

INTERPERSONAL PROXIMITY IN SOCIAL AND COGNITIVE SPACE

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We explore how humans solve some problems of living in a social world. In particular, we focus on the ability to see affiliation or alliance patterns in social communities. We draw on data from two naturalistic studies in which subjects were observed interacting and required to reveal their perceptions of the patterning of that interaction. In both cases, the observed interaction patterns and the subjects' reports correspond closely. But in both cases, subjects are shown to simplify and exaggerate the observed patterning. Individual subjects, moreover, appear able to reveal more details about interaction patterns among those with whom they interact frequently, while they gloss over details involving interaction among others with whom their own interaction is infrequent.

In recent years, there has been an increasing interest in the question of how much humans and other primates are aware of, and use, information on the patterning of association among individuals in their own communities. A number of writers have observed that evolutionary theory indicates that primates generally, and humans in particular, gain in fitness by being sensitive to the social structure in which they are embedded. These writers all agree that, since primates are social animals, skill in dealing with conspecifics is critical to their adaptation and reproductive success (Lachman and Lachman, 1979). Thus, Cheney, Seyfarth and Smuts (1986, p. 1364), arguing from evolutionary principles, suggested that primates generally should "not only recognize the close associates of other animals but also recognize that certain sorts of relationships share similar characteristics, regardless of the particular individuals involved." Sailer and Gaulin (1984, p. 91) argued that among

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primates, "individuals would be especially attuned to the kinds of social grouping that typically occur in their own species." And Freeman, Freeman and Michaelson (1988, p. 416) proposed that, "humans, even more than their primate cousins, should be relatively adept at tasks involving the perception and recall of . . . social relationships among their peers."

As noted by Cosmides and Tooby (1994a, p.53), early hominids were confronted with a variety of relational problems: "foraging (hunting and gathering), kinship, predator defense, resource competition, cooperation, aggression, parental care, dominance and status, inbreeding avoidance, courtship, mateship maintenance . . . and so on." Problems of this sort involve complex reasoning about social life. Thus, among humans, natural selection has led to the ability to process social information. Such a selection process suggests that humans have evolved specialized cognitive mechanisms for dealing with the social world.

Actual research on human cognition, however, has displayed very little interest in the problem of how people organize information about social structure. Indeed when psychologists have constructed models of social perception, they have focused exclusively on attributes of the actors involved; they have been concerned with the question of how subjects might represent other people in terms of such personal characteristics as gender, age, occupation and ethnic background (Brewer, 1988; Brown & Wootton-Millward, 1993; Fiske & Neuberg, 1990; Ostrom, Carpenter, Sedikides & Li, 1993).

Physical characteristics are neither the only nor necessarily the most relevant factors involved in social perception. A number of studies have recognized the import of action in understanding human behavior. Much of the experimental evidence is based on infants' perceptions of motion for inanimate objects (see Carey & Spelke, 1994, for a review). Leslie's work on pretense (1987) and on agency (1994) has examined the study of interaction among two or more individuals. While these studies certainly are related to the problem of how social interaction is structured, it is not their main focus. As pointed out by Leslie, "Understanding agents and action, however, requires an analysis over a larger scale to capture relations between agents . . ." (1994, p.137). Thus, problems of how subjects represent the patterning of social *relationships* have been neglected.

Moreover, most of what is known about social perception has been obtained through laboratory experiments with subjects who have no intimate association with the target individuals. In the ordinary world, social knowledge is seldom acquired in this sort of splendid isolation. Individuals acquire information by interacting with other individuals in complex social contexts. Recently, researchers have called attention to

our lack of information on the kinds of social perceptions that emerge in natural settings (Ebbesen and Konecni, 1980; Funder, 1987; Kanfer and Tanaka, 1993). Murphy and Medin (1985, p. 314) put the problem succinctly in these words: "Future research on concepts and categories can help . . . not by controlling the effects of world knowledge and experience, but by exploiting them—by bringing the concepts into contact with the whole cognitive system that created them."

The present paper is an exploratory study designed to focus on the "social" part of social perception. First, we will introduce data that will allow us to examine the patterning that is displayed when human interaction is observed in natural social contexts. Then, we will introduce data that will permit us to uncover the patterning that human subjects reveal when they are asked to describe those association patterns. And finally, we will define a procedure for examining the similarities and differences between these two kinds of patterning.

ASSOCIATION PATTERNS AND THEIR PERCEPTION

Human interaction is patterned. As Roger Brown (1965, p. 48) described it, people "do not randomly approach one another . . . some are usually together, some meet often, some never." Indeed, whenever human association is examined, we see what can be described as thick spots—relatively unchanging clusters or collections of individuals who are linked by frequent interaction and often by sentimental ties. These are surrounded by thin areas—where interaction does occur, but tends to be less frequent and to involve very little if any sentiment.

The presence of such thick spots and thin areas has been reported again and again whenever interaction has been observed in natural settings (Cohen, 1971; Davis, Gardner & Gardner, 1941; Festinger, Schachter & Back, 1950; Freeman et al., 1988; Homans, 1950). Human interaction is typically patterned in such a way that people are divided up into more or less bounded clusters, or groups. Within each cluster, people are mutually supportive; between groups, they are potential competitors.

Humans, moreover, generally do seem to be aware that interaction is patterned in this way. In ordinary conversation, people use the words "group" and "clique" to describe collections of individuals who are linked by regular interaction. Used in this sense, the group idea is based on the patterning of interpersonal ties. This is precisely the point made by Olmstead and Hare (1978, pp. 10-11) in their proposed distinction between ordinary categorization and categorizing people into groups:

To assign persons (or things, for that matter) to categories or classes or types on the basis of some common characteristic such as age, sex, or political

party affiliation is, as the saying goes, to "group" them. It is quite clear, however, that the result is something other than a family or friendship group. In the first-mentioned use of the term, individuals are put together "on paper"; in the latter case there is interaction among persons . . .

Thus, individuals who appear to be closely associated are "grouped" together and assigned to a single category; those who interact rarely are put into different "group" categories.

Perhaps the best evidence that people think that the patterning of this kind of friendly association divides everyone up into categories comes from an experiment by DeSoto (1960). DeSoto examined how quickly human subjects could learn a miniature "social structure." He varied both the expectations of subjects entering the experiment and the structural properties of the patterns being learned. Subjects who were told that they were learning who "likes" whom were able to learn a structural form that was both symmetric and transitive in significantly fewer trials than when they were presented with any other form.

These subjects apparently entered the experiment with the prior belief that the kind of friendly association we are examining here includes two properties: symmetry and transitivity. Symmetry, the ordered pair $\langle x, y \rangle \in F$ if and only if $\langle y, x \rangle \in F$, occurs when actor x associates with actor y , and actor y also associates with actor x . Transitivity, $\langle x, y \rangle \in F$ and $\langle y, z \rangle \in F \Rightarrow \langle x, z \rangle \in F$, is characterized by the notion that friends of friends are friends. And, as Davis (1967) proved, that is precisely the kind of relation, both symmetric and transitive, that is categorical. Within a category, everyone is associated with everyone else and no category member is associated with any member of another category. In the minds of these subjects, then, interpersonal association appears to be structured in terms of categories; it is patterned in such a way that people can be divided up into groups.

This process has also been illustrated in natural settings. Cairns, Perrin and Cairns (1985) focused their research on a community of adolescents in a junior high school. Their subjects were asked to name classmates "who hang around together a lot." Although the instructions did not require it, subjects consistently responded to the request by assigning each individual to one and only one of a collection of non-overlapping categories. Thus, these subjects' spontaneous responses to the question produced a strict partitioning of the individuals into non-overlapping categories.

Yet, though this evidence suggests that the notion of group is categorical in the minds of human observers, it is clear that the observed patterning of human interaction is not. In a comparative study of observed association patterns in seven communities, Freeman (1992a)

showed that, although collections of individuals did exhibit the kinds of clustering described above, the patterning consistently violated transitivity; it could not be organized into categories in any direct way.

It would seem, then, that people are somehow able to reorganize their experiences in such a way that they can "see" a categorical pattern in a world of experience that is not simple enough to permit categorization. In effect, when they are exposed to patterns involving recurrent association in the world of experience, people seem to reorganize that experience in order to fit it into a categorical scheme. Our aim here is to discover just how that reorganization is accomplished. In the next section we will review some earlier work on cognitive categorization.

COGNITIVE CATEGORIES

The notion that people impose a categorical structure on the world of experience is certainly not unique to the area of interpersonal association. Increasing evidence suggests that people use categorical schemes to organize their knowledge about a wide range of experience, so much so that categories are increasingly taken to be the fundamental "building blocks for human thought and behavior" (Medin, 1989). Objects of all kinds are mentally grouped into categories according to their characteristics (Medin, 1989; Mervis & Rosch, 1981; Oden, 1987; Rosch, 1978; Tversky & Hemenway, 1984).

A good deal of effort has gone into discovering exactly how people reorganize their experience in order to construct cognitive categories. It usually has been argued that this process is somehow based on similarity (Medin, 1989; Murphy & Medin, 1985; Rosch, 1975; Rosch & Mervis, 1975; Tversky, 1977; Tversky & Hemenway, 1984). Objects that possess similar characteristics, features or attributes are classified together into the same category; those that differ fall into different categories.

Similarity unquestionably plays an important role in our categorization process (see Goldstone, 1994, for a review). Even when subjects are given a clear task with specific criteria for categorization that do not consist of similarity assessments, similarity intrudes (Allen & Brooks, 1991; Webster, 1993). Similarity, however, is not the basis for all category types. Barsalou (1982, 1983, 1991) has shown that categorization can be context-dependent with "ad hoc" categories developed to satisfy any given situation. Several others (Boster & Johnson, 1989; Carey, 1985; Keil, 1989; Murphy & Medin, 1985) have shown that categorization can be theory-dependent with categories developed based on specific theories and levels of experience that people possess.

In the current situation, the individuals in question are not being categorized according to the similarity of their social characteristics, but

rather in terms of how frequently and intimately they interact—their social proximity.¹ While the same kinds of cognitive processes may occur with social proximity data, we cannot simply rely on the established models that were built for categories based on similarity of attributes. The problem here is to determine how people organize their experience with social proximities in order to be able to treat them in categorical terms.

Different individuals, of course, have different experiences of who interacts with whom and how much. We would not, therefore, expect every individual to have exactly the same mental image of social structure. But there is evidence that at least the main patterns of behavioral affiliation and avoidance are regular and recurrent, even in different contexts (Freeman, 1992a; Webster, Freeman and Aufdemberg, 1994). We would expect, therefore, that with even minimal exposure to publicly displayed patterns of recurrent behavior, subjects should come to an agreement on its main patterns (Freeman, 1992b). As Cosmides and Tooby (1994b, p. 99) put it:

Our cognitive adaptations go beyond the information they are given, and reconstruct from fragmentary cues highly accurate models of local conditions. . . . Our minds can do this because this fragmentary information is operated on by evolved procedures that were selected precisely because they reflect subtle relationships enduringly present in the world.

To address this question, we will present the results of two naturalistic studies. Each of these studies generated two kinds of data: (1) those that might be expected to reveal the observed, long-term patterns of association in a community, and (2) those that might be expected to reveal the community members' perceptions of those interaction patterns.

STUDY 1: THE BEACH

One study that provides both types of data was conducted in 1986 by Freeman, Freeman and Michaelson (1988, 1989). They studied a community of recreational users of a southern California beach. While the members of the beach community were never formally organized and

1. Of course, one consequence of frequent face-to-face interaction is frequent spatial proximity. When two actors interact face-to-face they are necessarily physically close. A viewer *might* assign them together in a single category as a consequence of the similarity of their patterned use of physical space. It is much more immediate, however, and it strikes us as more likely, that a viewer would use their proximity in interaction or in physical space directly as a basis for categorizing. The question is one of how this information is processed. Our stance, that people directly process social proximity, is consistent with Marr (1982).

TABLE 1. Distribution of Sizes of Observed Subsets of Interacting Individuals at the Beach

Size of Subset	Number of Times Observed
2	173
3	104
4	41
5	23
6	6
7	3
8	2
9	1
Sum	353

group membership was seldom mentioned, the regular users of the beach knew one another well. Some had been involved in the beach community for over nine years.

Data on interaction were collected by systematic observation at that beach over a period of 31 consecutive days. Since attendance tended to be high at mid-day and near the end of the day, two half-hour periods, 12:30 to 1 p.m. and 4 to 4:30 p.m., were selected as the observational periods. One researcher was present to observe and record interactions among the individuals present. Records of any collections of two or more individuals who were observed interacting together were made. Interaction events included all incidents where individuals were observed communicating.

During the period of observation, a total of 95 individuals were recorded as having been at the beach. Many of these, however, were one-time visitors. The data we will examine here provide records of the interaction among the 43 most regular users of the beach during the period of observation. The regulars included all those who had attended three or more days while observations were being made.

During the observational period, 353 events in which interaction linked various subsets of these 43 people were recorded. The distribution of the sizes of the observed subsets is shown in Table 1. The interaction record, then, comes in the form of a 43 person by 353 event binary matrix. An entry of 1 in that matrix indicates that the person designated by the row was involved in the interaction event designated by the column.

Cognitive data from members of the beach community were collected at the end of the 31 days of observation. Each community member was presented with a deck of cards. Prior to each interview, the deck was shuffled to randomize the order of the names. Each card listed the name

of one individual. All 43 names were included. Subjects were asked first to sort the cards into groups of people who were "very close—who interact together at the beach all the time." Subjects were instructed to place each person into only one group. The number of groups was not restricted; subjects were allowed to make as many or as few groups as they liked. Then they were asked, repeatedly, to relax their criterion of closeness a little bit, and to merge the existing groups into broader ones in which the individuals were still close, but a little less tightly-knit. This process was repeated until there was only one group, or until the subject was unwilling to merge any more groups.

Overall, the members of the beach community were able to construct this nested sequence of partitionings without apparent effort. Each produced at least one partitioning, and the average subject was able to merge groups and produce partitionings at 2.6 levels. The number of groups produced on the first partition ranged from 1 to 8 with a mean of 4.2 and a standard deviation of 2.0. The average group contained 5.6 members and the standard deviation was 4.9. On the last partition (or, in some cases, the last partition before everyone was merged into a single group), the number of groups produced ranged from 1 to 4; the mean was 2.2 and the standard deviation was .6. The average size of groups was 14.9 with a standard deviation of 7.5.

Each subject, then, generated a person by group matrix in which an entry of 1 indicates that the subject assigned the person designated by the row to the group designated by the column. Since there were 43 subjects, there are 43 of these cognitive matrices. These matrices were aggregated to produce a 43 person by 628 group matrix with the same binary form as the behavioral data described above.

As they stand, the observed data and the cognitive data cannot be directly compared. We are dealing here with two distinctly different types of data. We have records of individuals' participation in events of interaction. And we have the participants' judgments about which collections of people are linked by interaction at various levels. These two kinds of data produce matrices that, since they refer to the same individuals, have the same number of rows. But, because they are built from completely different operations, they will generally have different numbers of columns. They are not directly comparable. To compare these two kinds of data, then, we will have to transform them both into some common structural form. A natural way to do this is to convert them both into measures of the closeness or social proximity of each pair of community members. One of these measures will be built from observed association, the other from subjects' perceptions of association.

There is a direct way to transform such rectangular, person by category, matrices into square, person by person, proximity matrices. If we

multiply a rectangular person by social event matrix by its transpose, the result is a square symmetric person by person proximity matrix in which each cell is a tally of the number of events in which the row person and the column person interacted together. The principal diagonal of this square matrix simply shows the total number of events in which each person appeared.

Similarly, the perceived proximity matrices for all subjects, or for any subset of subjects, can be calculated. A synthetic example of the procedure is given in Table 2. If we begin with a rectangular person by group matrix that records subjects' judgments about interaction, we end up with a symmetrical person by person matrix in which each cell records the number of levels at which any of the subjects classified a given pair of individuals together. The principal diagonal shows the total number of times each person was placed in a group. Even though two or more subjects may create the same groups, as illustrated by subjects 1 and 3 in Table 2, information produced by all subjects at all levels is recorded in this matrix.²

Obviously, a person by person, perceived proximity matrix also can be calculated for each individual subject's reported classifications. The same transformation procedure is followed as before, by simply aggregating the assignments of each subject at all levels. Thus, the perceived proximity of any two community members is simply a count of the number of levels at which they were assigned together by the subject being examined.

Important structural features of a proximity matrix can be revealed by determining its principal components (Belsley, Kuh, and Welsch, 1980). The advantage of such treatment is that the structural features of the matrix are arranged in terms of their importance—the first principal axis captures the most variance, the second captures the next most, and so on. The result, of course, is that we can determine the preeminent structural features of a data matrix simply by examining the first few eigenvectors of the output.

The principal components of both the behavioral and the collective cognitive matrices from the beach data were determined. The eigenvalues for the first eight principal components in both data sets are shown in Figure 1. The first principal component of the matrix of observed behavior accounted for 21% of the variance while the first principal component of the matrix of the collective perceptions of the subjects

2. Subjects varied in the amount of differentiation they provided for the groups they created. And, since there is no reason to regard subjects' first, second or subsequent sort as inherently superior to any other sort, analyses were performed on the aggregated data. The aggregated data matrix, because it contains all of the available cognitive information, provides a much richer data source to examine.

TABLE 2. Synthetic Example of Individuals (rows) by Groups (columns) in Reported Data for 3 Subjects

I. THE RAW DATA										
Individuals	Subject 1			Subject 2			Subject 3			
	Groups			Groups			Groups			
	Level 1	Level 2		Level 1	Level 2		Level 1	Level 2		
	1	2	3	1	2	3	4	1	2	3
1	1	0	1	1	0	1	0	1	0	1
2	1	0	1	1	0	1	0	1	0	1
3	0	1	1	0	1	0	1	0	1	1
4	0	1	1	0	1	0	1	0	1	1
5	0	0	1	0	0	0	1	0	0	1

II. THE AGGREGATED MATRICES

Individuals	Groups										Transposed Matrix Individuals					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	
1	1	0	1	1	0	1	0	1	0	1	1	1	1	0	0	0
2	1	0	1	1	0	1	0	1	0	1	2	0	0	1	1	0
3	0	1	1	0	1	0	1	0	1	1	3	1	1	1	1	1
4	0	1	1	0	1	0	1	0	1	1	4	1	1	0	0	0
5	0	0	1	0	0	0	1	0	0	1	5	0	0	1	1	0
											6	1	1	0	0	0
											7	0	0	1	1	1
											8	1	1	0	0	0
											9	0	0	1	1	0
											10	1	1	1	1	1

III. THE PROXIMITY MATRIX

Individuals	Individuals				
	1	2	3	4	5
1	6	6	2	2	2
2	6	6	2	2	2
3	2	2	6	6	3
4	2	2	6	6	3
5	2	2	3	3	3

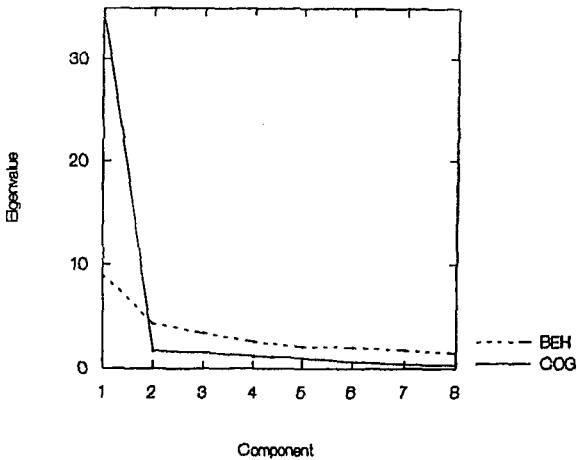


FIGURE 1. Eigenvalues of the first eight principal components of both the behavioral and cognitive beach data.

accounted for 81% of the variance. Thus, almost all of the cognitive structure is captured in a single factor. This suggests that the cognitive structure is very simple as compared with the behavioral structure.

Although they do differ dramatically, there are important similarities between these two structures. The first two principal components of the behavioral data are shown in Figure 2; those for the cognitive data are shown in Figure 3. The first principal component (the X-axis) of the behavioral data in Figure 2 shows relatively dense clustering on both the left and the right and a rather sparse area in the middle. The second component displays some spread in the right-hand cluster and relatively little on the left. The first principal component of the cognitive data in Figure 3 shows the same kind of clumping on the right and the left. But at the same time, it shows relatively little differentiation along the second (the Y-axis) component, except among the points in the middle. These images indicate that individuals, both behaviorally and cognitively, were divided into two broad social groups. The cognitive data, however, show a much tighter, more compact structure than do the observed data.

When we compare these two figures in terms of where they locate individual points, we find that the clumping along the X-axis is similar for both images. We can see points 16, 15 and 8, for example on the left side of both pictures, while points 33, 25 and 19 appear on the right. It is less clear whether point positions along the vertical dimension are maintained.

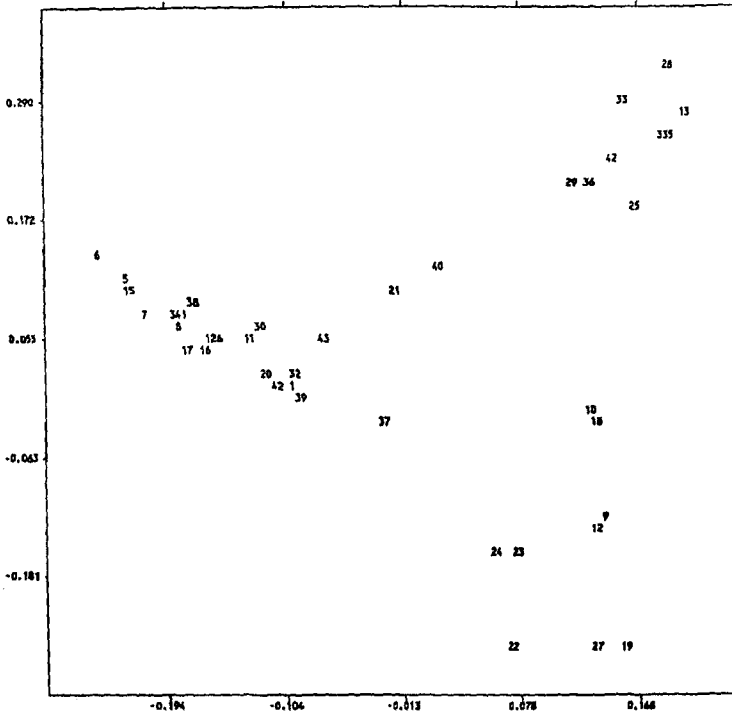


FIGURE 2. Plot of the first two principal components of the behavioral beach data.

We can get a more detailed picture of the similarities and differences between these two structures by projecting them onto a single image. To do that, we stacked the two matrices into a single 86 by 43 matrix and calculated the row-row correlations. These correlations were used to extract the principal components. The results reveal the overall structure of both behavior and the cognitive image of that behavior.

In this combined analysis, the first principal component accounts for 47% of the variance and the second for 5.8%. These two components are plotted in Figure 4. They reveal the main features of the patterning of interaction and the subjects' collective cognitive image of that patterning. In the figure, hollow circles show the proximities of individuals in terms of their observed interaction, and filled circles show their proximities in terms of our subjects' perceptions. Each line connects the pair of circles that represent a single individual.

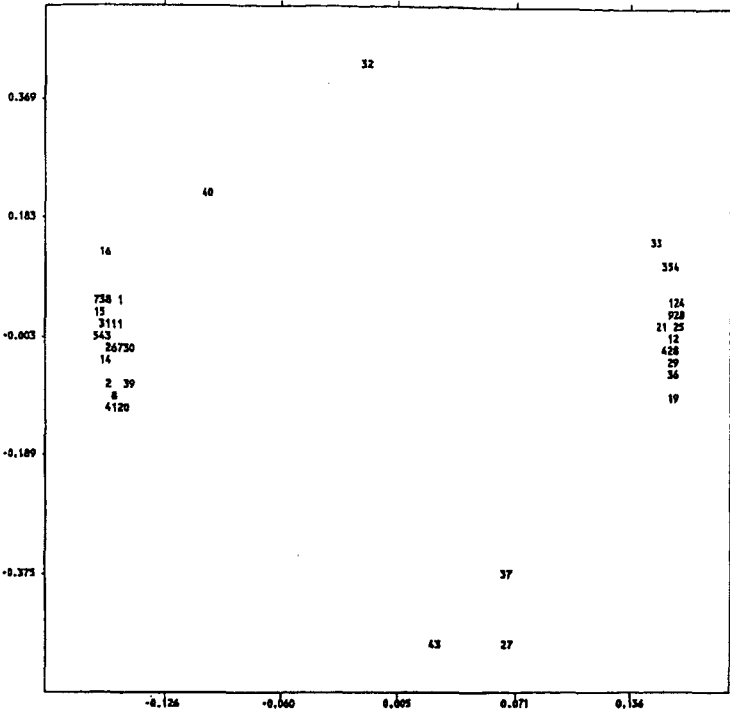


FIGURE 3. Plot of the first two principal components of the cognitive beach data.

It is obvious here that the filled circles, representing the shared cognitive image, are clustered into tighter bundles than the hollow ones that represent the observed behavior. This suggests one way that the subjects reorganize the observed structure of behavior. The cognitive image shows more spread along the first principal axis than the behavior. But the behavior shows more spread along the second principal axis. This suggests that the subjects are extremely sensitive to the split between the individuals on the right and those on the left, but are relatively insensitive to the variation in interaction shown in the vertical dimension. In cognitive terms, the whole community seems to be split up into two groups that permit almost every person to be classified as one of "them" or one of "us." Five individuals are located in the ambiguous area in the middle of the first axis. These are individuals about whom there was no consensus in the community. Some subjects assigned them to one group,

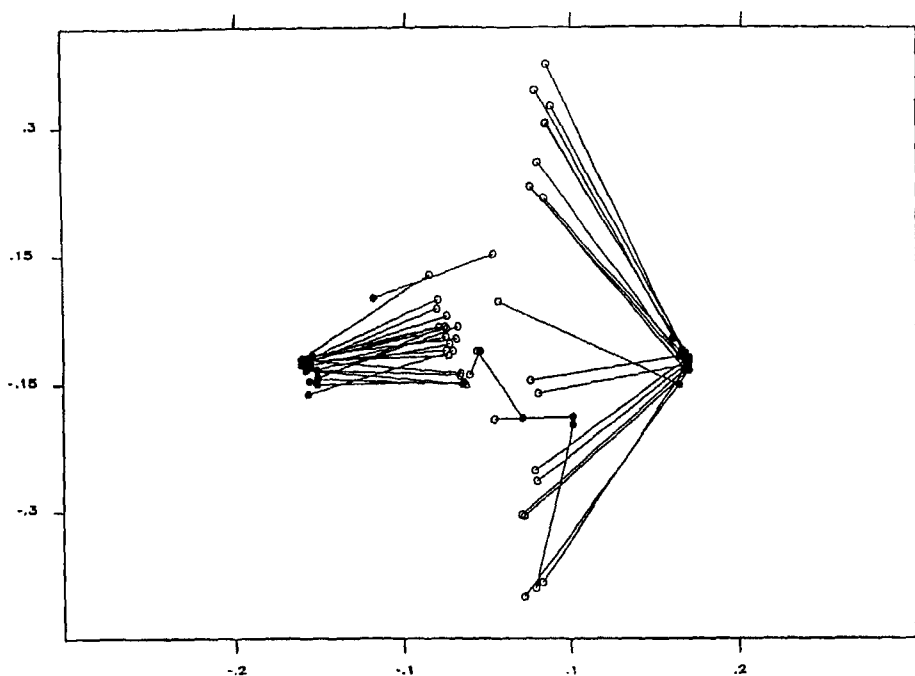


FIGURE 4. Plot of the first two principal components of the combined beach data.

some to the other. And when asked about them, many members of both clusters described these individuals as "floaters."

INDIVIDUALS' PERCEPTIONS AND GROUP MEMBERSHIP

This same kind of analysis can be used to examine a single subject's perception of the structure. Figure 5 shows the image produced by one subject. Similar to the collective image, this subject sees the community divided into two main clumps. However, the cluster on the left is seen as having three distinct levels along the first axis, but the one on the right is clumped together into a single level. It is clear, then, that this subject's cognitive image involves greater differentiation among individuals in the cluster on the left than in the one on the right.

This pattern of differentiating more on the left, however, is not common to all subjects. The image produced by another subject is shown in Figure 6. In that image, the cluster on the left is collapsed almost completely, while that on the right is spread out into at least three distinct

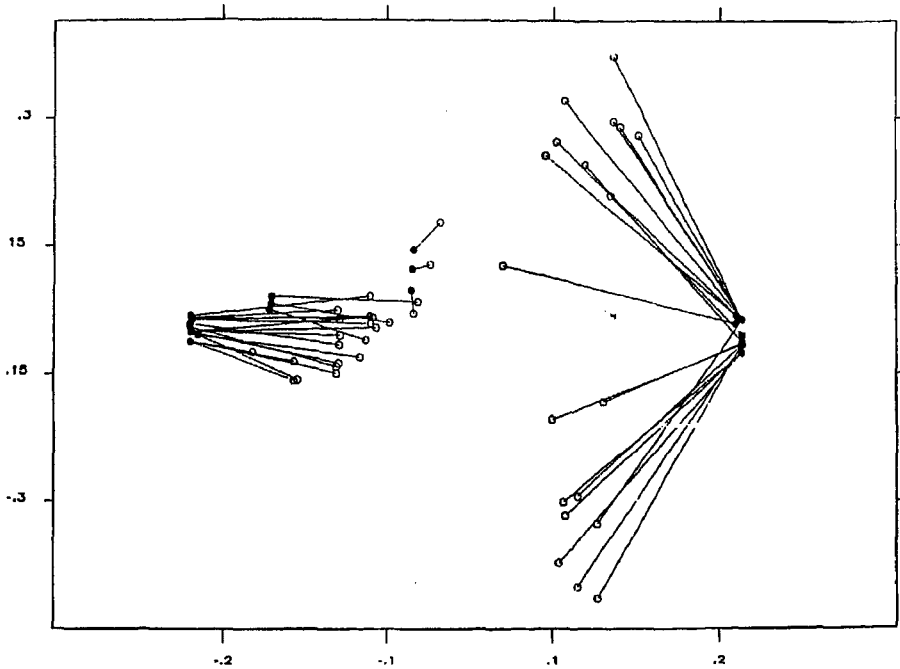


FIGURE 5. Plot of the first two principal components of the combined beach data as seen by one subject.

clusters. This subject, then, lumps the members of the cluster on the left and splits the individuals on the right.

This kind of lumping and splitting is consistently displayed in the responses of subjects. The overall patterning of what is lumped and what is split depends upon the location of the subject in the interaction space. As a general rule, subjects differentiate more among the individuals in their immediate vicinity and less among those who are farther away. Among the 43 subjects, 23 distinguished the same number of levels in the cluster to which they assigned themselves as they did in at least one other cluster, 18 subjects reported more levels in their own cluster than in any other cluster and only two subjects reported some other cluster with more levels than their own. The null hypothesis that subjects who distinguished more levels in at least one cluster did so without reference to which cluster was their own yields a $\chi^2 = 12.8$, $df = 1$, $P < .001$. Thus, subjects tended to differentiate more levels in their own groups. Indeed, the subject whose responses are shown in Figure 5 located himself as a

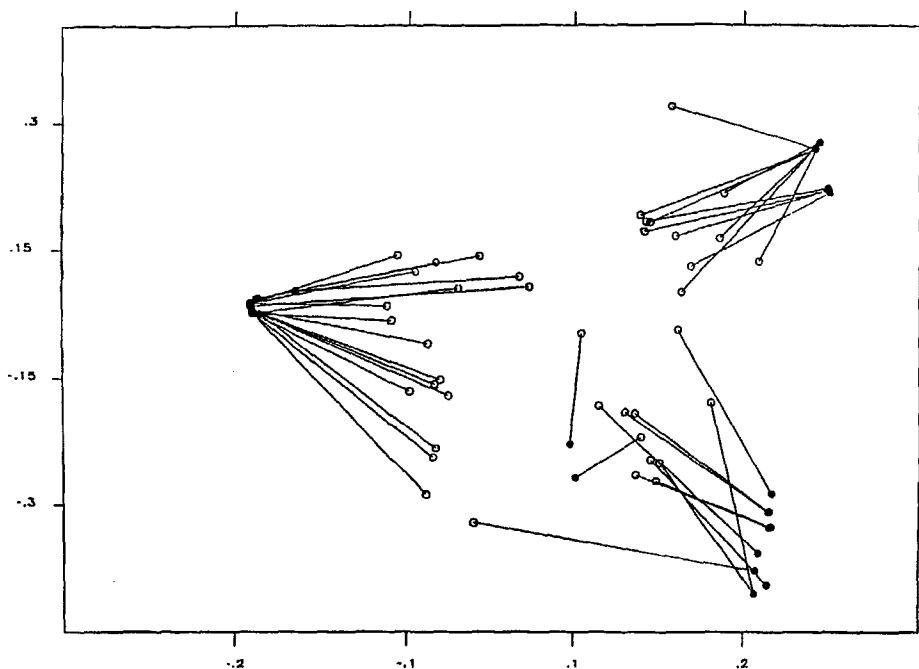


FIGURE 6. Plot of the first two principal components of the combined beach data as seen by another subject.

member of the interactive cluster on the left; the subject shown in Figure 6 located herself in the right-hand interactive cluster.

STUDY 2: THE RESIDENCE HALL

The second data set is similar in form. It was collected by Webster in a university residence hall during the spring quarter of 1991 (Webster, 1993). The residence hall housed 42 undergraduate students. Thirty-nine residents, 19 females and 20 males, participated in the study. All except two of the students had been living in the residence hall for two academic quarters and, therefore, most of the residents knew one another well. Unlike the individuals at the beach, the university students interacted in multiple social activities. Thus, two different social settings were chosen for the eight weeks of systematic observations.

The subjects were observed in the dining facility for 26 mealtimes, 14 lunches and 12 dinners. For every meal, the dining facility was open for two hours. The entire two hours were observed. An interaction event

was recorded for those students who ate at the same table together. Tables ranged in size with some seating only two individuals, some groups of four and the largest accommodating up to 40 individuals. Thus, the number of those eating together was not limited by the table size. The subjects also were observed once a week for two hours at a social meeting in the common room of the dormitory. Participation was completely voluntary. All of the residents were invited but were not required to attend. Individuals who were observed communicating with one another were noted.

There were 157 events in which two or more individuals were observed eating a meal together at the same table. On average six separate interaction events were observed at each meal. In total 83 pairs, 44 triples, 16 groups of four, 10 groups of five and 4 groups of size six were observed. For the social meetings, there were 139 events in which two or more individuals were seen interacting. On average 20 separate interaction events were recorded at each meeting. There were 95 pairs, 32 triples, 10 groups of four, 1 group of five and 1 of size six.

Since there is no reason to expect the behaviors in the two settings to be comparable, these two observed data sets are analyzed separately. Thus, one of the observed data matrices, the EAT matrix, is a 39 person by 157 event matrix while the other, the MEET matrix, is a 39 person by 139 event matrix.

Cognitive data in the residence hall were collected during week five of the observational period and at the end of the observational period. A pile sort task similar to that in the beach study was used. Subjects were asked to sort all of the residents into groups of people who "frequently interacted with one another on a social basis." Once the initial partitions were made, the subjects then were asked to merge the piles so that those individuals within a pile interacted with one another on a less intimate level.

Thirty-seven of the 39 subjects completed the cognitive task. An aggregation of the cognitive data across all subjects produced a matrix consisting of 39 persons by 681 piles. All of the subjects were able to produce at least one level of partitioning, and the average subject was able to merge groups 2.4 times. On their first partitioning subjects on average reported 10.8 groups with a standard deviation of 2.5 and a range from 5 to 14 groups. The average group contained 2.9 members with a standard deviation of 1.2. Subjects' final partitioning on average produced 6.95 groups with a standard deviation of 2.3 and a range from 1 to 12 groups. The average size of the groups was 4.9 with a standard deviation of 3.1.

Principal components for all three of these data matrices were extracted. The eigenvalues associated with the first 11 principal components for all three analyses are shown in Figure 7. As in the earlier case,

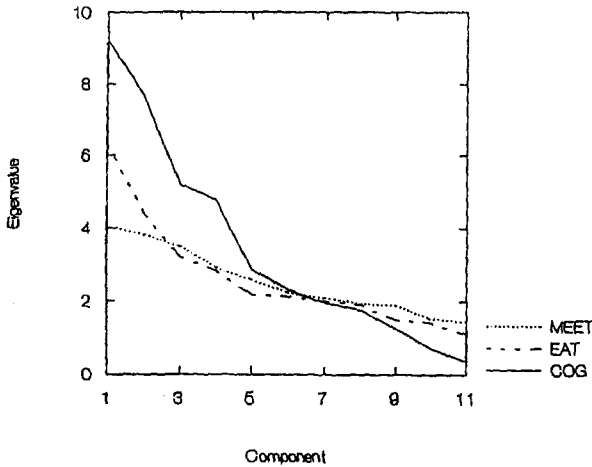


FIGURE 7. Eigenvalues of the first 11 principal components of both the behavioral (MEET and EAT) and the cognitive residence hall data.

the first principal component captured more of the variance for the cognitive data, but here the results are less dramatic. In this case, the first component of the cognitive data accounted for 24% of the variance, while that for the EAT data accounted for 16% and for the MEET data 10%.

The combined image of the residence hall community was produced by the procedure described above. The three data sets were stacked into a 117 by 39 matrix, row-row correlations were calculated and these correlations were analyzed using principal components. The first two principal components for the combined residence hall data accounted for 15.4% and 12.4% of the variance respectively.

The image for the three data sets is shown in Figure 8. In the figure, hollow circles show the proximities of individuals in terms of eating behavior, hollow squares show their proximities in terms of communication,³ and filled circles show their proximities in terms of our subjects' perceptions. Lines connect the pair of hollow symbols to the filled circle that represents the cognitive image of that individual.

Again, we note that the filled circles are clustered in tighter bundles than either the hollow circles or squares. However, as we can immediately see, the residence hall data yield a more complicated image than we saw at the beach. Not only do the filled circles show more spread

3. Note that these two indexes of interaction frequency, although they were recorded in different contexts, locate individuals in similar regions of the space. This is evidence for the stability and regularity of interaction across contexts.

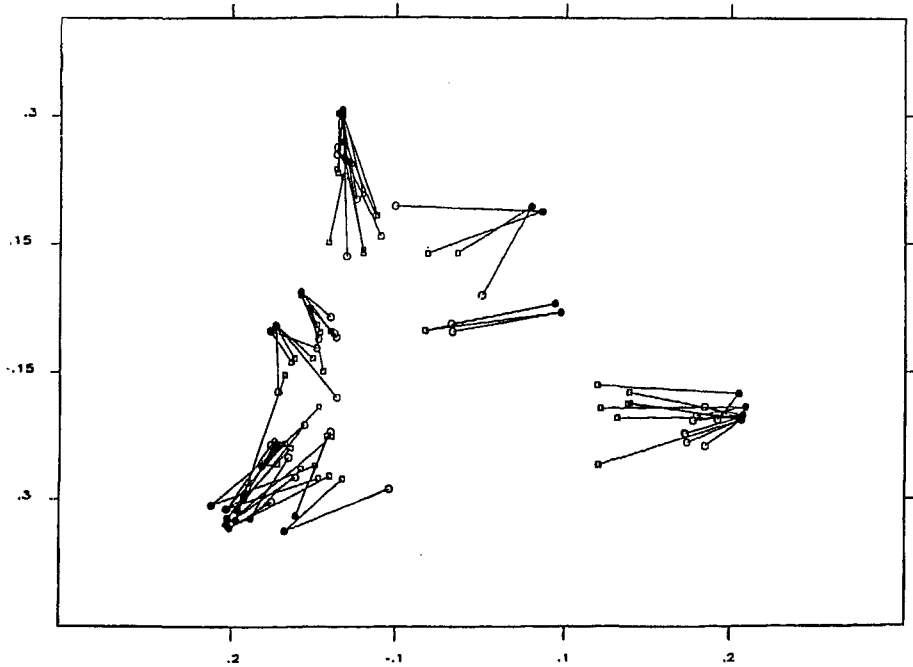


FIGURE 8. Plot of the first two principal components of the combined residence hall data.

along the first principal axis than the hollow symbols, but they also show more spread along the second. This suggests that cognitively the residence hall is divided into more than just two main groups. Instead, there appears to be at least six cognitive groups.

The most distinct cluster is located on the right. These seven individuals are clustered together, both in their behavior and in the way that they are seen. The three types of data, however, do suggest slightly different internal structures within this group. Cognitively, there appears to be a core of five individuals with two individuals seen as slightly peripheral. The eating behaviors show only three of the five core members as tightly clustered with the other four more spread. Finally, the communication pattern is again somewhat different with one of the core individuals shown as the most peripheral.

Similar small clusters are visible in both the upper and the lower left-hand corners, but neither of these clusters is behaviorally distinct from the rest of the individuals. If we examine the area around the upper left corner, we see four individuals who are viewed as a very tight

cluster, even though behaviorally one of the four is particularly close to the others. Next we see four individuals who, though they are not directly at the corner, are all mentally moved up in that direction. These individuals are apparently viewed as peripheral members of the corner cluster. This is evident in contrast to the one individual who is behaviorally located in the corner area but who is mentally moved down and away from the corner in order to be paired up with another individual. Although the eating data place this individual within the corner group, the communication data clearly agree with the cognitive data that this individual belongs with a single partner as part of a two-person group.

Again, the differences between the behavioral and cognitive data are seen in the clusterings in the lower left corner. While behaviorally these individuals are shown to be linked together, cognitively they are partitioned into two distinct groups. Within the middle cognitive cluster, there are three small clusters: one three person cluster and two two-person clusters. These seven individuals are mentally shifted to form a distinct cognitive cluster separate from the thirteen individuals in the lower left corner. This cluster of thirteen is viewed as a much looser group than any of the other groups.

Finally, the last pair of individuals in the left center are mentally moved to their own area, nearer the center of the picture. This pair, it would seem, are viewed as a separate two-person cluster.

Overall, then, the collective cognitive image of association in the residence hall divides everyone into six clusters. Again, the cognitive image shows less variation than the behavioral data. However, the locations of points in cognitive space is more spread out along both the first and the second dimensions than was seen with the beach data. Subsequent dimensions of the residence hall data further emphasize the distances among the six groups. And, as in the case of the beach data, the distances between points in different clusters is greater in the cognitive data than in the behavioral representations.

These data display the same tendency for subjects to differentiate more in their own group than they do in other groups. All but one of the 37 subjects placed themselves in a group with others in their very first sort. Thirty-two, or 86.5%, of them subsequently merged other groups with the group in which they had placed themselves; thus, they differentiated levels of membership in their own group. But only 60.8% of the subjects merged others into groups of which they were not members; they were less inclined to differentiate levels of membership in other groups. Among the 37 subjects, 12 reported more levels in their own cluster than in any other cluster, 19 distinguished the same number of levels in their own cluster as they did in at least one other cluster and 6 reported some

other cluster with more levels than their own. The degree of differentiation of levels for the residents is not as substantial as in the beach data, but it is significant ($\chi^2 = 4.9$, $df = 1$, $P < .05$).

DISCUSSION

Although they were discussing similarity-based categorization, the words of Rosch, Mervis, Gray, Johnson and Boyes-Braem (1976) are almost prophetic in the present case. They said (p. 433):

Any person or culture may exaggerate existing structure so that attributes, motor-movements, and shapes characteristic of only some members of a category may be thought of as though they were characteristic of all. By such a mechanism the basic category cuts in the world are made to appear even simpler and more structured than they are in reality. . . . The correlational structure of the environment, modified by selective ignorance and exaggeration of the attributes and structure of that environment, are mirrored in categorization systems.

This kind of simplification and exaggeration is precisely what subjects at the beach and in the residence hall seem to be doing. In every case, in building cognitive images of social structure, these subjects seem to be both simplifying and exaggerating. Individuals who seldom interact, those who are separated by relatively large social distances, seem to provide exemplars for forming cognitive categories. And, once established, these exemplars apparently are moved further apart in the cognitive images; cognitive distances between clusters are greater than behavioral distances. At the same time, although there appear to be levels of category membership in the minds of the subjects, individuals who are assigned to the same category are closer together in subjects' cognitive representations than they are in behavior; their differences are minimized.

Overall, then, when relatively large behavioral distances separate individuals, those distances are exaggerated in cognitive space. In contrast, when there are relatively small behavioral distances separating individuals, those individuals are grouped together and, in the cognitive image, they are reduced. The result is a simplified representation of the structure of social association.

The degree of simplification seems to be determined to some degree by the complexity of the behavior being simplified. The beach behavioral data embodied two, or at most three, groups. And, in that case, subjects were able to capture almost all of the main structural divisions in a single

principal component. But in the case of the residence hall, the multiple-group divisions could not be captured by a single factor. There, the first principal component of the cognitive data, though dominant, captured far less of the overall structure.

Moreover, as we mentioned above, we have shown that individual subjects display a systematic procedure in building cognitive images of the social structure in the community. Each subject seems to simplify less in his or her own region of the social space; each is able to report relatively subtle variations in association patterns among people who are close. But when it comes to describing details of association in distant regions, subjects lump everyone together and simplify more dramatically.

This same kind of systematic procedure has been displayed in studies of social cognition based on similarities and differences among the characteristics of individuals. Since the seminal work of Tajfel (Tajfel, 1972; Tajfel & Wilkes, 1963), numerous studies have identified a similar kind of cognitive patterning. Categories are constructed in such a way that the actual differences between categories are exaggerated and the differences within categories are reduced (Doise, 1978; Wilder, 1986). Much of this research on differential perception has focused on social characteristics. It has shown that subjects see people whose traits differ from their own as relatively homogeneous; they are able to provide more detailed information for those individuals whose traits match their own than they can for individuals who have traits that differ from theirs (Linville, Salovey & Fischer, 1986; Ostrom & Sedikides, 1992; Park, Judd & Ryan, 1991).

The generalizability of the present results is, of course, limited. We have studied only two communities. And it is possible that the distinctness of the groupings displayed in our cognitive data is at least partly an artifact of our use of pile sorts to collect the data. People do use multiple schemas to organize their social worlds (Fiske & Neuberg, 1990; Judd & Park, 1988; Ostrom et al., 1993). Thus, research on other communities and research drawing on other data collection techniques is needed. But, despite these weaknesses, we have succeeded in producing one important result: as the evolutionists have suggested it should be, the patterning of affiliations in natural communities is perceived and processed by the human inhabitants of those communities.

