AMAN | aman12006 | Dispatch: March 16, 2013 | CE: N/A
Journal | MSP No. | No. of pages: 15 | PE: Jon Speilburg

Brokerage and Social Capital in the Prehispanic U.S. Southwest

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ABSTRACT In social network analysis, *brokerage* refers to the processes through which individuals or larger groups mediate interactions between actors that would otherwise not be directly connected. Brokers occupy key intermediate positions that have alternately been interpreted as sources of social capital or potential disadvantages. Recent empirical studies suggest that the relationship between brokerage and rewards or risks varies considerably depending on the nature of interactions in a given setting. In this study, we use a large settlement and ceramic database including sites across the western U.S. Southwest (C.E. 1200–1400) to identify settlements that likely filled brokerage roles in ceramic networks. We develop a new structural measure of brokerage and compare long-term outcomes for settlements characterized by varying degrees of brokerage. We argue that brokerage was not a major source of social capital in our study area, as interactions instead favored the formation of discrete groups over such intermediate positions. [*U.S. Southwest, social network analysis, brokerage, social capital, archaeology*]

RESUMEN En el análisis de redes sociales, intermediación se refiere a los procesos a través de los cuales individuos o grupos más grandes sirven de mediadores en interacciones entre actores que podrían de otra manera no estar directamente conectados. Los intermediadores ocupan posiciones intermedias importantes que alternativamente han sido interpretadas como fuentes de capital social o potenciales desventajas. Estudios empíricos recientes sugieren que la relación entre intermediadores y recompensas o riesgos varia considerablemente dependiendo de la naturaleza de las interacciones en un contexto dado. En este estudio usamos un asentamiento grande y una base de datos de cerámicas incluyendo sitios a través del sur del Suroeste de los Estados Unidos (1200-1400 E.C.) para identificar asentamientos que llenaron los papeles de intermediarios en redes de cerámica. Desarrollamos una nueva medida estructural de intermediación y comparamos resultados de largo plazo para poblaciones caracterizadas por diferentes grados de intermediación. Argüimos que la intermediación no fue una fuente mayor de capital social en nuestra área de estudio en la medida en que interacciones en cambio favorecieron la formación de grupos discretos en vez de tales posiciones intermedias. [*Suroeste de Estados Unidos, análisis de redes sociales, capital social, arqueología*]

There is a long history of research in the social sciences focused on how social relations can enhance or diminish the ability of an individual or group to obtain power, influence, or other advantages. In recent years, much of this research has been couched in terms of *social capital*, defined generally as resources accrued by individuals or larger groups through the possession of a durable network of social relations (Bourdieu 1986; Coleman 1988; Putnam 1993, 2000). Despite the vast literature on social capital in the broader social sciences and the long-standing interest among anthropologists in social relations and networks in general, the concept of "social capital" has been relatively

  DOI: 10.1111/aman.12006

underutilized within anthropology, with several notable exceptions (Patulny and Svendsen 2007; Schneider 2006, 2008; Smart 1993; Svendsen 2006). This reflects broad disciplinary divisions, as sociologists, political scientists, and economists have tended to focus on the structure of social relations as the potential source of influence and power, whereas most anthropologists have emphasized historical contingency and the formation of groups based on specific kinds of relations (e.g., shared culture, ethnicity, practice).[1] Between these two streams of research, however, there is fertile ground for exploring how the structure and content of social relations can intersect to provide or constrain opportunities for individuals and social groups (Adler and Kwon 2002).

In this study, we examine the complex nature of social relations at regional scales by applying models and methods from social network analysis (SNA) to networks of interaction, exchange, and population movement in the late prehispanic U.S. Southwest (C.E. 1200–1400). SNA refers to a broad array of formal approaches directed toward characterizing the structure of relations among social entities (Wasserman and Faust 1994). Classically, such relations are visualized and analyzed using network graphs in which actors, defined as individuals or larger social units, are depicted as nodes, with the social connections among them represented as lines. A key aspect of SNA approaches is that an understanding of relationships and flows of information and resources among actors is seen as essential for understanding the behavior of and outcomes for those actors (Borgatti and Halgin 2011).

Network and relational thinking in general have a long history in anthropology, going back to researchers such as Bronislaw Malinowski and Alfred Radcliffe-Brown (Freeman 2004). Social anthropologists from the Manchester School, in particular, made important contributions to the development of SNA by conducting some of the first formal empirical studies of social networks (Barnes 1954; Bott 1955, 1957) and systematizing many of the theoretical and methodological concepts (Boissevain 1979; Kapferer 1972; Mitchell 1969, 1974; also Nadel 1957). Applications of SNA in anthropology waned somewhat after the 1970s (Knox et al. 2006), but formal SNA approaches have once again made a major resurgence in recent years (e.g., Bernardini 2007; Brughmans in press; Horst and Miller 2005; Johnson et al. 2001; Knappett 2011; Mills et al. 2013; Terrell 2010; Wutich and McCarty 2008).[2] We argue that the time is ripe for anthropologists to engage in interdisciplinary discussions on the nature of social networks, as researchers studying the structure of social relations from other perspectives are increasingly aware that networks are fundamentally influenced by culture (Pachucki and Breiger 2010).

In this study, we explore the relationship between one particular kind of network position, known as *brokerage*, and the outcomes for actors filling this position. Brokerage refers to the process through which an actor in a network (an actor can be an individual or a larger social unit such as a community) mediates interactions among other actors that would otherwise not be connected (Burt 1992). As we discuss further below, there are two primary models used to describe the outcomes of brokerage. These two divergent positions, which we refer to as the individualist and collectivist models, respectively suggest that brokerage is (1) a source of social capital or (2) a potentially risky position for the broker over the long term. We argue that differences in the advantages or disadvantages associated with brokerage may reflect broader differences in the organization of interactions among individuals or larger groups in particular contexts. To test expectations associated with both models, we develop a new structural measure of brokerage and apply this measure to a large settlement and ceramic database covering much of the western U.S. Southwest. We then compare this measure to several settlement population parameters to determine the extent to which brokerage is associated with settlement growth or persistence. Our results suggest that sites filling brokerage roles tend to be among the smallest sites occupied at any given time, in low population-density areas, and are more frequently short lived in comparison to other sites in our sample. Overall, these results suggest that brokerage within our network most closely fits expectations based on the collectivist model, perhaps further suggesting that interactions among settlements and the inhabitants of those settlements were organized similarly to other cases where this model applies. Finally, a consideration of the demographic properties and physical locations of sites fulfilling brokerage roles suggests that brokerage in our study area may have been a strategy directed toward mediating risks associated with agricultural production in marginal environments.

SOCIAL CAPITAL, NETWORK STRUCTURE, AND BROKERAGE

Although there is a general consensus among most researchers that social capital is built from the resources obtained through aspects of social organization including networks and trust, the applications of this concept are astoundingly diverse (Adler and Kwon 2002; Koniordos 2008). In particular, when social capital is translated from a general concept into a specific characteristic of an individual or group, there is quite a bit of disagreement as to what exactly constitutes or generates advantage or influence. Many researchers who emphasize formal network approaches argue that much of the confusion arises when definitions stray from those focused on embedded resources within networks of interaction. From this perspective, social capital is the information, influence, and social credentials obtained through investment in durable social relations, which can further be converted into other forms of capital (Bourdieu 1986; Lin 2001). Although definitional debates are far from resolved, in the context of this study, we rely on this network-based definition of *social capital* and the models it supports.

Within the formal SNA framework, explorations of social capital are most often directed toward identifying and characterizing specific structural positions or relationships that generate advantage for individuals or groups within networks. One of the most commonly invoked structural relationships in recent research is *brokerage*. As described above, intermediate brokerage positions within networks have been interpreted variously as advantageous or risky for the individuals and groups acting as brokers in different contexts. Empirical studies of the process of brokerage in contemporary settings suggest that the relationships between brokerage and rewards likely vary in ways that reflect underlying differences in the nature of social relations in a given context and how they are valued (Xiao and Tsui 2007).

Although the literature is quite diverse, we suggest that there are two major currents of thinking on the potential outcomes of brokerage for the broker. We define these perspectives as the individualist and collectivist models. Anthropologists and social psychologists have often used a dichotomy between individualist and collectivist settings for interaction to describe broad differences in values associated with group membership and identity (Shweder and Bourne 1984; Triandis 1995). In general, individualist settings are those where individuals tend to act and make decisions with a fundamental concern for autonomy, whereas collectivist settings are those where individual decision making is often subsumed by the needs of larger groups. Although this basic division is useful, individualism and collectivism should be seen as opposite poles of a continuum of variation rather than discrete categories (Hollan 1992; Kusserow 1999; Mines 1988). No setting is entirely individualist or collectivist, but there is a considerable agreement among researchers on the characteristics of the extremes of this spectrum (Hui and Triandis 1986). We do not argue that such general models of cultural values associated with interaction among individuals apply directly to our consideration of interaction at the scale of communities. However, empirical explorations of brokerage among both networks of individuals and larger collectives (communities, organizations, etc.) suggest that how interactions are valued in a given setting may be an important factor in determining the rewards and risks of brokerage and the nature of social capital in general (Allik and Realo 2004; Realo and Allik 2009).

What we call the individualist model is most often associated with Ronald Burt and his influential concept of structural holes (Burt 1992, 2001, 2004, 2005; see also Brass 1985, 2009; Granovetter 1973). To Burt, structural holes are gaps in network structure that can potentially be bridged by social relations, linking groups of densely connected actors within a network. Brokers span structural holes and, with a foot in two worlds, have access to diverse sources of information and resources as well as an ability to control flows of information and resources across that network. In this individualist model, an actor's intermediate position is seen as a source of social capital, based on access to resources embedded in diverse networks (e.g., labor, exchange partners, political influence, etc.), which can be converted into material advantage. A broker has an ability to accrue added value through their structural position to the extent to which they can prevent other actors from spanning the same gap in network structure. Thus, brokerage is potentially an arena of competition.

The individualist model of brokerage has most frequently been applied to examinations of networks of economic interaction, career advancement, and interorganizational relations, although the general model has been argued to apply to all manner of situations (Burt 2005). In a number of contexts, individuals acting as brokers within larger organizations have been shown to have better long-term outcomes and rates of advancement than individuals or organizations that do not act as brokers (Burt 1992, 2004; Seibert et al. 2001). In the case of interorganizational interactions, brokerage is often related to long-term survival, economic success, and influence (Fernandez and Gould 1994; Provan and Milward 1995). Thus, in the individualist model, brokerage is seen as a source of social capital, an individual good for the actor in a brokerage position and a factor promoting stratification of influence or success across a network. Importantly, the studies cited above demonstrate broad similarities in the outcomes associated with brokers in a number of settings regardless of whether nodes are individuals or larger collectives, suggesting that brokerage is relevant across a range of social scales.

The collectivist model of brokerage has been developed in recent years in large part as a response to the individualist model espoused by Burt and colleagues. A number of scholars working primarily in non-Western contexts have conducted empirical studies that suggest that, in highly collectivist settings, brokers are not likely to accrue advantages based on their intermediate positions (e.g., Batjargal 2007; Bian 1997; Xiao and Tsui 2007; see also Lee 2009). In such settings, strong commitment among individuals or larger units within tightly connected groups is often valued and promoted over diversity in social relations (Coleman 1988). An actor bridging a structural hole is often seen as manipulative or at odds with cooperative cultural values of the group. Although brokers are found in intermediate positions within a network, in such situations, they are unlikely to successfully control the flow of resources between densely connected groups of actors. Brokers (whether individuals or larger collectives) are often, instead, on the periphery of multiple groups and viewed with a great deal of suspicion by actors on either side of the boundary that they span. Brokerage, especially in such contexts, is a fragile relation that is likely to only persist under limited circumstances such as social or spatial isolation (Krackhardt 1999; Stovel et al. 2012). In large part, the fragility of brokerage arises because it is most advantageous for the broker to promote additional social ties among its relations, a process known as network closure, rather than to maintain an intermediate position. Overall, the collectivist model suggests that brokerage is unlikely to be tied to social capital or advantages for brokers and that, instead, brokerage will often lead to network closure, where relations strengthen between the actors that are brokered through time.

The collectivist model of brokerage relations, like the individualist model, has frequently been explored from the formal social network perspective in relation to career advancement and interorganizational networks, in particular in Chinese organizations (Batjargal 2007; Bian 1997; Xiao and Tsui 2007). Several case studies from these contexts suggest that in networks where closure is valued over brokerage, occupying a brokerage position is often detrimental to the long-term success of an individual or group (Xiao and Tsui 2007). In the collectivist model, brokerage is seen as a highly unstable relation that can have negative consequences for the broker (or at least is a relation unlikely to have positive consequences). Conversely, in such settings, network closure, the creation of densely connected and largely discrete groups of actors, is often seen as a source of social capital for the group as a whole, as dense connections promote trust and facilitate frequent social transactions. A classic example of the collective advantages of closure comes from James Coleman's (1988) discussion of the wholesale diamond market among Jewish merchants in New York, who frequently exchange thousands of dollars in merchandise for inspection with no formal contract. Coleman suggests that such exchanges are facilitated by the closed nature of social networks involving religious, neighborhood, and ethnic ties, which diminish the need for expensive formal mechanisms for insuring exchanges. Coleman (1988) argues that, in such situations, closure provides better outcomes for the network as a whole by both increasing trust among actors and allowing for efficient sanctioning.

Although the methods and terminology differ, archaeologists have independently developed characterizations of network position that closely relate to the concept of brokerage. Based on data from the Formative Mesoamerican center of Chalcatzingo, Kenneth Hirth (1978) defines what he calls "gateway communities" as communities within networks of exchange that are positioned at strategic intermediate points to facilitate the delivery of resources across that network. Gateway communities are typically located along important boundaries and often at physical barriers to transportation. Because of their strategic positions, Hirth argues that gateway communities should flourish and obtain considerable influence (i.e., social capital). Hirth sees the establishment of gateway communities as a top-down process driven by the expansion of networks associated with the emergence of social stratification. This model has also been applied to nonstate contexts, including the Southwest, suggesting that similar processes may have operated at varying scales of social and political complexity (Kohler 1980; Wilcox 2002; see also Schortman and Urban 2012). In a similar vein, Peter Peregrine (1991) has explored the relationship between corridors for exchange and settlement prominence along the Mississippi River. Using formal network methods, Peregrine demonstrates that the massive mound center of Cahokia, located at the confluence of the Mississippi,

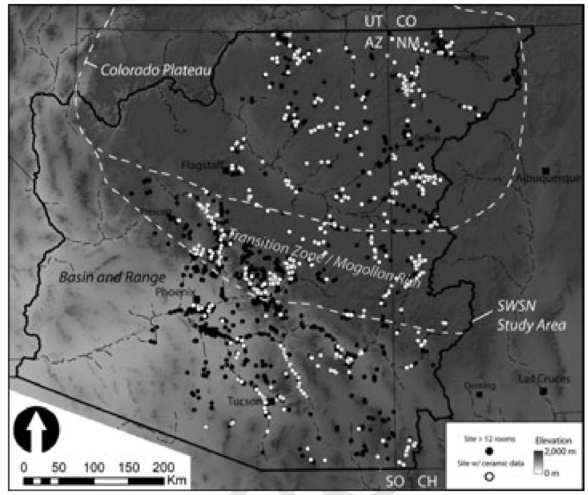

FIGURE 1. *Map of the study area showing all known sites with more than 12 rooms, sites with ceramic data, and major physiographic features and divisions.*

Missouri, and Illinois rivers, was positioned at the point of highest geographic centrality in terms of riverine corridors for exchange. From this, he argues that this intermediate position may have allowed the inhabitants of Cahokia to partially control exchange, perhaps driving the growth of this center. Both of these archeological studies suggest a positive association between intermediate network position and settlement size and prominence essentially analogous to the individualist model of brokerage described above. Importantly, unlike the sociological models of brokerage, these archaeological models also provide specific spatial expectations for the locations of nodes acting as intermediates or brokers within a network.

THE SOUTHWEST SOCIAL NETWORKS PROJECT DATABASE

In this study, we explore the contrasting models of brokerage described above using archaeological data from the Southwest Social Networks (SWSN) Project. The SWSN Project is an interdisciplinary collaborative effort focused on characterizing broad patterns of interaction across a large portion of the U.S. Southwest using formal methods from SNA. The SWSN Project settlement database contains site size, occupation period, location, and architectural information on over 1,700 late prehispanic (C.E. 1200–1500) sites of greater than 12 rooms, spanning a large area west of the continental divide (Mills et al. 2013). This database builds on the earlier Coalescent Communities Database (CCD; see Hill et al. 2004, 2012; Wilcox et al. 2003), which contains information about every documented major settlement across the U.S. Southwest and portions of northern Mexico for the late prehispanic period. The SWSN database also contains painted and plain ceramic type and ware counts, and associated metadata, from over 700 of these sites (Figure 1). These data were gathered from published sources, unpublished notes, new analyses of existing collections, and new

Table 1. *The total number of known settlements >12 rooms in the study area through time and the number (percent) where decorated ceramic counts are available*

	1200–1250	1250–1300	1300–1350	1350–1400
No. of settlements	1,143	1,198	688	583
No. of settlements with ceramic data	279 (24%)	313 (26%)	174 (25%)	144 (25%)

in-field recording conducted by SWSN Project team members. This database is a compilation of an enormous amount of excavation and survey data across the Southwest, representing more than a century of research.

Although the SWSN database contains ceramic data for a substantial number of settlements, it is incomplete (Table 1). Ideally, we would want our characterizations of a network to be based on the "whole network," including all possible actors and all ties. This is the gold standard for many applications of SNA but is rarely attainable at a large scale. Because of this, several researchers have explored the effects of network sampling (e.g., node or edge removal) on various graph- and node-level network indices. These studies suggest that although potential error associated with many measures increases as the sampling fraction decreases, broad characteristics of networks and the relative (i.e., rank-order) values for node-level indices are robust under many circumstances, even when samples of the complete network are small (Borgatti et al. 2006; Costenbader and Valente 2003; Marsden 1993). In this study, because of the potential for increased error associated with network sampling, we take a conservative approach by not relying heavily on the values of network indices for specific nodes but instead limiting our interpretations primarily to broader patterns. Related to this is the question of how the boundaries of a network are defined. Our study area is limited to a portion of the U.S. Southwest, west of the continental divide. During the period considered in this study, this boundary falls along a zone of relatively low population density (Hill et al. 2004) separating the densely populated western Pueblo region from the densely populated Rio Grande to the east, two areas that are increasingly distinct through the period considered here. The definition of this boundary, of course, limits the scale at which our results apply to those areas specifically included. Such geographic-boundary specification is not uncommon in SNA in general (e.g., Galaskiewicz 1979; Laumann et al. 1983) and is an analytical decision consistent with network methods and theory because networks, unlike social groups, "have no 'natural' boundaries" (Borgatti and Halgin 2011:2).

For the current study, we concentrate on those sites with decorated ceramic type–ware counts for the period from C.E. 1200 to 1400.[3] In the U.S. Southwest, ceramic wares are broad and usually long-lived groupings of ceramics defined based on similarities in technology and design, often with geographically cohesive distributions. Decorated wares usually include multiple types, which are finer stylistic designations with shorter intervals of production and use. In the analyses presented below, we rely on ware classifications because these larger categories capture regional-scale variation in ceramic assemblages but are more robust to inconsistencies in recording among observers.[4] Our analyses further focus exclusively on painted ceramic wares because these wares are more frequently used in public contexts and circulated over greater distances than plain ceramics (e.g., Duff 2002; Peeples 2011). Although the details are constantly being debated, most archaeologists agree that decorated ceramics had considerable economic and social value within the highest-order social networks present in the prehispanic Southwest, and as such are reliable indices for both social and material capital at the largest spatial and organizational scales (Crown 1994; Mills 2007).

Our approach defines similarities in the proportions of different decorated wares among settlements (see below) as a proxy for the strength of relations among the inhabitants of those settlements. Numerous studies focused on the circulation and production of ceramics across the Southwest and beyond suggest that similarities in ceramic assemblages can be generated through a number of different processes including but not limited to exchange, emulation, population movement, frequent interaction, and active signaling of social boundaries (Mills and Crown 1995; Stark 1998). At the scales considered here, we argue that patterned similarities capture the effects of all of these processes (and likely others) to provide a general indication of robust relationships among settlements. A decision to make, use, exchange, or discard a specific kind of ceramic vessel is an intentional choice. When wares are used and discarded in similar proportions, this suggests shared consumption practices. We do not claim that individuals within every settlement interacted directly with all other individuals that shared consumption practices, but only that interaction was likely greater among the inhabitants of settlements with similar frequencies of wares than with those who used and discarded quite different sets of wares. Wares in the Southwest have been used in this way in other analyses at large spatial scales to explore the diversity of social relations because they encompass both stylistic and technological information (e.g., Duff 2002; Nelson et al. 2011; Rautman 1993).

The interval considered here represents a period of rapid and widespread change across the study area, characterized by dramatic regional-scale population movements including the migration of people out of the Kayenta region in the northern portion of our study area into central and southern Arizona as

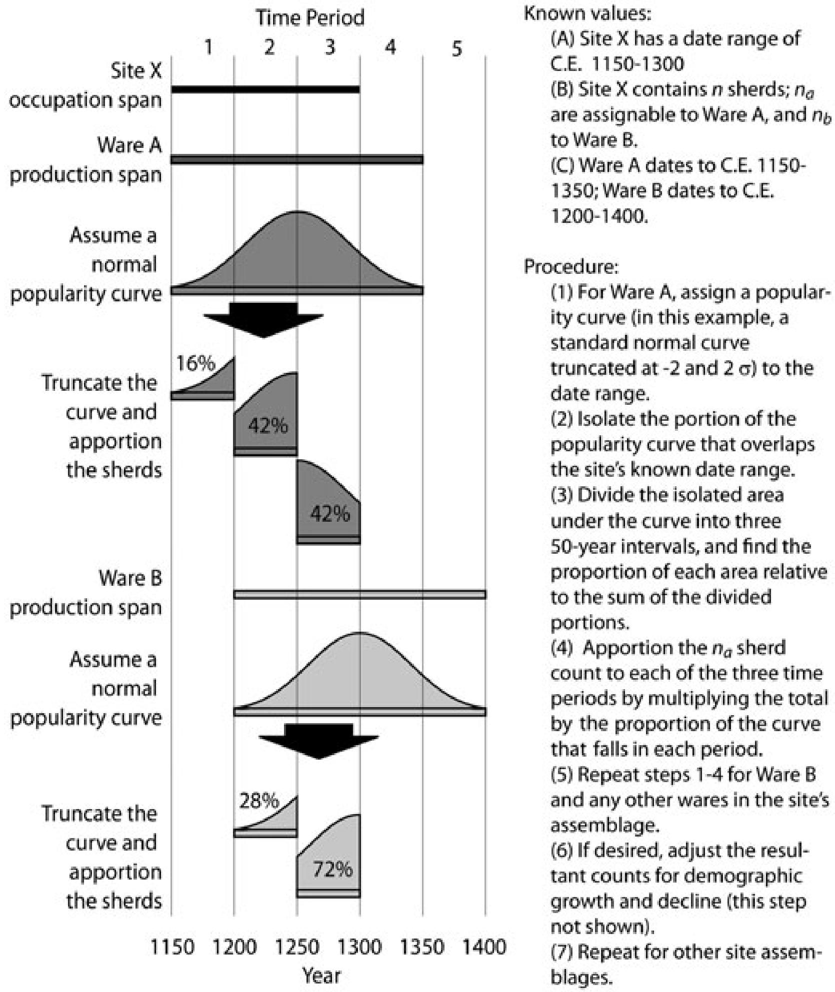

FIGURE 2. *Method used for apportioning ceramic assemblages into temporal intervals. (Adapted with permission from Roberts et al. 2012)*

well as western New Mexico (ca. C.E. 1275–1300; Clark 2011) and the consolidation of populations into clusters of large villages surrounded by unoccupied zones (Adams and Duff 2004; Hill et al. 2004). The dynamic nature of this period allows us to explore how the characteristics of brokers and the process of brokerage may have changed in nature or scale during the massive social transformations associated with this period of population reorganization.

NETWORK METHODS: A NEW STRUCTURAL MEASURE OF BROKERAGE

In the analyses presented below, each settlement with associated painted ceramic counts is treated as a node in a regional network.[5] Using methods described in detail by John Roberts and others (2012) and further explained in Figure 2, raw ceramic counts for each site were apportioned into each of the four 50-year intervals between C.E. 1200 and 1400 in which a site was occupied. This method for apportioning ceramic assemblages takes the date range for a site and the date range for each ceramic type, and assumes a normal popularity curve for each type through time to estimate the proportions of ceramics deposited in each interval in which a site was occupied.[6] This procedure is designed to address problems associated with comparing assemblages from sites with different occupation lengths.

Once ceramic assemblages have been apportioned, we then produce a matrix of similarities among occupied sites for each 50-year interval based on the relative percentages of all apportioned wares. We use the Brainerd-Robinson (BR) coefficient to define the scale of similarity among sites where the similarity (*S*) between site *a* and site *b* is defined as follows:

$$S_{ab} = \frac{200 - \sum_k |P_{ak} - P_{bk}|}{200}$$

where k is all ceramic wares, P_{ak} is the percent of ware k at site a, and P_{bk} is the percent of ware k at site b (Brainerd 1951; Robinson 1951). Traditionally, this measure ranges between 0 and 200, as 200 is the maximum possible difference in ware percentages between two sites (100% + 100%). For the purposes of this study, we divide these scores by 200 so that they range between 0 (indicating no similarity) and 1 (indicating perfect similarity). This change is merely cosmetic but

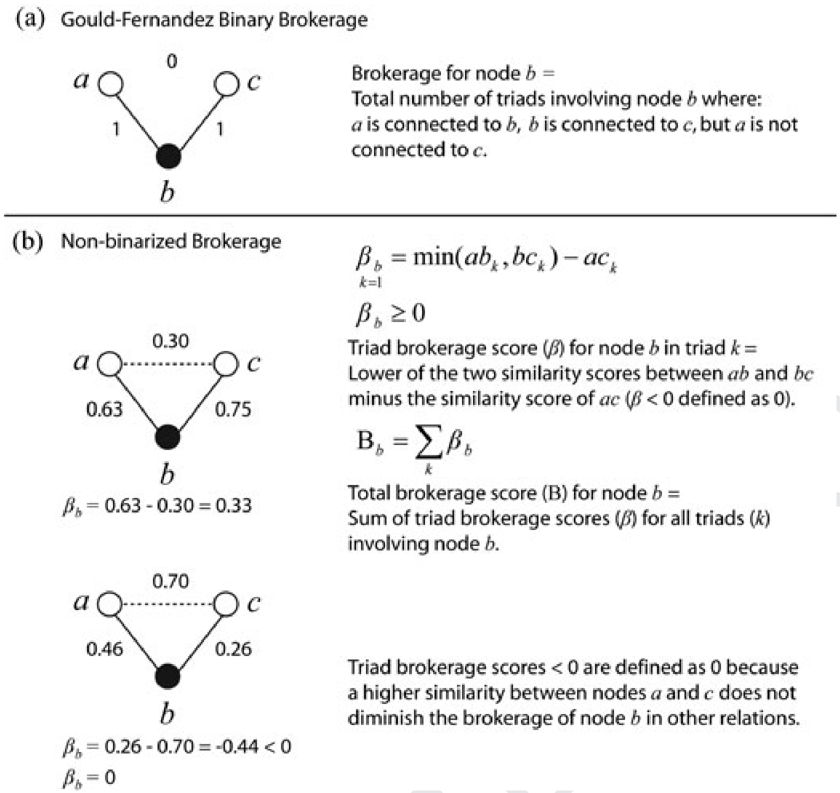

FIGURE 3. *a. Method for calculating brokerage used for binary networks by Gould and Fernandez (1989). b. The new method for nonbinarized relations used in this study.*

helps to simplify the calculation of other network properties. This procedure produces a symmetric matrix of BR similarity scores among all sites, with the number of rows and columns equal to the number of sites. As described above, we treat these BR similarity scores as a general indication of the strength of relationships between sites (i.e., greater BR similarity values suggest stronger potential connections between those sites). Thus, rather than following classical SNA approaches that define a social tie as either present or absent, we measure the potential strength of ties (see also Opsahl et al. 2010). These ties are undirected, meaning that we make no assumptions about the directionality of interaction or influence across these connections.

Using this matrix of BR similarities, we then define a structural measure of brokerage whereby potential brokers can be identified from the ground up within the actor-to-actor network (see Fernandez and Gould 1994; Gould and Fernandez 1989; Kirkels and Duysters 2010). Importantly, this structural definition of brokerage allows us to identify sites with a high potential for acting as brokers but not necessarily sites occupied by people actively mediating relations at a regional scale. We keep this caveat in mind throughout the discussion presented here.

Roger Gould and Robert Fernandez (1989) have previously formulated a useful structural characterization of brokerage based on triads. Using their method, for each set of three sites (i.e., network nodes) within the ceramic network (*a*, *b*, and *c*), site *b* is defined as a broker if *a* is directly tied to *b*, *b* is directly tied to *c*, but *a* is not directly tied to *c*. The total brokerage score for each site is defined as the number of such triads in which a site is involved. In our study, because we calculate similarities in terms of the proportions of ceramic wares among all sites in our sample, rather than simply the presence or absence of ties, we can extend this binary model of brokerage to nonbinarized relations. Figure 3 provides the details of this nonbinarized brokerage measure. In short, we examine every possible relationship among sets of three sites within our network, and for each triad (*a*, *b*, and *c*) the triad brokerage score for site *b* is the minimum BR similarity score of *ab* and *bc* minus the BR similarity score of *ac* (with negative values assumed to be 0). This triad brokerage score ranges from 0 to 0.5.[7] The total brokerage score for each site is then calculated by summing triad brokerage scores across all triads in which that site is involved. This measure is sensitive to the total number of sites in our sample for a given period. Thus, to standardize total brokerage scores, we divide these values for each 50-year interval by the number of sites in our sample for that interval. This standardized total brokerage measure provides a general characterization of the degree to which a site is similar (in terms of the relative proportions of ceramic wares) to pairs of other sites that are not similar to one another. We suggest that settlements characterized by relatively high standardized brokerage scores have

Table 2. *Characteristics of and expectations for brokerage in the individualist and collectivist models*

Model	Relationship between brokerage and social capital	Expectations
Individualist	Brokerage increases social capital and probability for long-term success	Settlement size/longevity will increase in relation to brokerage scores
Collectivist	Brokerage does not increase social capital and may lead to long-term disadvantages	Settlement size/longevity will not increase (and may decline) in relation to brokerage scores; Brokered relations will tend toward closure

a high structural potential for acting as brokers and mediating relations across our network of ceramic similarity. This measure is comparable to other node- and graph-level measures of centrality (e.g., betweenness, transitivity, etc.) calculated based on weighted ties (e.g., Freeman et al. 1991) but is particularly well suited to situations where the relationships among nodes are based on relative similarities.

EXPECTED OUTCOMES FOR BROKERS

The individualist and collectivist models described above suggest dramatically different relationships between brokerage and social capital, which further suggest different outcomes for brokers over the long term. Proponents of the individualist model argue that brokers obtain social capital based on their intermediate positions, which translates into long-term advantage, success, growth, and persistence. Conversely, the collectivist model suggests that brokers are unlikely to obtain social capital or any long-term advantages based solely on their intermediate positions in highly collectivist social settings, and in fact they may even face disadvantages by being on the periphery of multiple groups. Further, this model suggests that brokerage is a fragile position and brokered relations should tend toward closure over time.

Based on these disparate perspectives, we can develop archaeological expectations for the likely characteristics of settlements acting as brokers in terms of both models (Table 2). We suggest that demographic properties of settlements including their size, local population density, and persistence can be used to characterize differences in outcome attributable, in part, to differences in network position. Increased persistence and size may not always indicate increased social capital and the long-term advantages associated with it, but migration (especially at regional scales) is often associated with considerable social and economic costs, often resulting in migrants having decreased social status in destination areas. Thus, for the purposes of this study, we interpret increases in settlement size, local population density, and longevity as general indicators of increasing relative advantage and success at the scale of settlements and regions. We do not suggest that network position is the only factor driving differences in relative advantage but, rather, that by documenting robust patterns in the relationship between brokerage and outcomes for settlements, we should be able to characterize the general nature and direction of the relationship between brokerage and social capital.

If brokerage increases social capital, as the individualist model suggests, we would expect sites in brokerage positions to gain prominence and influence in regional networks, the benefits of which are likely to translate into material advantage (e.g., access to labor, diverse exchange partners, etc.). Such material advantages should further promote settlement growth and persistence over the long term. Thus, if brokerage was a major source of social capital in our network, we would expect sites with the highest structural potential for brokerage to be among the longest-lived and largest sites within our sample. This characterization is similar to the archaeological models put forward by Hirth (1978) and Peregrine (1991) in which settlement growth and importance is positively related to intermediate network positions.

If the collectivist model provides a better fit for the processes governing interaction in our network, we would instead expect no positive relationship between brokerage and social capital or material advantages that might promote settlement growth or longevity, and might even see a negative relationship because of the potential risks associated with brokerage. Thus, we would expect sites with the highest structural potential for brokerage to be among the smallest and shortest lived in our network for any given period. Further, under the collectivist model, we would also expect brokerage relations to show a marked tendency toward closure, seen as a source of social capital for the network as a whole, where pairs of sites that are brokered become more similar to each other through time, effectively diminishing the role of the broker.

BROKERS IN THE LATE PREHISPANIC U.S. SOUTHWEST

Using the methods outlined above, we calculated brokerage scores for all sites in our database for each of the 50-year intervals between C.E. 1200 and 1400. As noted above, brokerage scores are influenced by the number of sites in a network, so we standardize these scores by dividing total brokerage for each site for each interval by the number of sites occupied in that interval. Figure 4 shows all sites for each interval with points scaled based on their standardized total brokerage scores. As these maps illustrate, sites with high standardized brokerage scores tend to be spatially

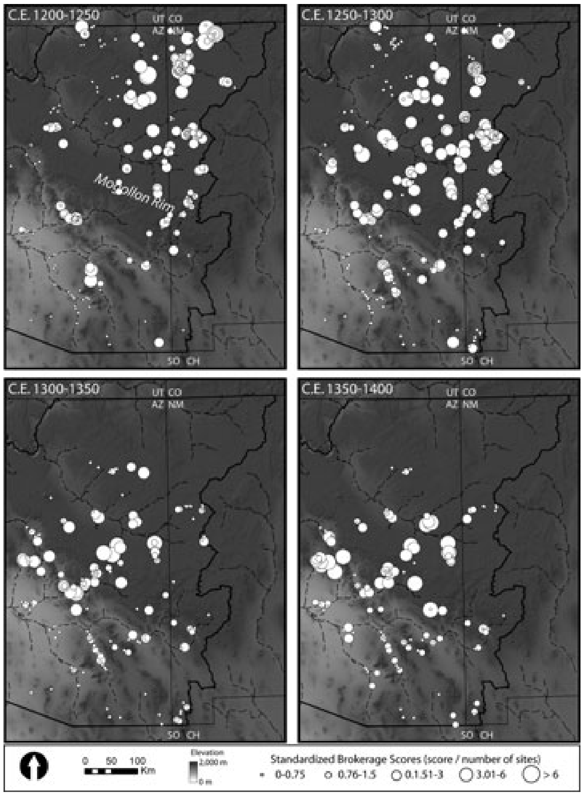

FIGURE 4. *Maps showing the distribution of standardized total brokerage scores through time.*

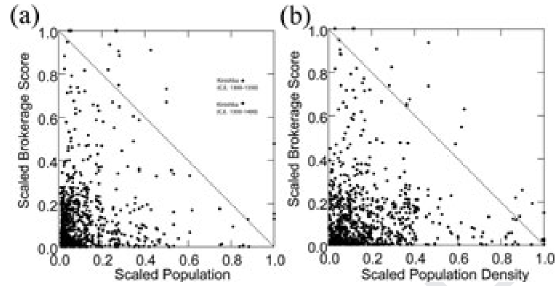

FIGURE 5. *Scaled brokerage score for each site plotted against scaled site population (a) and scaled population density within a ten-kilometer buffer around each site (b).*

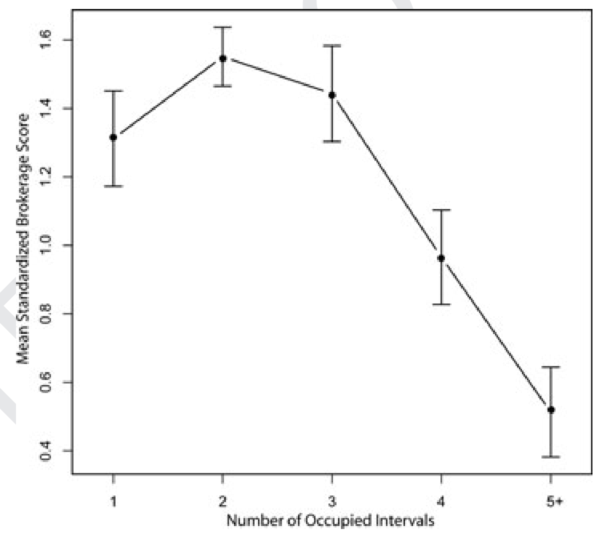

FIGURE 6. *Mean standardized brokerage scores by number of occupied 50-year intervals. Confidence intervals for each point represent one standard error above and below the mean.*

concentrated during each interval, but the locations characterized by the highest scores change through time.

Prior to C.E. 1300, sites with the highest brokerage scores are almost exclusively located on the Colorado Plateau in the northern half of our study area, in particular along the Arizona–New Mexico border. An examination of the specific relationships for these sites suggests that they have diverse ceramic assemblages, including wares common across many portions of the northern Southwest, but they generally lack wares that are common south of the Mogollon Rim, a prominent geographic barrier in the region. This suggests that the sites with the highest potential for brokerage at this time were well positioned to mediate relations among different portions of the northern Southwest, but there were likely fewer connections that spanned the Mogollon Rim.

After C.E. 1300, there is a dramatic increase in brokerage scores for sites along either side of the Mogollon Rim and nearby transition zones. Indeed, by C.E. 1350, essentially only sites in the central portion of the study area along this transition zone and nearby areas—including the Petrified Forest, Silver Creek, Upper Little Colorado, Mogollon Rim, and Perry Mesa areas—have high brokerage scores. The settlements with the highest brokerage scores after C.E. 1300 have diverse ceramic assemblages but, unlike earlier periods, the most common wares are frequently found on both sides of the Mogollon Rim (Jeddito Yellow Ware, Roosevelt Red Ware, White Mountain Red Ware, and Zuni Glaze Ware). This suggests that, after C.E. 1300, sites with a high potential for brokerage were well positioned to mediate connections that spanned long distances across this transition zone. The concentration of sites with high brokerage scores along either side of this prominent physiographic and cultural boundary (Herr 2001) fits the general expectations for the location of gateway communities outlined by Hirth (1978).

Next, we consider the relationship between population and brokerage through time. In this study, we use population estimates for each settlement previously produced for sites in the CCD. These population estimates are based on room counts and occupation spans along with estimates of site occupancy using growth curves or empirical information on site growth where available. Population estimates are divided into the same 50-year intervals used for our network data (see Hill et al. 2004). We calculate local population density by taking the total estimated population within a ten-kilometer buffer around each site. To more easily compare population and brokerage values through time, we scale values for both site population and population density within each time period by dividing values by the largest

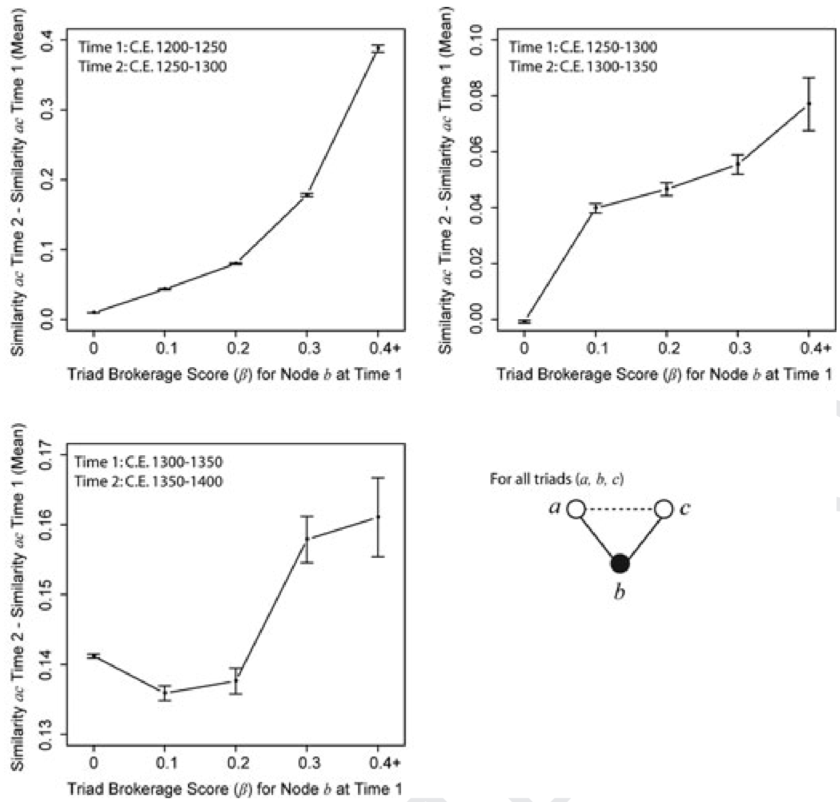

FIGURE 7. *Triad closure as a function of brokerage. These plots show the triad brokerage scores (rounded) against the mean change in similarity between brokered nodes for consecutive time periods. The positive trends in the three graphs indicate that high-brokerage triads at time 1 predict a tendency toward triad closure at time 2. For a given triad, closure is defined as a decrease in similarity between brokered sites.*

population value or density value obtained for that period so that all values range between 0 and 1. We similarly scale the total standardized brokerage scores for each period to range between 0 and 1 by dividing scores by the maximum value obtained for each period. This rescaling allows us to compare relative differences in population across multiple periods while controlling for the effects of increasing site size through time.

Figure 5 shows the scaled total brokerage score against the scaled population by site and scaled population density around each site. Interestingly, both of these plots are essentially triangular, with very few sites characterized by high relative population or population density and high brokerage. Indeed, only one site is characterized by high relative population and brokerage for either plot, specifically Kinishba Ruin just south of the Mogollon Rim. Kinishba Ruin is large (∼800 rooms), but it is also one of the most spatially isolated sites in our site study area (Cummings 1940). There are only two other contemporaneous major sites within about a day's walk from Kinishba in any direction. Overall, this suggests that sites with a high structural potential for acting as brokers in our study area tend to be relatively small, in low population-density areas, or in spatially isolated locations.

Figure 6 illustrates the relationship between brokerage and site persistence or occupation span, measured as the number of 50-year intervals between C.E. 1200 and 1500 in which a site was occupied. As this plot shows, for sites occupied for two or more intervals, brokerage scores tend to decrease the longer a site is occupied.[8] Sites with the highest structural potential for brokerage during any period tend to be relatively short lived. Further, the longest-lived sites tend to have the lowest brokerage scores for all periods in which they are occupied. Overall, this suggests that brokerage is generally negatively correlated with settlement persistence in our study area.

Finally, we consider evidence for closure. As described briefly above, if brokerage leads to closure within our network, we would expect two sites that are linked by a broker to become more strongly connected to each other through time. To test this possibility, we first find all sites that were occupied in each of the three sets of consecutive intervals for which we have data (1200–1250 and 1250–1300; 1250–1300 and 1300–1350; 1300–1350 and 1350–1400). We then compare triad brokerage scores (β) among these sites for the first period in each set (e.g., C.E. 1200–1250) against the change in BR similarity scores through time between the two brokered sites in that triad (e.g., BR similarity between brokered sites in 1250–1300 minus BR similarity between the same two sites in 1200–1250). Such a comparison allows us to directly assess the degree to which brokerage in one period relates to increases or decreases in similarity among the two brokered sites in the next period. Specifically, if the process of closure is at work, we would expect that, as brokerage increases for one site in a triad, the other two brokered sites in that triad should see an increase in BR ceramic similarity scores in the subsequent 50-year interval. Figure 7 shows the results of this comparison. For the purposes of this figure, we excluded all triads where the similarity scores between the two brokered nodes changed by less than one percent, because these relationships almost exclusively represent sites with extremely small BR similarity scores for either period. This figure illustrates that greater brokerage scores for particular triads tend to result in increased ceramic similarity among brokered sites in subsequent time periods. Although the magnitude of this increase varies through time, a positive relationship is present for all intervals for which we have data. Overall, this suggests that relations in our network do show strong and consistent tendencies toward closure.

CONCLUSIONS

The results presented here suggest that sites with the highest structural potential for brokerage tend to be among the smallest sites occupied in a given interval, located primarily in low population-density areas, and relatively short lived (or at least not among the longest-lived sites). Further, pairs of sites that are brokered in our network show a strong tendency toward closure—that is, increased similarity through time. Although our structural measure of brokerage can only suggest which sites or areas may have been actively mediating social relations at a regional scale, the consistency in the characteristics of sites with high brokerage scores and the high degree of spatial concentration during each interval suggests that our measure does likely capture broad patterns of actual brokerage at regional scales. Further, the typical characteristics of brokers suggest that brokerage was likely not a major source of social capital or advantage in our southwestern case study—or at least not in ways that translated into increased site size, local population density, or longevity.

Based on the results described above, we argue that the network of ceramic similarity in our study area shows strong similarities to expectations based on the collectivist model of brokerage relations. From this, it could be argued that the production and circulation of decorated ceramics among settlements were largely organized in ways that rewarded network closure at a regional scale (i.e., the formation of dense and largely discrete groups) over the long term, rather than the maintenance of intermediate positions such as brokerage. From this, we might expect broader similarities in the nature and motivations for interactions in our case study and other networks of interaction that also fit the general collectivist model. We do not argue that such similarities necessarily suggest a common causal explanation for the relationship between brokerage and social capital in our network and contemporary networks where the collectivist model also fits, but simply that similar mechanisms for interaction were likely involved (see McAdam et al. 2001 on mechanical similarities). Importantly, the results presented here are in line with previous studies in the U.S. Southwest, which suggests that conformity in social relations in middle-range and tribal societies may facilitate cooperation and reduce social stresses associated with increasing populations (Kohler et al. 2004; Nelson et al. 2011).

One question that the results presented here raise, however, is that if brokerage is not associated with increased social capital or advantage over the long term, how and why did settlements end up filling brokerage roles in such a regional network? A number of previous studies in the U.S. Southwest have suggested that the environmental marginality of the Southwest may have promoted the creation of expansive and potentially diverse networks as a means for buffering risks associated with agricultural production, especially in low population-density regions (e.g., Rautman 1993). Such risk-buffering strategies were likely one factor that would have made brokerage positions tenable, and perhaps even desirable, over the short term, whether or not the residents of such settlements actively sought to position themselves as brokers. At the same time, the diversity of distant interactions characteristic of brokerage relations and ever-changing local populations that often characterize settlements in low population zones likely would have hindered community stability over the long term (see Herr 2001).

Beyond expectations based on sociological models of brokers, our study also suggests that location played an important role in the process of brokerage. Settlements with the highest brokerage scores were increasingly concentrated along either side of the Mogollon Rim and nearby transition zones through time. This broad transition zone is a major physiographic break across the U.S. Southwest, and it has often been described by archaeologists as a cultural boundary, lying along the edges of traditionally defined archaeological culture areas. Many of the areas characterized by sites with consistently high brokerage scores are also areas with evidence for occupation by diverse groups of people, including migrants with histories from and social connections to many portions of the Southwest (see Duff 2002; Mills 1998). This diverse environment also appears to have been the location of the earliest manifestations of widespread religious and social transformations characterizing much of the Southwest in the 14th century and later (e.g., the Katsina religion and Southwest regional cult; see Adams 1991; Crown 1994). As this suggests, although settlements that likely acted as brokers at regional scales may have been somewhat smaller and more short lived than many sites in other portions of the study area, such areas were also likely socially creative because they were characterized by diverse groups of individuals who negotiated differences and created new institutions and practices that facilitated cooperation (see also Duff 2002; Duff and Schachner 2007; Peeples 2011). Importantly, areas with a high structural potential for brokerage, characterized by diverse social connections, may have also been well positioned to facilitate the rapid spread of such new social institutions and practices across the greater Southwest during the late-13th- and early-14th-century social transformation.

As this case study suggests, broad similarities and differences in the settings of social networks and how interactions are valued can have a fundamental influence on the rewards or risks faced by actors in those networks. We have highlighted a general distinction between brokerage and closure here, but there are likely many other important dimensions of variation that can influence outcomes for network actors. Sociologists and others engaged in formal SNA studies are increasingly coming to terms with the roles of history, space, and culture in mediating the outcomes of networks (Pachucki and Breiger 2010). Sociocultural anthropologists and archaeologists are well positioned to add to this discussion by identifying specific mechanisms that can influence the rewards and risks meted out through networks. Beyond this, archaeologists may be in a unique position to explore such processes over long timescales and across a broader array of social and political scales than have typically been explored in other fields. This broad perspective is particularly important as the relationship between cultural–historical setting and network development has been implicated in models of emerging social stratification and complexity (e.g., Braun and Plog 1982; Hirth 1978). We argue that formal network methods and models are particularly well suited to archaeological data and are likely to generate new and exciting directions.

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NOTES

Acknowledgments. The research presented here was conducted as part of the SWSN Project, supported by the NSF Human and Social Dynamics program (University of Arizona no. 0827007 and Archaeology Southwest no. 0827011). We would like to thank the numerous individuals and institutions who provided the data and access to collections necessary to create the SWSN Project database. We would further like to thank the School of Advanced Research in Santa Fe, New Mexico, for hosting the seminar where this article was initially presented. We are grateful to Ronald Breiger, Jeffery Clark, Barbara Mills, John Roberts, and the entire SWSN Project team for providing comments on earlier drafts of this article and for the many productive discussions that led to the development of the ideas presented here. Finally, we would like to thank Michael Chibnik and the seven anonymous *American Anthropologist* reviewers who provided insightful and thorough comments and suggestions that helped us to improve the presentation and clarity of our arguments.

1. A major exception to this broad characterization is that economic anthropologists have frequently explored the relationship between network position and influence, power, or other outcomes (e.g., Bohannan and Dalton 1962; Sahlins 1960).
2. As Knox and others (2006) note, however, relational thinking and the network metaphor continued to be incorporated into anthropological research, especially for studies of economic relations and kinship.
3. In the analyses presented below, we only include sites with at least 30 decorated ceramic sherds identified to type.
4. Ceramic type and ware names in the SWSN database were standardized among the various projects included into a single coding ontology. A list of all types and wares and associated date ranges is available at http://www.archaeologysouthwest.org/SWSN.
5. All analyses described here were conducted using scripts written by the authors for the open-source R statistical program (version 2.15). These scripts are available from the authors on request.
6. Initial apportioning is based on type designations (where available) rather than ware designations, because types typically have shorter durations than wares. After this procedure, time-apportioned ceramic assemblages are grouped into wares.
7. This measure cannot exceed 0.5, because Brainerd-Robinson similarity scores for all sites in a triad are influenced by changes in similarity between any two of the three nodes involved in that triad. Consider a triad involving three sites (*a*, *b*, and *c*). If sites *a* and *b* have 75 percent of their ceramic assemblages in common (i.e., BR similarity score of 0.75) and sites *b* and *c* also have 75 percent of their ceramic assemblages in common, sites *a* and *c* must have at least 25 percent of their assemblages in common (i.e., the minimum possible similarity score between sites *a* and *c* is 0.25). In this case, the triad brokerage for site *b* would be $0.75 - 0.25 = 0.5$. Accordingly, any combination of similarity scores between three nodes is incapable of producing a triad brokerage score greater than 0.5.
8. Brokerage scores were standardized by period by dividing them by the number of sites in our sample for each interval.

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Query

Q1 Author: please advise as to whether “adapted” (rather than “reprinted”) is correct as set for Figure 2, as it has been revised.