ±1 year for older people) and computed the age of each ego (age = 1972—year of birth). With the Chalmers's assistance, Denham inferred ages of people missing from the Chalmers's records and used four independent procedures to verify all age data (Denham 1978). Undetected age errors, if any, are infrequent, small enough to be disregarded safely, and almost certainly pertain only to the very old.

The people learned to sort, order, and label the cards using their own criteria and criteria that Denham proposed. Almost everyone participated frequently in sorting, ordering, and labeling, but nobody became a "key informant" for this or any other purpose.

## Sorting: Language Group Affiliations

Early on, Denham was told that everyone at MD-DD was Alyawarra, but it became obvious that, although everyone understood and spoke the Alyawarra dialect, some used it as a second language. Late in the project, Denham asked four groups of people to sort 217 cards from the photodeck, indicating his interest in "tribal affiliations" but with the meaning of the concept unclear to him and unspecified to them. The four groups consisted of five men, five women, three women, and three men. The first two groups sorted the cards on a single afternoon at one camp, and the last two sorted them the following morning at another camp. There were no known contacts among members of these groups while these data were being collected. Each group reached a consensus before a card went into a final category. Each time the cards were sorted, Denham marked each card to designate the linguistic group to which ego was said to belong. This process identified four dialect groups: Alyawarra, Aranda, Anmitjira, and Warramunga.

All sorting groups agreed that 173 people were Alyawarra and 13 were Aranda. Three of four groups said 12 of the remaining 31 people were Alyawarra and one was Aranda. That left 18 people with unclear linguistic affiliations, despite vigorous debates surrounding some decisions. Although Anmitjira and Warramunga were mentioned several times, no one was classified unambiguously as being a member of either.

Using genealogical data for people whose portraits were not available, Denham determined that 220 of 264 people were Alyawarra (100% or 75% agreement), 21 were Aranda (100% or 75% agreement), and 23 were of unclear linguistic affiliations. Although the research focused on the Alyawarra, Aranda speakers and those with unclear linguistic affiliations were active members of the population, and their genealogies and kin terms are used below. The procedure described here was laborious, but we have confidence in the end result.

## Ordering: Genealogies

Denham obtained genealogical data by recording the identities of parents and spouses at the time each person officially joined the research population and verifying them later, but many people did not have living parents or spouses. Furthermore, the people would not willingly mention the names of the dead or acknowledge the prior existence of deceased infants.

Denham did not attempt to obtain information about deceased infants but learned to use the photodeck to reconstruct genealogies upward through deceased ancestors without violating the injunction against directly mentioning the dead. By arranging portraits of living people showing known parent-

child, sibling, and spouse relationships, then extending the process upward with blank cards representing deceased ancestors and their siblings, he obtained the information without resistance. To each deceased person identified this way, Denham assigned a unique ID number in a sequence separate from that of living people and added that person to the dataset. Finding no restrictions on discussing lineage and section affiliations of deceased ancestors, he recorded this information as he constructed the genealogies.

Because of tight logical connections among moiety, section, and country affiliations, and parent-child and spouse relationships, most errors in these data were detected and corrected in the field. Remaining errors in patrilineage memberships, if any, almost certainly are confined to small descent groups and long-deceased female ancestors. Without the photodeck, this job would have been virtually impossible; with it, constructing genealogies for all 264 people was straightforward but time consuming.

## Labeling: Kinship Data

Denham collected normative and pragmatic kinship data.

*Normative*. After Denham made the portraits and mounted them on the cards, he used the portraits and known genealogical relations between selected, well-known, and well-documented pairs of people to elicit kinship terms and their relational *significata* in strict accordance with Tax's ([1937] 1955) six rules or principles that serve as structural features of kinship terminologies (Scheffler 1982). In other words, Denham used Rivers's genealogical method to learn the Alyawarra kinship vocabulary and to define the normative kinship data relationally. He simply could not imagine another thorough, systematic way to obtain an initial understanding of Alyawarra kinship.

*Pragmatic*. Next, in a move that proved controversial, Denham recorded one and only one kinship term that each ego applied to each alter and gave the Aboriginal speakers complete control over which term to use. Denham selected a person whose portrait was in the deck and showed that person, one card at a time, all of the portraits in the deck, including his or her own. As each portrait appeared, ego gave Denham one kinship term that he or she used to refer to the person in the portrait (alter). Denham entered a code corresponding to that term on ego's card in the cell corresponding to alter's personal identification number. The result was a list of 225 terms from each of 104 carefully selected and broadly representative egos, yielding 23,400 pragmatic kinship responses elicited under standardized conditions. The

sample data record, which is the first of 104 kinship data records, lists File#, Record#, EgoID#, and 225 two-digit codes corresponding to the kinships term that ego applied to each of 225 alters.

Sample: 22 0001 001 24101317211016121310121921171716212121281717
10171905121617211721116161716171716030517161617170516161617051
61717170916030516160505161617160917051605160505010505050505016
05050309051616010109161605090509050505090903190505012103172 61
70811111817161711022811171119181716111728161603121616 16180303
16030305031616180316180305160503160316031805160316 16081609080
51616080116160816160801080516160816160816170805 03170516050508
1608161716081605161919010505050116080805

The resulting dataset is based on terms of *reference*, not terms of address. In fact, Denham rarely heard kinship terms used for either reference or address. Generally, people used other kinds of group membership terms, augmented by informal contextual cues, for address and reference, including terms denoting section, country, age group, and residential group memberships. For example, to refer to Jim Austin, you could say "that old Burla" and point your chin in the direction of his body, residence, country, photo, whatever, so that as much of the message rested on your chin as on your words. Likewise, to call Jim from across the *ngundya*, you could look in his direction and shout, "Hey you, Burla." Two or three Burla men might look up, but because it was clear who you were looking at, the ones who were irrelevant went on about their business and old Jim responded.

Hence, the kinship terms in use here seemed to constitute a "technical vocabulary" of reference terms used mainly in discussions when context was not sufficient, when you had to have absolute identifications that were precise and unambiguous. Examples of such situations included discussing relations among participants in initiations and discussing relations between people and the sacred stones who were classified as Fa, FaFa, and so on.

In addition to "typographical" errors, the kinship data could contain errors of identification made as informants responded to the portraits. Denham attempted to prevent this problem by giving most people a great deal of practice in using the photodeck before kin term elicitation began and by encouraging more than one person to be present when kin terms were being elicited.

Sometimes, ego easily arrived at a kin term for alter; at other times, he or she engaged in lengthy debates with other participants before deciding on a term. It was common to hear people say, "Tell him the proper Alyawarra way," as these discussions proceeded. On a few occasions, informants came to Denham several days later with other people to correct an earlier response based on continued discussions that followed elicitation sessions. We con-

clude that everyone attempted to provide the "best" term in all cases, and the last half of this article represents various attempts to decide precisely what *best* means in this context.

As the data accumulated, they contained many nonuniform kinterm reciprocals (i.e., the pair of kinship terms that ego and alter used for each other often did not agree with normative data described above). Denham was acutely aware that each pair of people could be related through no known geneapath, one and only one geneapath, or multiple nonredundant geneapaths of equal or unequal length. To deal with this, he assumed that *all* of the nonuniform kinterm reciprocals could have been resolved in accordance with the reciprocal relations embedded in the terminology based on Tax's rules (Tax [1937] 1955).

Following traditional anthropological practice, Denham might have investigated what the people *could* have done had he asked them to resolve those discrepancies. Instead, he investigated the discrepancies themselves. The rest of this article focuses on relationships between what the people *could* have done (that is, use their kinship terms as uniform reciprocals in accordance with Tax's rules; Tax [1937] 1955) and what they *actually did* under standardized elicitation conditions (that is, apply the terms such that the blooming, buzzing confusion of the real world prevailed over the sterility of the ivory tower).

## ANALYTICAL METHOD

The Alyawarra data introduced above are amenable to analysis from many perspectives using various methods to test alternative hypotheses concerning the nature and operation of descent, marriage, and kinship among the Alyawarra. Here, we review six analytical approaches that have been used to interpret the Alyawarra data, each of which has yielded important insights into Central Australian Aboriginal social organization.

### RB Normative Model

The Alyawarra are neighbors of the Aranda. Their kinship system resembles the Eastern Aranda four-section system but differs from Aranda further west who use eight-subsection systems. Nevertheless, Alyawarra kinship terms closely resemble those reported by Spencer and Gillen (1927) for Aranda in the Alice Springs area at the beginning of the twentieth century, and the normative structure that underlies those terms closely resembles that

FIGURE 2
Radcliffe-Brownian (RB) Model
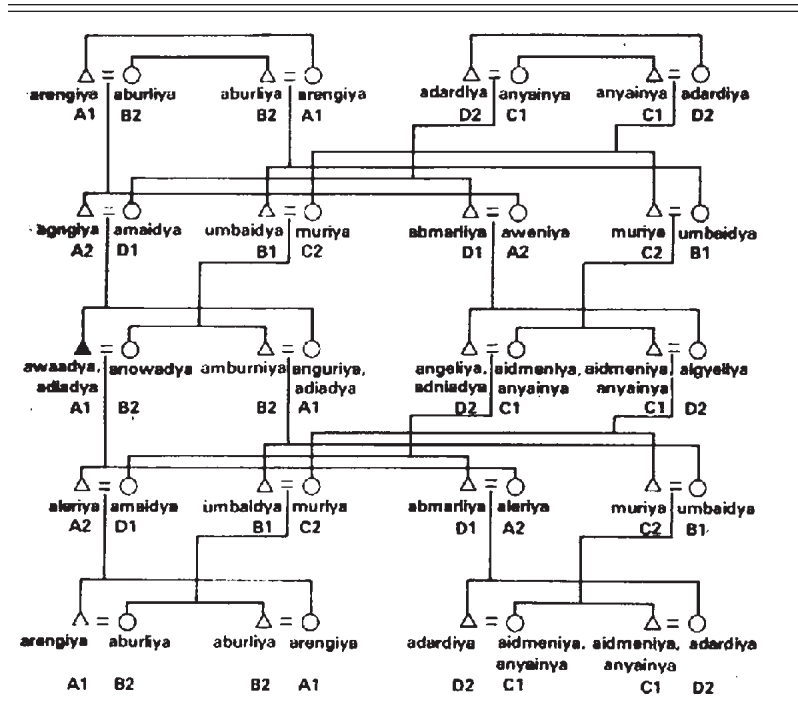


built into the Kariera model used by Radcliffe-Brown (1930) and his intellectual heirs.

Figure 2 is a normative model in the manner of A. R. Radcliffe-Brown (1930)—hence called the *RB model*—and was the first model that Denham, McDaniel, and Atkins (1979) tested against the Alyawarra data. They derived it by combining Denham's normative data with many published attempts to understand Central Australian kinship using a normative approach. It incorporates language, rules, normative data, and ideal genealogical relationships as well as kinship and section terms; rests squarely on Tax's ([1937] 1955) rules as elucidated by Scheffler (1982); and accurately represents what the Alyawarra said they did. Think of this kind of model as the "default option" for understanding section systems.

The RB model holds a set of genealogically based kinship "positions" that correspond to each of the Alyawarra (and Aranda) kinship terms. But the positions are equivalence classes that categorize genealogical relatives and

are not actual genealogical relatives. According to this model, all marriages entail sister exchange with classificatory bilateral second cousins.

When Denham, McDaniel, and Atkins (1979) examined actual genealogical relationships and kinship term applications, they discovered that behavior often violated the rules built into the RB model. Some have argued that a logical model constitutes only part of what determines people's behavior and cannot be tested legitimately by examining the extent to which behavior complies with it. If there were no discernable relationship between Alyawarra rules and behavior, we might be sympathetic to this argument, but that is not the case here. Some Alyawarra rules and actions display close fits, and some display moderate but imperfect fits. In still other ways, actions are entirely systematic but so far removed from the rules as to suggest the operation of another set of rules radically different from those embedded in the RB model. Thus, the RB model is convincing as a closed logical system but is of limited use as a guide to action.

### JRA-1 and JRA-2 Age-Biased Geometric Models and the Axiom of Generational Closure

Figure 3 reflects the first attempt by Denham, McDaniel, and Atkins (1979) to understand widespread systematic differences between norms and pragmatics. The JRA model, named for John R. Atkins who invented it, retains as much of the RB model as possible because of its good fit with practices in some areas, but it modifies RB as needed to accommodate incompatible practices.

McDaniel's quantitative analysis of the Alyawarra data in 1979 used FORTRAN, SPSS, and SOCSIM software to extract 240,000 nonredundant genealogical paths connecting discrete pairs of individuals, to group together ego-alter pairs according to the nature of their linkages, to attach kinship term applications and demographic data to the pairs, and to print the results to facilitate a manual search for deeper patterns underlying the surface patterns that the computer detected. Denham, McDaniel, and Atkins (1979) included a great deal of tabular data that clearly display exactly where the discrepancies lay.

The computations revealed that the single greatest problem with the RB model was that it was based on what Atkins (1981:390) called the "axiom of generational closure," that is, "the tacit but widely accepted supposition that any 'normal' kinship system—or at least every proper model of such a system—must entail an infinite or open series of successive genealogical generations each of which is not only discrete but also closed."

## FIGURE 3
## JRA-1 Open Format Age-Biased Model



Key: Assuming that ego is in section K, then **K, P, B, N** are section designations and **K1, K2**, through **N1, N2** are implicit 8-subsection designations. A 1, A 2, B 1, B 2, C 1, C 2, D 1 and D 2 are distinct kin terms consistent with 8 implicit
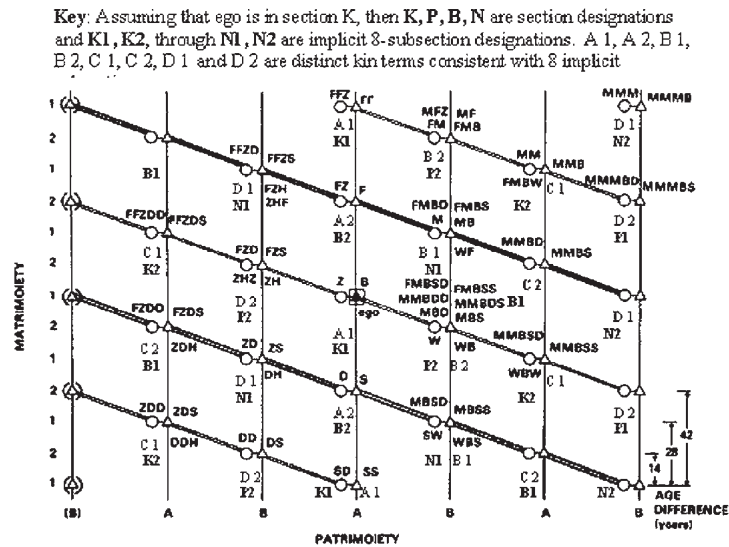
A large mean age difference between husbands and wives is incompatible with generational closure. Yet the Alyawarra data revealed a fourteen-year H > W mean age difference that is not atypical of Australian systems and certainly is too large to be neglected by kinship theorists. This difference precluded brother-sister exchange and biased marriages by male egos in favor of real or classificatory MBD and MMBDD and against FZD (Hammel 1976). These and other profound effects of the age bias, including a strong tendency toward asymmetric exchange between patrilineages, ramified throughout the structure and operation of the system. Thus, on the basis of their computational analyses, Denham, McDaniel, and Atkins (1979) concluded that a model of Alyawarra kinship, marriage, and descent that deals with pragmatics as well as norms must incorporate demographic realities.

The JRA-1 model in Figure 3 is Atkins's open-format diagram for an arrangement of Alyawarra classificatory lineages that accommodates (1) H > W age differences; (2) an asymmetric order of classificatory patrilines that move from left to right in terms of wife-giving (leftmost in an adjacent pair) and wife-taking (rightmost in an adjacent pair); and (3) distinct kinship positions in the classificatory array that correspond to distinctive kinship terms

(Denham, McDaniel, and Atkins 1979). Spouse-giving and -taking happen asymmetrically: ego's sisters go to men on average fourteen years older than ego, and ego's wives come from men on average fourteen years younger than ego. Thus, brother-sister exchange is extremely unlikely, and a male ego's MBD or MMBDD may be a potential spouse but his FZD is not. Denham, McDaniel, and Atkins (1979) called this an "age-biased *Kariera*-type system," but it incorporates kin-term distinctions consistent with eight subsection divisions (A 1, A 2, B 1, B 2, C 1, C 2, D 1, and D 2, as we have labeled them in the diagram). These designations for eight-subsection equivalence classes for the Alyawarra kinship terms (each of which contains several distinctive kinship terms) are precisely those used by Denham, McDaniel, and Atkins (1979:7).

Figure 3 incorporates an infinite series of discrete but open generations, but Atkins went further to derive the JRA-2 Helical Format age-biased version of his model that rests on a finite set of open generations (Figure 4; from Tjon Sie Fat 1983). In a four-section system, when a small number of patrilineages engages in the asymmetrical exchanges described above, the two generations pass through each lineage in turn and spiral around each other in a manner that can be best depicted, if carried on for a sufficient number of generations, as a double helix. This model rejects ethnocentric Western notions of generations and embodies the Alyawarra conception of two open generations as subsequently and independently reported by Bell (1993:19). The kinship terms used here are identical with those used in the RB model but work radically differently as can be seen by comparing the RB and both JRA models.

### FTSF Family of Age-Biased Algebraic Models

Franklin Tjon Sie Fat (FTSF; 1983) took the JRA-2 helical geometric Alyawarra model as a starting point for developing a generalized age-biased algebraic model that accommodates both the RB normative model and the JRA-2 helical geometric model, and also accommodates other extranormative variables including number of patrilines and matrilines, number of generations, and H-W age differences. Furthermore, his generalization accommodates McConnel's (1939–1940, 1950) age-biased model of Wikmunkan kinship, which fell on deaf ears when she published it.

Most importantly, Tjon Sie Fat's (1983) work demonstrates that the RB model, which became fossilized early in the twentieth century due in part to anthropologists' ethnocentric conception of generations and in part to their failure to consider extranormative data, is only one instance of a much more general model. If a society to which RB applies has no systematic H-W age

FIGURE 4
JRA-2 Helical Format Age-Biased Model with Double Helix "Twist"
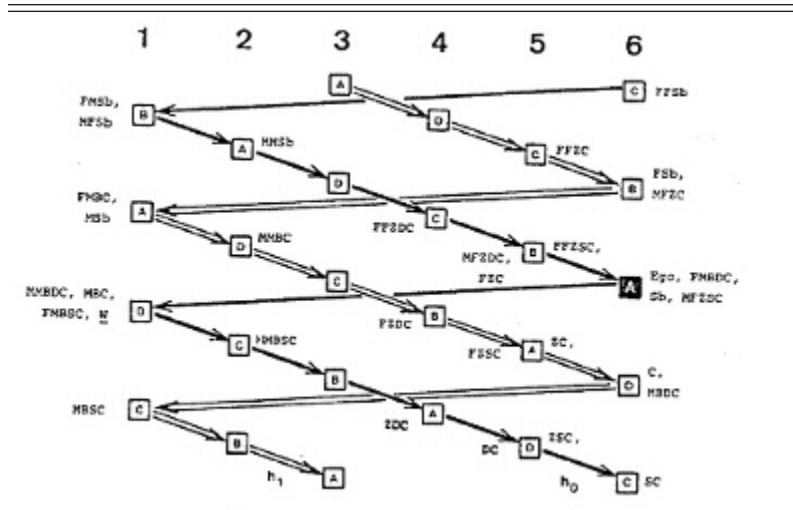


difference, RB may be sufficient, in some sense, to represent the kinship system. But if the society is characterized by a systematic H-W age difference, then the axiom of generational closure fails, the default option fails, and an age-biased model such as the JRA model *must* be invoked if there is to be any meaningful relationship between norms and pragmatics. The precise nature of the resulting age-biased system is determined by the values of the variables in the FTSF family of models (also see Atkins and Denham 1981; Tjon Sie Fat 1981; Atkins 1982).

## DRW-1 Model

Yet another approach to the Alyawarra data shows that the JRA-2 double helix model may be too neat as it stands. The JRA model and the FTSF family of models based on it are abstractions not unlike the RB model. Both JRA-1 and JRA-2 took into consideration Denham's quantitative field data, but the models were not generated computationally, and Denham, McDaniel, and Atkins (1979) had no technology with which to determine the precise fit between the JRA models and the Alyawarra data. Likewise, this matter was not addressed in the FTSF Family of Models. It is, however, possible now to measure the fit between the JRA models and the Alyawarra data.

FIGURE 5
Fit between Alyawarra Behavior and the JRA Model, by Section[1]
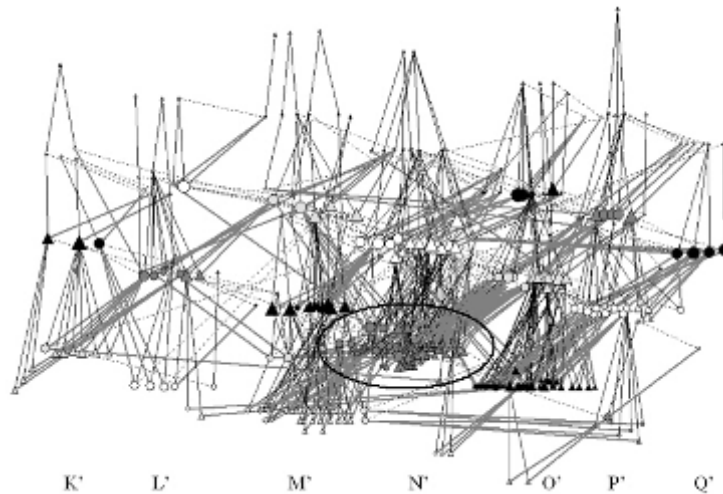


At this point, D. R. White (DRW) joins the cast of characters, bringing with him long experience with computer-based analysis of genealogical networks (Brudner and White 1997; White 1997; Houseman and White 1998; White and Schweizer 1998; White and Houseman 2002) and the use of Pajek software designed and developed by V. Batagelj and A. Mrvar (1998). Pajek, like White's earlier Pgraph software (White and Jorion 1992, 1996), is designed for the analysis and visual display of very large networks of any kind, including genealogical and marriage networks (de Nooy, Mrvar, and Batagelj 2002). This section is a summary of DRW's methods and results from Denham and White (2002).

Figure 5 depicts classificatory patrilines in the Alyawarra data that were identified by a simple algorithm for matching genealogical and interlineage marriage relationships to the JRA model. The algorithm used here to group lineages into classificatory patrilines incorporates a variant of a well-established analytical algorithm based on *regular equivalence* (White and Reitz 1983; Reitz and White 1989; see also Hanneman 1998). Regular equivalence analysis allows us to examine two ideas: (1) that actual patterns of interaction are the regularities out of which roles emerge; and/or (2) that the rules governing role behavior have consistent enactments in actual behavior. Conversely, we may find from a regular equivalence analysis that there are exceptions to the consistent enactment of interaction patterns or that named

TABLE 1
Calculation of the First Motif-Equivalence for
Sorting Actual Lineages into Classificatory Lineages

```
                1 1 1 1 1 1 1 1 1 2
    1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0        EXPLANATION

 1  0 0 0 0 0 0 1 0 0 0 0 0 0 0⑤1 0 0 0 0        Linkage up to step 4:
 2  0 0 0 1④0 0 1 1 0 0 0 0 1 0⑧0 0 0 0        8 ¹1²15³6
 3  2 0 0 0 0⑧③0 0 0 0 0 0 0 0 0 0 0 0 0        8 ²2³5
 4  0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0                        3 ⁴6
 5  0 1 0 0 0④0 0 0 0 0 0 0 0 0 0 0 0 0 0                      15⁴6
 6  0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0
 7  0 1 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0        Magnitudes by step:
 8  0⑥0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0        1 O 2 O 3 O 4 O 5 O 6 □
 9  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
10  0⑦0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0⑦        Classification at Step 6:
11  0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0        (8,10,14) (1,2) (3,5,15,17) (6)
12  0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
13  0 0 0 0 0⑦0 0 1 0 0 0 1 0 0 0 0 0 0 0        Final classification:
14  ⑧1 0 0 0 0 0 0③0 0 0 0 0 0 0 0 0 0 0        (8,10,14)(1,2,11,18,19,20)(3,4,5,7,9,15,17)(6,13)
15  0 0 0 0 0 0③0 0 0 0 0 0 0 0 0 0 0 0 0
16  1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
17  0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
18  0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
19  0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
20  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

roles or the behavior of role occupation differs from the behavioral patterns discovered in observed interactions. This approach, then, gives us two views of role behavior. One is based on the usual approach of social scientists who have historically used labels or attributes of actors to define social roles and to understand how they give rise to patterns of interaction. The other is based on abstract patterns of actual interaction. Regular equivalence analysis seeks to identify regularities in patterns of network ties among people, regardless of whether the people name their positions in the network, and use those interaction patterns as an alternate way to define social roles that can be compared with the conventional approach.

Our use of regular equivalence takes into account four specific motifs of the JRA model: (1) generalized exchange among lineages (and classificatory lineages); (2) preferential MMBDD marriage; (3) classificatory MBD marriage; and (4) demographic and historical realism, in which classificatory siblings are of similar age and a genealogical drawing of the network will show actual historical generations to be in correspondence with similarly aged classificatory sibling sets. Because of these specificities, we call our variant of regular equivalence a *motif-equivalence* analysis.

Table 1 shows a procedure for computing the first motif of our analysis—namely, generalized exchange—for the largest twenty lineages. Men's lineages are in the rows, and those of wives are in the columns. The numbers in the cells are the numbers of marriages between each of the $20 \times 20$ lineages. Because directed exchange rather than reciprocal exchange is the character-

istic motif of generalized exchange, the procedure used here classifies lineages into equivalence sets to maximize the number of marriages along a directed chain of classificatory lineages. We pair lineages along a chain according to the number of marriages, beginning with 8 • 1 (i.e., the ordered pair with the largest number of asymmetric marriages [males in lineage 8 • females in lineage 1 = 6 links, males in 1 • females in 8 = 0 links]). We then look for the next largest number of asymmetric marriages for a third lineage connected to 1 or 8, and find two candidates, 1 • 15 and 8 • 2. This establishes an equivalence between lineage 1 and 2 such that the motif-equivalent classes are {8} •{1,2} • {15}. The circles of decreasing line width show how successive iterations of this procedure are done to arrive at step four with equivalence classes {8} • {1,2} • {3,5,15} • {6} and at step six with {8,10,14} • {1,2} • {3,5,15,17} • {6}.

The procedure finishes with equivalence classes {8,10,14} {1,2,11,18,19,20}, {3,4,5,7,9,15,17}, and {6,13} but does not classify 12, which has symmetric marriages with 13, and 16, which has symmetric marriages with 1. In the explanation to the right of the matrix in Table 1, we show the sequential order (in small superscripts) of linkages between numbered lineages, and the decreasing magnitude of the linkages at each step (with circles ordered by thickness, ending in a dotted circle and a dotted square).

The motif-1 equivalence sets do not capture the other three motifs (i.e., the marriage norm, classificatory sibling sets, and historical generations composed of people of similar ages). For example, the equivalence sets resulting from the generalized exchange motif do not correctly capture the motif of MMBDD marriage preference. Nor do they capture the classificatory MBD marriage preference that is derived from motif-equivalences for classificatory mothers, brothers, daughters, and spouses that imply cMcBcD = cWife. The latter motif is easily identified when the graph of the kinship network puts classificatory siblings in the same spatial cluster such that the cMcBcD = cWife equivalence set forms recurrent patterns in Figure 5, as will shortly be explained in detail.

*Procedure for solving a motif-equivalent problem with graph-drawing methods.* There is no existing computer algorithm that will capture regular equivalence sets according to specific motifs such as the four we have identified here. Graph-drawing procedures using Pajek, however, can represent a kinship network on a computer screen in a manner that allows us to manually manipulate blocks of persons who belong to different lineages. The graph that is manipulated can (1) reflect the assumption that there is a rough equivalence across sibling sets in the time span between parents' marriages and their children's marriages, and (2) show actual ages of the specific people in

the network by the relative sizes of the nodes that represent them (triangles for males, circles for females). The vertical axis of the graph represents historical time, and the lineages are drawn as compact units with uniformly separated generations also representing historical time. Then the field anthropologist or analyst can move lineages manually on the screen to create different arrangements that meet the criteria of historical verisimilitude, with people of the same age at the same level in the vertical dimension of historical time. By keeping track of historical time and actual ages, we can manually move lineages into positions of motif-equivalence with considerable ease, even though a computer cannot yet do this job with any existing algorithm.

Figure 5 shows the results of manually executing a motif-equivalence algorithm for finding the optimal arrangement of the Alyawarra kinship network so as to match the properties of the JRA or other idealized kinship models in such a way that they have historical verisimilitude. We did this by starting with our motif-1 procedure described above. From a total of fifty-four lineages, each defined by patrilineal descent from a common (known) apical ancestor, we found the pair of lineages with the greatest number of intermarriages and placed the lineage that predominates as wife-takers to the left of the one that predominates as wife-givers. We call these two lineages *M* and *N*, and let them be the seeds of classificatory lineages M' and N'. The vertical alignment of individuals in each generational cohort in these lineages is then set so that the age-cohorts match, across lineages, in terms of a common metric of historical time. Because of the difference in the age of marriage of males and females, the relative generations of pairs of intermarried lineages will usually be staggered when measured against historical time. Thus, the alignment of generations across intermarried lineages will not occur on the same horizontal plane, but on a diagonal, as is seen in Figure 5.

Next, all other lineages that are predominantly wife-givers to M are added to the classificatory patriline N' that contains N. All other lineages that are predominantly wife-takers from lineages in N' are added to a new classificatory patriline M' that contains M. The same analytic logic applies here as in the motif-1 procedure, except that there are additional constructions as to relative ages of generations within lineages, actual ages that must correspond to real historical time, and motif-2 and -3 recurrent patterns of marriage. At each step in generating this emergent structure, we place lineages so that we achieve motif-4 age and historical verisimilitude, and simultaneously optimize the motif-1 criterion (generalized exchange) and the motif-3 criterion (classificatory MBD marriage).

In Figure 5, dotted lines represent marriages that connect husbands to wives. Because wives are typically younger than husbands and the marriage ties follow a directed chain, these dotted lines should run on a gradual diago-

FIGURE 6
Motif for Optimizing Fit between Alyawarra Behavior and the JRA Model[1]
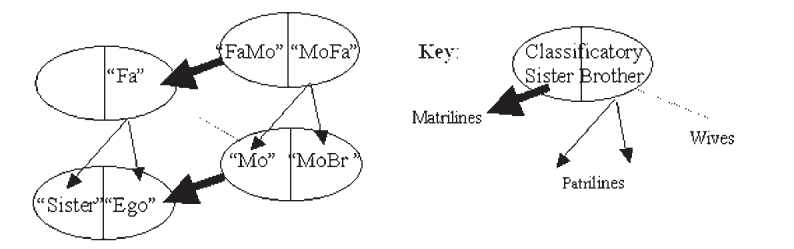


nal that slopes downward to the right and in a straight line as successive pairs of lineages are connected by marriage. Thin black lines represent patrilineal descent that connects fathers to their sons and daughters. These thin black lines are centered vertically but fan out horizontally from the location of the father to those of their offspring, so siblings are spatially and generationally proximal. Finally, to satisfy the requirement of optimizing on the pattern of classificatory MBD marriage, we have organized the graph so that a maximum number of the wider and solid gray lines run diagonally downward to the left, opposite in slope, and more sharply inclined as compared to the husband-wife dotted lines.

In Figure 6, the graph on the left expresses the pattern that is optimized for each classificatory sibling set, such as the one within the circle at the center of Figure 5. Here, as interpreted by the key on the right side of the figure, classificatory FaMo and classificatory MoFa are classificatory siblings, which implies a classificatory MoBrDa marriage between *Fa* and *Mo* that will carry over in the next generation to one between *Ego* and a classificatory *MoBrDa*.

The process of manually ordering lineages to correspond to classificatory lineages that conform to this type of structure is now repeated to identify other potential classificatory patrilines. This procedure retains some of the equivalences derived by motif-1 (Table 1) but separates out some elements from the equivalence classes. In Figure 5, to the right of N', we add successive wife-givers O', P', Q', and so on until no more can be identified. To the left of M', we add successive wife-takers L', K', J', and so on until no more can be identified. At each stage, the relative age cohorts are adjusted so that they are uniform across the diagram in the sense that the average age of each cohort for each classificatory patriline follows a regular progression. The arrows at the bottom of the figure show the dividing points between the classificatory patrilines derived by this procedure.

*Interpretation*. By displaying real relationships among all of the real people in the Alyawarra database, Figure 5 invites us to measure things that are not measurable in Figures 2–4. For example, in Figure 5 there are seven classificatory patrilines K' through Q'. This is an empirical determination based on iteratively applying the algorithm described above until we ran out of data (i.e., there is no a priori cutoff for how many classificatory patrilines there should be). After applying the motif-equivalence algorithm iteratively to its conclusion in the case of the Alyawarra data, motif-equivalent lineages are those that are wife-givers to other motif-equivalent lineages, as well as wife-takers from a different set of motif-equivalent lineages.

About 74% of the marriages are consistent with the fourteen-year age bias of the JRA models (with an average Fa-Child difference of forty-two years and Mo-Child difference of twenty-eight years, roughly a 3:2 ratio), but the motif-equivalence algorithm, as applied manually to produce Figure 5, reveals two exceptional marriage patterns that occur with lesser frequency. One represents men with a much younger cohort of wives ($H > W \cong 28$ years); the other represents men with a same-age cohort of wives ($H > W \cong 0$ years). Thus, a system such as this can have RB and several variants of JRA operating concurrently but with different frequencies of occurrence. If the mean H-W age difference were to change, we would expect to see changes in those frequencies; if the mean were to drop to zero, the system would revert to "pure" RB. The cooccurrence of multiple variants in a single system is compatible with the FTSF family of models.

Figure 7 shows that among the Alyawarra speakers proper, there are five classificatory patrilines (M' through Q') and five classificatory matrilines, mostly formed by the dark gray lines running diagonally from sets of nodes at the upper right to other sets at the lower left. But the asymmetric JRA marriage structure extends beyond the Alyawarra proper. One of the matrilines runs far to the left to connect to children of patrilines of Aranda-Alyawarra and Aranda speakers who have intermarried with Alyawarra and intermarry in turn with Aranda patrilines. This pattern is compatible with the open universe depicted in the JRA1 model but is incompatible with the JRA2 double helix model.

## DRW-2 Model and the Axiom of Universal Reciprocity

Alyawarra kinship terms (Denham, McDaniel, and Atkins 1979:7, 19), which are almost identical to Aranda terms, are consistent from grandparent down to grandchild with the RB model and with the finer distinctions of both JRA models. Thus, at the level of terminology alone, without asking how the

FIGURE 7
Fit between Alyawarra Behavior and the JRA Model, by Language[1]
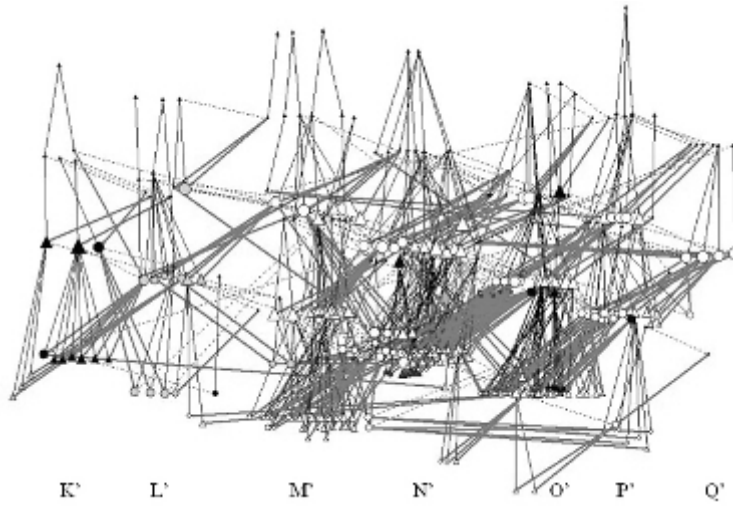


terms are realized with respect to specific alters, there is little to distinguish RB from JRA.

But in their initial quantitative analysis of the Alyawarra data, Denham, McDaniel, and Atkins (1979) discovered that about 23% of 3,200 kin term applications displayed an anomalous "Omaha" pattern deeply imbedded in the so-called alternating generation pattern of the RB model that typifies Central Australian kinship. In this anomaly, a male ego applies the kin term that normally glosses as *mother* to his own mother, to his mother's brother's daughter, and to his mother's brother's son's daughter. A systematic deviation of this magnitude from the standard alternating generation pattern could not be dismissed as random noise. Denham, McDaniel, and Atkins were unable to demonstrate any connection between the Omaha anomaly and the demographic factors that generated the age-biased JRA models, and they left it as an unsolved problem in their 1979 article.

In the blood marriage subnetwork that appears in Figure 8, some of the nodes are shaded to show the individuals for whom Denham collected reciprocal kinship terms. Reciprocals do not, in general, follow Tax's ([1937] 1955) law of uniform reciprocals, at least not for the single terms elicited reciprocally from each ego with respect to an alter. The most common departure is when a term for a potential spouse (terms 13, 14) is used reciprocally

FIGURE 8
Known Kin Terms for Those in Blood Relinkings[1]
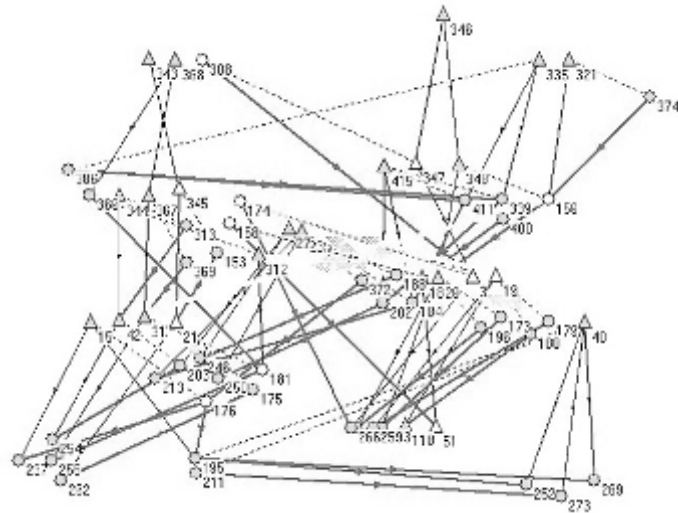


NOTE: Shading key to language: black = Aranda, white = Alyawarra, light gray = intermediate.

(in a gender-appropriate manner) with a term for a matrilineal relative (terms 8, 9). One person is saying same-generation *potential spouse* (classificatory MMBDD or MBD), and the other is saying *mother* or *mother's brother* (M = MBD, MB = MBS). These two most basic generation-merging equations of an Omaha-type terminology "raise" the potential spouse to an unmarriageable category in the senior generation.

There is clear evidence for the asymmetric use of Omaha terminology in that when ego and alter are in potential-spouse genealogical positions, they never shift to a reciprocal use of Omaha terms: Only one person shifts, not the other. That is, one person is made "senior," but the other is never made reciprocally "junior." Hence, even if Denham had collected alternate terms (second or third most preferred terms), there is no hint in the pattern of first-term responses that the use of Omaha terms would turn out to be reciprocal. No such instances occurred in the blood-marriage subnetwork data.

In sum, ego's terms for potential spouse and *potential spouse's siblings* have two distinctly different reciprocals in violation of the axiom of universal reciprocity. On one hand, alter may reciprocate with a term that agrees with the potential spouse designation in accordance with Tax's ([1937] 1955) law of uniform reciprocals; on the other hand, alter may reciprocate

with an equally legitimate term that designates ego as a member of *other generation* in terms of the JRA model, thereby saying "Don't marry here." Denham failed to grasp this distinction in the field at least in part because of his mistaken assumption that Tax's law of uniform reciprocals applied universally.

Data and analyses introduced here raise serious questions concerning the "axiom of algebraic closure" on which the JRA double helix model was based. That axiom says that for any given culture to operate coherently, only a single logic is possible. Yet our investigation of relationships among RB, JRA-1, JRA-2, DRW-1, and DRW-2 at the level of practice shows how they form a coherent dynamical system that can not only be oriented demographically in line with age differences between spouses but also can be strategically inflected with Omaha terminology that blocks otherwise permissible marriages. In other words, we are now discovering that the interplay of different logics can be a key to understanding system dynamics and evolutionary change. Uses of nonreciprocal terms may act as claims on alternative futures and permissions. In contrast, the axiom of algebraic closure so widely used in modeling kinship "systems" is entirely self-contained and static. Our findings for the Alyawarra suggest that it lacks general validity and its use should be carefully circumscribed lest we assume out of existence the dynamical elements operating within the domains associated with kinship networks.

In the Alyawarra case, the full double helix of JRA-2 never exists at any one time. Rather, it is a projection into an unknown future and back to an obliterated or unremembered past. The facts that variant practices are available and that their frequencies change throughout time allow JRA-1 to be dynamic, not static as RB or helical JRA-2 suggests. For example, two generations hence, instead of completing a double helix future, there may be fewer patrilines and larger age differences, and the earlier two generations may no longer be remembered. Something like that was happening in 1971 when members of localized patrilineages no longer remembered the matrilineal ties of deceased ancestors. When that happens, the system may easily transform itself into a different age-skewed model (Tjon Sie Fat 1983) without abandoning the logic of sections or subsections in the RB model. Likewise, intermarriages with neighboring Aranda patrilineages induce additional transformations.

## DRW-3 Model of Cohesion and Coloring versus Motif-Equivalent Roles

To test the convergence properties and reliability of the manually implemented algorithm that produced Figure 5, DRW attempted to replicate the

model by two different means. The first approach used computer algorithms to find regularly equivalent groups. The algorithms proved to be too sensitive to missing data to produce a single reliable solution. Using the most advanced generalized blockmodeling approach (Batagelj 2002; Doreian, Batagelj, and Ferligoj 2004), different random starting configurations produced alternate configurations that fit various models but none conclusively. The second and more successful approach used a different type of blockmodeling based on graph coloring. It rests on regular equivalence with the additional constraint that no nodes belong together if they have a parent, child, or spousal relation. On one hand, if the usual regular equivalence algorithm (White and Reitz 1983) is instructed to incorporate this constraint, the scaling tends to differentiate generations but only within the general model of Figure 7. On the other hand, if we impose nonequivalence among members of the same section, then the scaling recovers sections as equivalence clusters but generational gradations are lost: Because parent/child or spouses are always in different sections, no scaling information is gained from the constraint rule.

If and only if, however, we impose nonequivalence between members of the same subsection, the regular motif-algorithm recovers meaningful subclusters. Model DRW-3 is an outgrowth of that approach (details on these results of using a formal regular equivalence algorithm are available from DRW) and produces a simpler and more determinate understanding of Alyawarra equivalence logic and social structure.

Figure 9 shows a graph coloring based on Model DRW-3, with actual data on generalized sibling sets (males in the same paternal generation in the same patrilineage) and their actual section memberships. Subsection memberships are easily imputed from this graph to each of the nodes. Generalized sibling sets were calculated for the seventeen actual patrilineages that had members in more than two generations. This was done by making male lineage members into equivalence sets according to their distance from the apical ancestor. These lineages had from three to five equivalence sets, with each set other than the apical ancestor having a father in the next higher generation. These classificatory sibling sets constitute the sixty-six nodes of Figure 9. There are three kinds of directed arrows in the figure: The short dotted lines are patrilines (black • dark gray • black; white • light gray • white), the short solid lines are the grandparent/grandchild patrilines between nodes of the same section (and shade), and the long solid lines are the affinal or father-in-law links (black • white • black; dark • light • dark gray).

Within the global moiety-like configuration of sections, the rules of section membership yield two "sides." In side 1, the nodes alternate between dark gray and black in adjacent patrilineal generations; in side 2, between

FIGURE 9
Graph Coloring Based on Generalized Sibling Sets
and Their Actual Section Memberships[1]
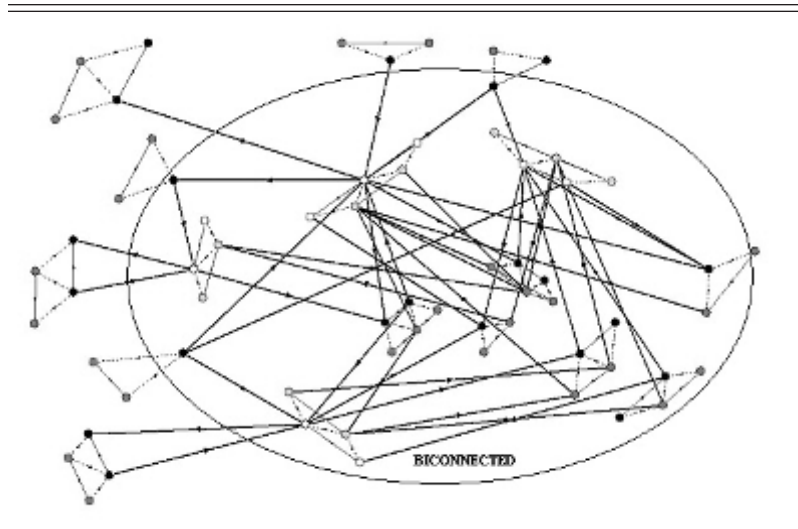


light gray and white. The relation between generationally adjacent nodes with alternating shades is coded with dotted lines and treated as "negative relations." This is consistent with the coloring of a graph in which all negative relations are of different colors. The lineages, then, are the spatially contiguous clusters of nodes with dotted lines connecting alternating colors for actual section memberships of each generalized sibling-equivalence set. Within each cluster, the zigzag dotted line goes from oldest generation to youngest generation.

Between the clusters, we have added a second set of negative arcs that indicate, for the men in that set, the links to their fathers-in-law, indicative of marriages between lineages. It is evident from the rules of section membership that these arcs will connect particular pairs of section shades from opposite sides. In fact, as can be seen from the figure, these connections are always between black and white and between dark gray and light gray, with the father-in-law/son-in-law link running in either direction but never reciprocally. The coloring model in Figure 9 is very close to how the Alyawarra section rules are laid out and therefore to how Alyawarra conceive of section rules.

The nodes *inside* the oval include forty-five sibling equivalence sets in which there is "role interlock" (i.e., there are two or more independent rela-

FIGURE 10
Graph Coloring Based on Generalized Sibling Sets
and Their Actual Section Membership[1]
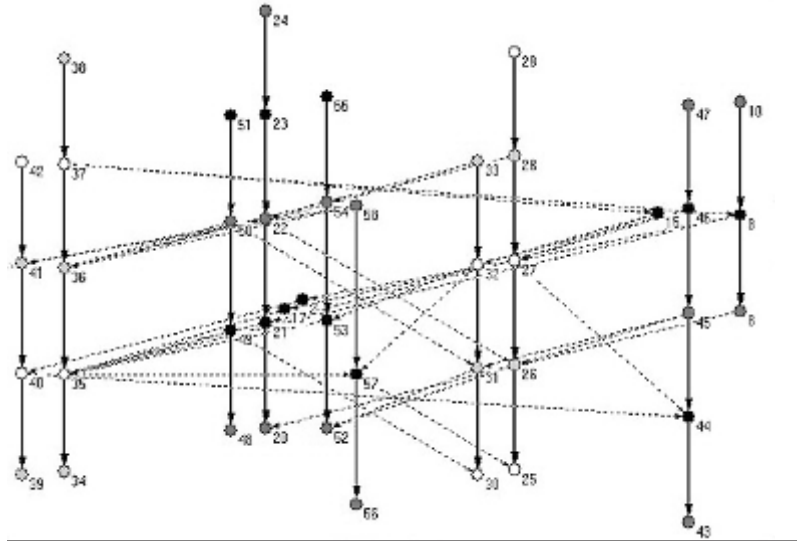


tionships between pairs of nodes within the oval). Technically, this is the bicomponent of the kinship network, and it contains no cut node whose removal would separate the interlocked set of forty-five nodes. The nodes *outside* the oval are distinguished by the fact that there is a single node in each case whose removal would disconnect them from the rest of the graph.

The structural arrangement of the loosely connected nodes outside the oval will fit any model of Alyawarra social structure that is consistent with section memberships. Not so with the interlocked set of forty-five nodes. Their structure may be more tightly constrained and thus provide a key to unlocking further models of Alyawarra social structure.

Now consider Figure 10. Here, we apply the motif-equivalence algorithm used manually to produce Figure 5 to the forty-five nodes within the oval in Figure 9. This process yields a very simple and highly determinate model of the structure. Although the model in Figure 10 is not the only one that fits the structure, it is uniquely the simplest model. It has only four generalized equivalence classes among lineages. Marriages are arranged so that daughters of a given line and section (shade) tend to marry into an equivalence set of husbands just below (older men) and to their left, such that when the leftmost lines are reached, the marriages presumably wrap around in a cylin-

drical manner to the rightmost lines, although there is only one such link in actuality. The ratio of generational time for men and women is 2:1. These age differences are consistent with women's first marriages, and this pattern of marriage is consistent with classificatory MMBDD, MBD, and other marriages that are expected with the various Alyawarra models previously discussed. There are very few exceptional marriage links among these equivalence sets, but those that do occur are consistent with classificatory FZD marriage and with women's marriages later in life as widows, for example. There is only one serious violation of these two alternative types of marriage, which is evident for node 57 of the original sixty-six equivalence sets.

The model in Figure 10, furthermore, is almost perfectly consistent with an eight-subsection system. Subsection relationships are easy to reckon. The first two of the four grouped sets of columns correspond to one set of four subsections, and the last two the opposing subsections: subsections of the same section are always at distance 2 following the angled dotted lines. They are also at distance 2 following the vertical solid lines. Furthermore, subsection memberships are uniquely ascribed in this graph. This is a model that is possibly helical or possibly one of open format that conforms to one of FTSF's simplest models of age-skewed systems (i.e., the one in which male generational time as offspring of first marriages of women runs at twice the age span as that of female generational time). This model apparently "cohabits" with the various other models we have analyzed here but is the simplest model that accords best with a substantial portion of the ethnographic data. It also cohabits with the variant usages of Omaha terminology that we have yet to fully understand but that possibly allow a means of switching marriage strategies in midstream in a very flexible set of options within the social organization. The social structure, once again, is not uniquely determined but is a set of coexisting, more or less open-ended evolutionary possibilities each of which is realized to varying degrees. Finally, although subsection memberships are not named, they are easily and uniquely inferred from knowledge of section memberships combined with genealogical linkages. Because the Alyawarra have unnamed moieties and behavior is unambiguously consistent with subsection membership, it is easy to see that a consistent cognitive model of subsection membership exists that works for all informants.

## Disruption

Perhaps our attempts to understand Alyawarra descent, marriage, and kinship are too clever by half. Do simple demographic anomalies keep the Alyawarra from complying with their own normative expectations? And if demographic or cultural disruption were sufficient to account for the Alyawarra's

failure to comply with their norms, could such disruption plausibly yield unambiguous systemic patterns of the kinds introduced above? We think not.

The fourteen-year H > W age difference is the single most important factor in generating deviations from the norms. Although precise comparative data are lacking, there is no reason to believe that such an age difference is atypical of Central Australian societies. Rather, it is more or less what we would expect when polygyny is common and young women marry shortly after puberty. Assuming that the sex ratio approximates 100 (it is 104 among the Alyawarra), something has to give somewhere, and young men spend many years on average in the queue waiting for wives.

Comprehensive, detailed demographic data for the Alyawarra population appear in Denham (1975). Nothing there suggests that the population is somehow anomalous. The sex ratio is normal, and the sizes of age cohorts among males and females are no more irregular than one would expect in any small population.

The Omaha anomaly does not appear to be related to demographic factors, and, in fact, it may not even be an anomaly. Hiatt (1996:55–56) described a pattern of remapping among the Gidjingali that looks a lot like what we see among the Alyawarra, but he concluded that he had discovered a personal or political usage that constituted a Gidjingali "joke." Perhaps he actually found a highly structured equivalent of our Omaha pattern but saw only the tip of the iceberg and failed to recognize it as such.

We have already dealt with marriage between close classificatory relations but not between distant classificatory kin. Distant classificatory sibling exchange, if it exists, is not detectable in the database for the following reason. Regardless of the kinship terms that two people apply to each other before marriage, they refer to each other as *anowadya* after marriage. *Anowadya* is the term they should use in accordance with the second cross-cousin marriage ideology. Furthermore, this terminological readjustment ramifies further among spouses' consanguines. For example, in 75%–80% of the cases for which data are available, people refer to spouses' F, M, B, Z, S, and D with terms that accord with the model, even though that often yields terms that are incompatible with known and close consanguineal relations between husband and wife. Hence, checking for the exchange of distant classificatory siblings after marriages have occurred leads one into a circular argument. Because we did not originally plan to use these data to prepare this article, Denham failed to elicit kinship reference terms that married couples applied to each other before marriage. That approach has the potential for yielding very noisy data, but it may be the only way to obtain the information required here. The oversight is unfortunate.

All things considered, using disruption to explain (or explain away) complex patterns that fail to conform to normative expectations seems not to be fruitful. Perhaps we are too close to the data to see something that is obvious. But as things stand now, we are pretty sure that we see genuine patterned regularities in the data rather than evidence of noise that might somehow keep the Alyawarra from following their own rules.

## CONCLUSION

The RB normative model functions as a kind of "cognitive core" for the Alyawarra system of descent, marriage, and kinship. It is not incorrect, but it is seriously incomplete and inadequate.

Examination of alternate models of Alyawarra social structure cannot be uniquely resolved into a single model but rather into a nested model with a unique simplest structure embedded in models that are more complex. Each layer of models conforms to actual marriages that are in 98% agreement with the RB section memberships. It is evident that the Alyawarra have a simple and powerful algebraic logic of kinship, but it is far more flexible than the closed-product algebras previously attributed to Australian kinship systems by anthropologists. It is probable that relative products such as Br of Fa are uniquely and consistently defined when individuals generate terminologies at a cognitive level (Pericliev and Valdes-Perez 1998; Read 2001). But even with consistency in reckoning A and B's relation given two or more genealogical paths between them, which is possible only with consistent marriage behavior, it is still not clear that anthropologists are justified in treating whole systems of kinship terms as group algebras, as is common in Australian ethnography.

The elegance of the double helix model for the Alyawarra, which tries to restore algebraic closure to otherwise discrepant reference terminologies, is marred by the fact that patterns of marriage among the deceased are quickly forgotten and no longer cast their shadow as a constraint on future behaviors. A more plausible model is that the "kinship system" can evolve dynamically across a class of network models influenced stochastically by age distributions at marriage in accordance with Tjon Sie Fat's (1983) algebraic model and to incorporate non-Alyawarra lineages in ways that are incompatible with both the RB and the Atkins models, thereby violating the axiom of algebraic closure. An open-format model that does not require the assumption of generational closure is one of the nested models that provide a good fit to the ethnographic data. The open-format model, moreover, is fully consistent with eight-section marriage behavior and the coherent cognition within that

structure that the behavioral consistency renders possible. The eight-section model does not imply a rigid prescriptive system of generalized exchange among lineages but rather a fully flexible system that operates within a set of rules that do not imply algebraic closure of the system.

Given the surprising flexibility of Alyawarra marriage behavior, the problem posed by the widespread extranormative application of Omaha terms disappears: we discover, consistent with that flexibility, recurring patterns in Alyawarra behavior that give people a great deal of discretionary control over marriage by applying Omaha terms nonreciprocally in violation of the axiom of universal reciprocity. The explanation for the use of Omaha kinship terms is straightforward. An English speaker, for example, might have a cousin who is considerably older, and ego might refer to or address this person as *Aunt* or *Uncle* as a token of respect and seniority without any requirement that this usage be reciprocated. Similar variants in usage patterns may occur for the Alyawarra but with one important caveat: Unlike the case of the English speaker, Alyawarra usages have implications for nonmarriagability. This is what we mean by the "variant logic" of Omaha terms. Although these usages seemed to occur without implying consistency or even reciprocity in the use of "Omaha rules" for kinship terms, today's informal patterns of usage can form the basis of tomorrow's formal ones and represent another potential path for the evolution of systematic changes in a kinship system. Such usages are entirely consistent with the flexibility we have found in the other "nested logics" of sections, subsections, and tendencies—with many exceptions, however—toward generalized marital exchanges between lineages.

The field experiment was not only successful, then, but our resultant findings also require fundamental rethinking of models for Australian kinship and classificatory systems generally.

## NOTE

1. Figures 5-10 appear enlarged and in color online at http://www.alc.edu/denham/Alyawarra/03ePst/03edMultiMeas.pdf

## REFERENCES

Atkins, J. 1981. Comment re: Franklin Tjon Sie Fat, more complex formulae of generalized exchange. *Current Anthropology* 22 (4): 390–91.

———. 1982. A family of helical models for age-biased marriage systems. Manuscript. Files of the author.

Atkins, J., and W. Denham. 1981. Comment on "Genealogical Structures and Consanguineous Marriage Systems." *Current Anthropology* 22 (4): 407.

Batagelj, V. 2002. Blockmodeling: POLNET 2002, Summer school on political and managerial networks. Tutorial, University of Konstanz. http://vlado.fmf.uni-lj.si/pub/networks/doc/KN/POLNET.PDF.

Batagelj, V., and A. Mrvar. 1998. Pajek: A program for large networks analysis. *Connections* 21:47–57.

Bell, D. 1993. *Daughters of the dream.* Minneapolis: University of Minnesota Press.

Brudner, L. A., and D. R. White. 1997. Class, property and structural endogamy: Visualizing networked histories, theory and society. *Theory and Society* 25:161–208.

Denham, W. 1975. Population properties of physical groups among the Alyawarra tribe of Central Australia. *Archaeology and Physical Anthropology in Oceania* 10 (2): 114–51. http://www.alc.edu/denham/Alyawarra/index.html.

———. 1978. *Guide to contents, structure and operation*. Vol. 1 of *The Alyawarra ethnographic data base*. HRAFlex Books OI5-001. New Haven, CT: Human Relations Area Files Press. http://www.alc.edu/denham/Alyawarra/index.html.

———. 2002. Group compositions in band societies database. http://www.alc.edu/denham/Alyawarra/index.html.

———. 2003. Alyawarra ethnographic archive. http://www.alc.edu/denham/Alyawarra/index.html.

Denham, W., C. McDaniel, and J. Atkins. 1979. Aranda and Alyawarra kinship: A quantitative argument for a double helix model. *American Ethnologist* 6 (1): 1–24. http://www.alc.edu/denham/Alyawarra/index.html.

Denham, W., and D. R. White. 2002. Sided with Omaha but no twist: Three logics of Alyawarra kinship. Paper presented at the Salon de Refusé, American Anthropological Association Annual Meeting, New Orleans, November 22. http://eclectic.ss.uci.edu/drwhite/Sided02Denham-White.pdf and http://www.alc.edu/denham/Alyawarra/index.html.

de Nooy, W., A. Mrvar, and V. Batagelj. 2005. *Exploratory network analysis*. Cambridge: Cambridge University Press.

Doreian, P., V. Batagelj, and A. Ferligoj. 2004. *Generalized blockmodeling*. Cambridge: Cambridge University Press.

Hammel, E. 1976. The matrilateral implications of structural cross-cousin marriage. In *Demographic anthropology: A quantitative approach*, edited by E. B. W. Zubrow, 145–68. Albuquerque: University of New Mexico Press.

Hanneman, R. A. 1998. Defining regular equivalence. In *Introduction to social network methods*, chap. 8. Riverside: University of California. http://faculty.ucr.edu/hanneman/SOC157/TEXT/TextIndex.html.

Hiatt, L. R. 1996. *Arguments about Aborigines*. New York: Cambridge University Press.

Houseman, M., and D. R. White. 1998. Taking sides: Marriage networks and Dravidian kinship in Lowland South America, transformations of kinship. In *Transformations of kinship*, edited by M. Godelier, T. Trautmann, and F. Tjon Sie Fat, 214–43. Washington, DC: Smithsonian Institution Press.

McConnel, U. 1939–1940. Social organization of the tribes of Cape York Peninsula, North Queensland. *Oceania* 10:54–72, 434–55.

———. 1950. Junior marriage systems: Comparative survey. *Oceania* 21:107–45.

Pericliev, V., and R. Valdes-Perez. 1998. Automatic componential analysis of kinship semantics with a proposed structural solution to the problem of multiple models. *Anthropological Linguistics* 40 (2): 272–317.

Radcliffe-Brown, A. 1930. Social organization of Australian tribes. *Oceania Monographs 1:1–124.*

Read, D. 2001. Formal analysis of kinship terminologies and its relationship to what constitutes kinship. *Anthropological Theory* 1:239–56. http://www.ingenta.com/journals/browse/sage/ant.

Reitz, K., and D. R. White. 1989. Rethinking the role concept: Homomorphisms on social networks. In *Research methods in social network analysis*, edited by L. C. Freeman, D. R. White, and A. K. Romney, 429–88. Fairfax, VA: George Mason Press.

Scheffler, H. 1982. Theory and method in social anthropology: On the structures of systems of kin classification. *American Ethnologist* 9:167–84.

Spencer, B., and F. Gillen. 1927. *The Arunta: A study of a Stone Age people*. London: Macmillan.

Tax, S. [1937] 1955. Some problems of social organization. In *Social anthropology of the North American tribes*, edited by F. Eggan, 3–34. Chicago: University of Chicago Press.

Tjon Sie Fat, F. 1981. More complex formulae of generalized exchange. *Current Anthropology* 22 (4): 377–99.

———. 1983. Age metrics and twisted cylinders: Predictions from a structural model. *American Ethnologist* 10:583–604.

White, D. R. 1997. Structural endogamy and the graphe de parenté. *Mathématique, Informatique et Sciences Humaines* 137:107–25.

White, D. R., and M. Houseman. 2002. Taking sides: From coherent practice to macro organization. Manuscript.

White, D. R., and P. Jorion. 1992. Representing and analyzing kinship: A network approach. *Current Anthropology* 33:454–62.

———. 1996. Kinship networks and discrete structural analysis: Formal concepts and applications. *Social Networks* 18:267–314.

White, D. R., and K. Reitz. 1983. Graph and semigroup homomorphisms. *Social Networks* 5:193–234.

White, D. R., and T. Schweizer. 1998. Kinship, property transmission, and stratification in rural Java. In *Kinship, networks and exchange*, edited by T. Schweizer and D. R. White, 36–58. Cambridge: Cambridge University Press.

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