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SOCIAL PROCESS AND HIERARCHY FORMATION IN SMALL GROUPS: A COMPARATIVE PERSPECTIVE*

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The author investigates the theory, methods, and findings of animal behaviorists and social scientists studying dominance hierarchies in small groups. In both disciplines: (1) the literature argues that the explanations of hierarchy structure are based upon differences in individual characteristics among group members; (2) although critical examination reveals that these explanations require stringent conditions to account for commonly occurring kinds of hierarchies in humans and animals, the available data indicate such conditions are not met; and (3) the hierarchy-formation process has not been adequately studied. In an attempt to alleviate the current problems in hierarchy research, I present the results of a particular animal study and develop a general explanation as to how hierarchy structures arise. This approach applies to both humans and animals and serves as a model of how the cumulative patterns of interactions among individuals produce group social structures.

Despite great differences in social behavior in many human and animal groups, **their dominance hierarchies are remarkably similar** (see Brown, 1975; and Wilson, 1975, for general background on dominance hierarchies). Why should species so diverse as animals are from one another, and as all the animals are from

humans, form dominance hierarchies so similar in structure? And, even more basically, how are we to study and explain the formation of dominance structures in small groups of men and animals? The goal, here, is to make a start toward answering these questions by developing a new approach to the study of hierarchy structures. This approach explains how hierarchies emerge from the interaction among group members rather than being generated by differences among those individuals. It treats hierarchy formation as a developmental process in which the outcomes of previous interactions influence the course of successive ones, and it indicates how patterns of interaction fit together to form the kinds of dominance hierarchies commonly observed.

This paper is in five parts: (1) a summary of the data collected on dominance hierarchies and the methods used to gather those data in both the animal behavior and the human social sciences literature; (2) a critical evaluation of the theories that have been proposed to explain hierarchy structures in both disciplines; (3) a presentation of the results of a study of hierarchy formation in an animal group; (4) a new approach to the theory of hierarchy formation; and (5) an evaluation of the new approach as well as a discussion of the implications of the results for continuing research.

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HIERARCHY STRUCTURES IN ANIMAL AND HUMAN GROUPS

The Animal Behavior Approach

One of the distinguishing features of the animal behavior or ethological tradition is the emphasis on behavioral observation and the use of ethograms (or catalogs of behavior) developed for each kind of animal or human group studied. In a typical ethological study, a group is observed for a period of time sufficiently long to discover the direction of dominance relationships among all possible pairs in the group. The direction of a dominance relationship in a pair is typically determined by asymmetries in the agonistic (a category including both aggressive and submissive behaviors) behavior of the individuals toward one another. For example, the individual who delivers all or the majority of aggressive acts in a pair is considered dominant, and the individual who receives the acts or initiates most of the submissive gestures is considered subordinate. The pattern of the relationships in a group is frequently represented in a "dominance matrix." A dominance matrix has either a "0" or a "1" in all off-diagonal cells: a "1" in the i, j cell indicates that individual i dominates individual j and a "0" indicates that j dominates i.

All the dominance relationships in a group, taken together, form the hierarchy structure. Theoretically, hierarchy structures can vary from linear, at one extreme, to the other extreme in which each individual in the group dominates an equal number of other individuals. In a linear hierarchy there is an individual A who dominates all others, an individual B who dominates all but A, and so forth, down to the last individual who dominates no one. An example of a dominance matrix for a linear hierarchy with five individuals is given in Table 1, and a matrix for a hierarchy as far away from linearity as possible—in which each animal dominates an equal number of animals—is given in Table 2.

A surprisingly uniform finding by ethologists is that hierarchies in small groups (less than about ten members) are frequently and perhaps predominantly

Table 1. Dominance Matrix Showing a Linear Hierarchy

Dominant Animal	Dominated Animal					Number Dominated
	A	B	C	D	E	
A	—	1	1	1	1	4
B	0	—	1	1	1	3
C	0	0	—	1	1	2
D	0	0	0	—	1	1
E	0	0	0	0	—	0

linear or near-linear. This finding is stable across many individual researchers' work and across an extremely broad range of animal species from insects to primates. For example, linear and near-linear hierarchies have been found among certain kinds of wasps and bumble bees (Wilson, 1971); various birds—such as chickens (Guhl, 1975), chaffinches (Marler, 1955), and red crossbills (Tordoff, 1954); domestic mammals—such as cows (Schein and Fohrman, 1955) and ponies (Tyler, 1972); wild mammals—such as coyotes (Bekoff, 1976) and buffaloes (McHugh, 1975); and primates in the wild and in captivity—including rhesus monkeys (Sade, 1967), baboons (Hausfater, 1975), and vervets (Struhsaker, 1967). In the primates, hierarchies can become more complex through both the formation of coalitions and what is known as dependent rank (Jolly, 1972). In dependent rank, a particular individual (animal) is able to achieve dominance over another animal in the presence of a third animal (frequently its mother or consort) but not able to do so if the third animal is not present. However, even in those groups where coalitions and dependent rank are found, there is often a linear or near-linear

Table 2. Dominance Matrix Showing a Hierarchy in Which Each Animal Dominates an Equal Number of Other Animals

Dominant Animal	Dominated Animal					Number Dominated
	A	B	C	D	E	
A	—	1	1	0	0	2
B	0	—	1	1	0	2
C	0	0	—	1	1	2
D	1	0	0	—	1	2
E	1	1	0	0	—	2

hierarchy if relationships are examined between pairs when a coalition partner or third party conferring dependent rank is not present.

Researchers in the ethological tradition who have studied human groups have frequently focused on hierarchical relationships; many of these studies have been on preschool children (McGrew, 1972; Missakian, 1976; Strayer and Strayer, 1976), but adolescent groups have also been examined (Savin-Williams, 1977; 1979; 1980). In addition to using nonverbal, behavioral measures of dominance, as in the animal studies, some studies have also employed verbal indices of dominance—for example, if A gives an order to B and B obeys, then A is rated as dominant to B (Savin-Williams, 1977; 1979; 1980). As in the animal studies, findings indicate that human hierarchies are frequently linear or near-linear (Missakian, 1976; Savin-Williams, 1977; 1979; 1980). In those studies where data have been collected for some but not all possible pairwise interactions, the data indicate that only a few interactions deviate from those expected in a linear hierarchy (McGrew, 1972; Strayer and Strayer, 1976).

Another uniform trend is that most studies by ethologists have been static. That is, in the great majority, studies have described a given hierarchy structure at some particular time rather than either explaining how that hierarchy structure was established or examining the processes by which members of the group changed rank over time.

The Human Social Science Approach

The research of sociologists and social psychologists, like that of ethologists, has provided, for the most part, static descriptions of social structure in small groups. There are a few notable exceptions (such as Newcomb's [1961] work) but these tend to utilize self-reported preference (friendship) data rather than observational data on asymmetric relationships. These static descriptions indicate a strong hierarchical component in the social structure of a

broad spectrum of human small groups. Three areas of research are of relevance here: the study of human small groups in laboratory settings, the study of these groups in "natural" situations, and the analysis of sociometric data.

When groups of unacquainted individuals are assembled in laboratory settings, a differentiation of members quickly emerges along such dimensions as frequency of originating and receiving various kinds of behavioral acts and ratings of leadership and likeability by fellow group members (see Collins and Raven, 1969; Gibb, 1969; and Hare, 1976, for comprehensive reviews). Some members show behavioral profiles that give them relatively high control over the actions of their fellows and over group activities in general, while other members exert relatively little influence on either group activities or their colleagues (e.g., see Bales and Slater, 1955, and the reviews cited above). Researchers using the status expectation paradigm have shown that external status characteristics—such as social class, race, and gender—influence the distribution of participation and prestige in these groups (see Berger et al., 1972, for a general statement of the paradigm and Fennell et al., 1978, for a provocative discussion of differences in male and female groups).

Although ethologists and laboratory small-groups researchers frequently collect the same kind of data—individual A directs an act of type X to individual B—their analyses of the data are different. As mentioned above, ethologists look at the hierarchy structures produced by all possible pairwise relationships among group members. Laboratory small-groups researchers, however, tend to concentrate on rank measures—the comparison of individuals in terms of total interaction rates or group preference scores. Bales et al. (1951) is a partial exception in that they give pairwise interaction frequencies for 18 aggregated sessions of six-man groups.

Studies in natural settings—such as those by Blau (1955) of a bureaucratic agency, Hanfmann (1935) of kindergarten children, Homans (1950) of an industrial work group, and Whyte (1955) of gangs—provide further confirmation of

the hierarchical structure of human small groups. These studies all find clearly differentiated status rank systems based upon both the behavioral actions and sentiments of group members. Although most of these studies, like the laboratory small-groups studies, do not provide data on all possible pairwise relationships in their groups, the work of Hanfmann (1935) is an exception. Her data indicate the presence of a near-linear hierarchy in kindergarten children, comparable to those reported by ethologists for other human and animal groups. (See Mazur, 1973, for a pioneering comparison of hierarchies in humans and animals; his approach and conclusions, however, differ from those presented here.)

The studies of sociometric data by Davis (1970), Hallinan (1974), and Holland and Leinhardt (1970; 1971; 1972) provide some of the most sophisticated descriptions available of social structure in small human groups. Although one might expect preference choices to yield structures considerably different from those produced by dominance relationships, there are in fact considerable similarities. These researchers have discovered (with high consistency across studies and samples) that there is a strong trend toward transitivity in the preference relations of group members (for example, if A chooses B as a friend and B chooses C, then A will choose C also). As will be explained in greater detail, there is a similar strong trend toward transitivity in the dominance relationships of human and animal groups. In a linear hierarchy all possible triads have transitive dominance relationships; and, in a near-linear hierarchy almost all the possible triads have transitive relationships. Davis (1970:850) suggests that, with more refined data where the stronger preference relation for every pair in a group could be determined, "sociometric data would tend to fit the model of a transitive tournament." A transitive tournament is another term for a linear hierarchy and, if Davis's suggestion is correct, then social structures produced properly refined preference relationships, and dominance relationships would be identical.

THEORIES PROPOSED FOR THE EXPLANATION OF HIERARCHY STRUCTURES

I will now examine theories proposed—explicitly and implicitly—in both the animal behavior and human social sciences literature, to explain the formation of hierarchy structures. This examination is based upon previous research by the author (Chase, 1974). The procedure used in that study was this: various theories of hierarchy structure were expressed in their basic (core) form, and that core form was converted into a mathematical model, a simple mathematical expression of what the core form implied. Then the stringency of the conditions needed by each mathematical model to predict the empirically common linear and near-linear hierarchies was examined and the available data inspected, to determine if the conditions were met.

The two mathematical models that proved to encompass most of the explanations of hierarchies were a correlational model and a pairwise interaction model. For example: explanations that are basically **correlational models** are those that indicate that individuals' positions in a hierarchy are determined by their physical attributes, their genetic endowment, their hormonal state, their past social performance, their **personality traits**, the social labels that they have been given, or any composite of these factors. In order to account for linear and near-linear hierarchies, correlations between ranks in a hierarchy and their scores on any of the above-mentioned variables or composites would have to be .9 or greater (Chase, 1974). This theoretical result holds for linear and near-linear hierarchies no matter what species of animal, including humans, are involved and no matter what variables or composite of variables are used to predict rank in a hierarchy. This is a high correlation coefficient, indeed, and one which indicates that any correlational explanation must fulfill a stringent mathematical condition.

An examination of the literature indicates that correlations of .9 or higher are not usually found between a factor pre-

dicting dominance and rank in a hierarchy. Some of the best correlational data available are for animals and, specifically, for the premier animal of dominance studies—the chicken. Correlations vary in size for different investigations and, in studies that examined the association between an individual's aggressiveness—as indicated by its success in fights with other animals, and its place in a hierarchy—correlations ranged from about .4 to .8 (Chase, 1974). These correlations, then, were not as high as the target value of .9, although some were near.

Explanations of hierarchies that are pairwise interaction models in their canonical form are, for example, differences in fighting ability for animals, theories dealing with the interaction of personality types for humans, and exchange theories for humans. In this model it is assumed that each member of a group has a pairwise contest with each other member, that the winner of a contest dominates the loser in the group hierarchy, and that an individual has a particular probability of success in each contest. This model requires that there must be one individual with a .95 probability of dominating each other individual, a second individual with a .95 probability of beating every one but the first individual, and so forth down to the last individual who has only a .05 probability of beating any other individual (Chase, 1974). These results hold, regardless of the species of animal and regardless of what factors are assumed to explain success in pairwise interactions. As in the correlational model, these results indicate that stringent mathematical conditions must be fulfilled with the pairwise interaction model. Again, it has been found that data which best determined if these conditions were met were from animals, specifically chickens, and that the required conditions were *not* fulfilled (Chase, 1974).

It is not that correlational and pairwise encounter theories and measurements give us no useful information about the success of individuals in dominance interactions or the places of individuals in hierarchies; they do, indeed; but the kind

of information they give us is not sufficient to account for a group level social structure, the overall hierarchy found in a group. Although individuals in a group may differ, it appears that the differences are not strong enough to explain empirically common dominance structures (see Hallinan, 1974, for a similar argument concerning individual differences and sociometric structures).

TRIADS AND THE FORMATION OF HIERARCHIES

If many of the currently accepted theories of hierarchies and dominance relations are not adequate, then what might explain the presence of linear and near-linear hierarchies so frequently found in human and animal groups? As discussed above, theories that attempt to explain hierarchy structure by correlations (or the characteristics of single individuals) and theories that use pairwise interactions (or the characteristics of pairs of individuals) appear to be inadequate. As Simmel realized long ago, three is a very important number in sociology, and I shall show that the structure of interaction in triads is very important for explaining the formation of linear and near-linear hierarchies. In order to understand the importance of triadic interaction, one must be aware of a simple mathematical fact: in a linear hierarchy all possible triads have transitive dominance relationships, and if a hierarchy is not linear it contains at least one triad with intransitive dominance relationships—and the fewer the intransitive triads, the closer the hierarchy to linearity. In a triad with transitive dominance relationships, if individual A dominates B and B dominates C, then A also dominates C. So, A dominates the other two members, B dominates C, and C dominates no one. Figure 1A shows a triad with transitive dominance relationships. In a triad with intransitive dominance relationships, the three individuals cannot be arranged in rank order because each individual dominates one other individual. That is, A dominates, say, B; B dominates C; and C dominates, rather than is dominated by, A. Figure 1B shows

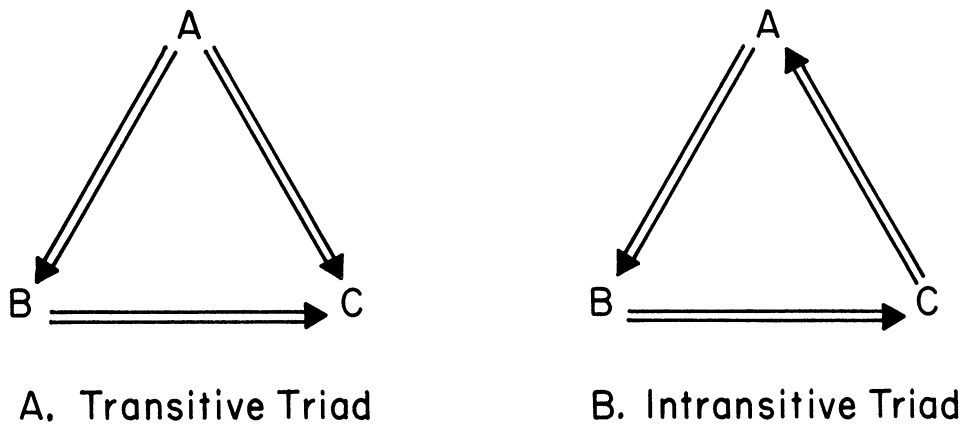


Figure 1. The Configuration of Dominance Relationships in a Transitive and an Intransitive Triad

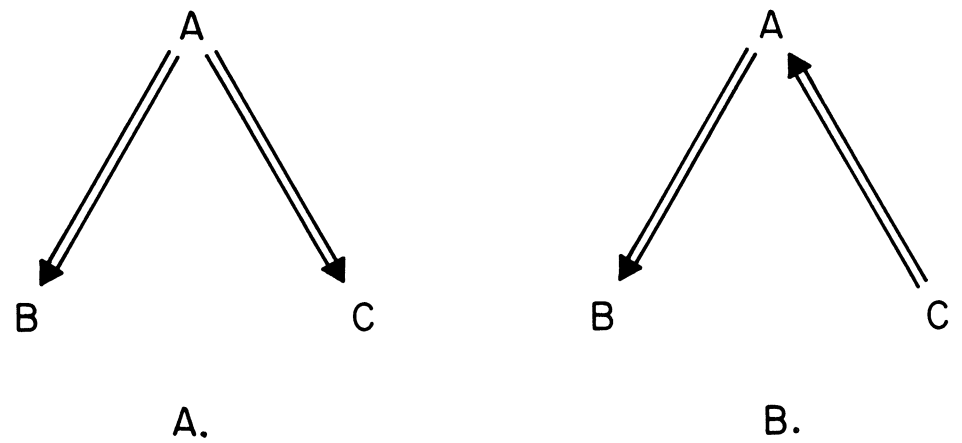


Figure 2. (A.) Final Configuration of Dominance Relationships in All Triads Having Two Extant Dominance Relationships at the End of the Observation Period. (B.) Initial Configuration of Dominance Relationships in Triad with One Reversal

a triad with intransitive relationships. In a linear hierarchy all individuals can be ranked uniquely from top to bottom by the number of group members they dominate, and, therefore, any three can be ranked with respect to one another and form a transitive triad (this can be seen, for example, by taking all possible subgroups of three in Table 1). In a hierarchy which is not linear, not all individuals are uniquely ranked by the number of group members they dominate—there is at least one tie and, therefore, at least one intransitive triad. Table 3 shows the dominance matrix for a group in which there is a tie in rank between A, B, and C and one intransitive triad involving A, B, and C.

Table 3. Dominance Matrix Showing a Hierarchy with One Intransitive Trait Involving A, B, and C

Dominant Animal	Dominated Animal					Number Dominated
	A	B	C	D	E	
A	—	1	0	1	1	3
B	0	—	1	1	1	3
C	1	0	—	1	1	3
D	0	0	0	—	1	1
E	0	0	0	0	—	0

Experimental Design and Data Collection

Could linear and near-linear hierarchies be so common because animals and humans use behavioral processes which

favor the formation of transitive triads and discourage the formation of intransitive triads? (Cf. Davis, 1970; Feld, 1980; Hallinan, 1974; Holland and Leinhardt, 1970; 1971; 1972 for discussions of forces promoting transitivity in preference relationships.)

In order to answer this question, I designed an experiment to determine the actual extent of transitive dominance relationships in groups of three individuals and, if transitivity were common, to discover the behavioral processes by which transitive relationships were generated. The species of choice for this experiment was the chicken; hierarchies in chickens are often linear or near-linear as are hierarchies in more socially complex species such as primates and humans, but at the same time the behavior of chickens is simple enough so that it is more tractable to analysis. In addition, the most extensive dominance research on any species is on the chicken.

In this experiment, groups of three previously unacquainted chickens were placed in a neutral cage, and all aggressive actions among the individuals were recorded. Twenty-four triads were observed; each chicken took part in three triads, and each chicken in a group had been in the same number of triads previously. The data recorded consisted of the identity of the chicken initiating an aggressive action (the attacker), the identity of the chicken attacked (the receiver), the kind of aggressive action (peck, feather-pull, claw (scratch), or jump-on), and the real (clock) time at which each attack occurred. Each triad was observed for four hours to give a grand total of 96 hours of observation time. A combined total of 2,801 aggressive acts was recorded, and the resulting average rate of aggression was 29.2 acts per hour or 116.7 acts per triad.

An SSR Keyboard was used to record the data. The data output from the Keyboard was converted to an electronic signal recorded on audio tape with a standard tape recorder, and the resulting data tapes were transcribed by computer to produce hard copies of the data record and files for later analysis by computer (see Stephenson et al., 1975, and Stephen-

son, 1979, for a description of the SSR Keyboard and its capabilities). An excerpt from a data record is presented in Table 4.

The Extent of Transitivity in Triads

When groups of previously unacquainted chickens are assembled, there are usually interchanges of aggressive actions between individuals although, in some pairs, one animal immediately submits to the other animal without ever fighting back. After either a short or more protracted series of interchanges, the asymmetric pattern of aggressive acts seen in established hierarchies develops: the interchanges stop and all or almost all of the aggressive actions are performed by one member of a pair against the other. At this point, one can think of a "decision" having been reached: **a dominance relationship has been formed with one animal being dominant and the other subordinate.**

In order to determine when a dominance relationship had been formed and, thus, to discover the extent of transitivity in the experimental triads, two criteria were used. One animal was considered to be dominant over another if: (1) it delivered any three aggressive actions in a row (any combination of pecks, feather-pulls, jump-ons, or claws) against the other animal and (2) there was a 30-minute period, following the third aggressive act, during which the receiver of the aggression did not attack the initiator. The involvement of either member of the pair

Table 4. Data Excerpt

Act Number	Real Time	Time Interval	Aggressive Acts
0	09:30:25.1	—	Session Begins
1	09:31:01.8	36.7 sec.	3P1 ^a
2	09:31:03.5	1.7	3P1
3	09:31:31.8	28.3	1P3
4	09:32:06.8	35.0	1P2
5	09:32:08.6	1.8	1PU2 ^b
6	09:32:10.1	1.5	1C2 ^c
7	09:32:14.9	4.8	3P1
8	09:32:18.6	3.7	1P2
9	09:32:21.2	2.6	3J2 ^d

^a "P" is the code for a peck.

^b "PU" is the code for a feather-pull.

^c "C" is the code for a claw (scratch).

^d "J" is the code for a jump-on.

with the third member of a triad was not considered in these criteria and neither was the length of time necessary for the completion of the three acts. Once formed, a dominance relationship could be reversed if the subordinate animal fulfilled the criteria. While somewhat arbitrary, these criteria have support as a valid index of stable dominance relationships—of the 54 dominance relationships meeting the criteria in this study, only two were later reversed within the four-hour observation period (afterward, each chicken was returned to its home cage). The average time required to fulfill the criteria in the 52 initially formed relationships was 82.6 minutes, and only two relationships were established within less than 30 minutes before the end of an observation period. There was, then, a sufficient time period after the formation of most relationships for reversals to occur.

An examination of the configuration of relationships at the end of each observation period indicated that 1 triad had no dominance relationships, 17 had two, and 6 had all three possible relationships. The 17 triads with two dominance relationships all had the same configuration—one animal dominated each of the other two. If the two dominance relationships were determined randomly, this configuration would have a probability of .25 and would be expected to occur, by chance, about four times in 17. This configuration is shown in Figure 2A. It is important to note that this configuration guarantees a triad with transitive dominance relationships regardless of which subordinate later comes to dominate the other (preliminary analysis of data from several groups of four chickens each, observed for 12 hours, indicates that subordinate animals tend to form dominance relationships among themselves, in time). If B later dominates C, there is a transitive triad with A on top, B in the middle, and C on bottom. If C later dominates B, there is a transitive triad with A on top, C in the middle, and B on the bottom.

Similarly, the 6 triads with three dominance relationships all had the same configuration, a triad with transitive relationships as shown in Figure 1A. A transitive

triad has a probability of .75 of occurring if relationships are determined randomly—and would be expected to occur between four and five times out of six. Taken together, these findings demonstrate a marked tendency toward transitivity in the experimental triads, and this finding corroborates those of the studies of human and animal groups reviewed earlier.

An examination of the two groups with reversals in previously formed dominance relationships gives additional support for the tendency toward transitivity. In one of these triads, animal A initially dominated B but was herself dominated by C (see Figure 2B). With this configuration an intransitive triad would have developed had B come to dominate C or a transitive triad if C had come to dominate B. In actual fact, A and C reversed their relationship, and this produced the configuration shown in Figure 2A which guaranteed a transitive triad. In the other triad, the initial configuration of relationships was intransitive, as shown in Figure 1B. By the end of the observation period, A and B reversed their dominance, with the triad having a transitive relationship shown in Figure 1A resulting.

Behavioral Processes Leading to Transitivity

I now present a data analysis that shows how the interaction process in triads helps to explain the tendency toward transitive dominance relationships. The first part of the analysis treats the long-term structure of the interaction process and the second part, the short-term structure.

1. *Long-term Processes.* This analysis of long-term processes includes the 17 triads with two relationships and the 6 with three relationships and excludes the 1 triad with no relationships. The analysis examines the effect of “winning” and “losing”—that is, the impact of either gaining dominance or becoming subordinate upon the further aggressive behavior of a chicken.

The analysis begins with the 16 triads in which only two dominance relationships were formed (no reversals) and 1 triad with three relationships in which one ani-

mal first became dominant over the other two and then one of the subordinates became dominant over the other. (All other triads will be examined later.) An inspection of the first dominance relationship formed in each of the 16 triads with two relationships reveals that there is one uniform pattern of behavior followed by each animal becoming dominant, and another pattern by each animal becoming subordinate. The rule of strategy followed by each subordinate is to withdraw almost totally from all subsequent aggressive activity—not only against the animal that has become its superior but also against the bystander animal. None of the sixteen animals becoming the first subordinate in these triads ever became dominant over the bystander, nor did any ever reverse its relationship with its superior. In addition, the rate of aggressive activity of these animals dropped to almost zero after they received the third attack from the chicken to which they became subordinate; their average rate of aggressive activity before the third attack was 15.8 acts/hr. and after this attack it was 0.2 acts/hr. (significant at the $p < .02$ level, Wilcoxon signed rank test). On the other hand, each chicken winning the first dominance encounter went on to be aggressive toward the bystander and to gain dominance over her.

There is a slight variation on these rules found in the single triad in which one chicken first became dominant over the two others and then one of the subordinates became dominant over the other. In this triad, the strategy of the initially dominant chicken was the same as in the preceding paragraph; she went on to attack—and win dominance over—the bystander. The loser of the initial dominance encounter, however, showed a small variation in strategy. After the third attack by the animal to which she became initially subordinate, she initiated no aggressive acts at all for 115 minutes; then she began to attack the bystander, later winning dominance over her.

The next part of the analysis concentrates on 4 triads in which three dominance relationships were formed. Figure 3 shows the order of formation of dominance relationships in these triads. In

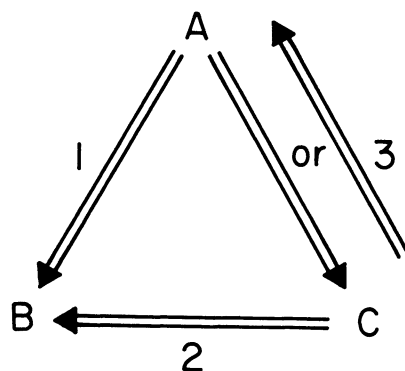


Figure 3. Configuration of Dominance Relationships in the Transitive Triad Resulting When the Initial Dominant and Bystander Engage in a Dominance Contest After Each Has Won over the Initial Subordinate

these triads the chicken losing the first dominance encounter lost a second dominance encounter with the bystander, and, then, the animal who won the first dominance contest engaged the bystander (who had won the second dominance contest in the group) in a contest to determine dominance. The strategy of the initial subordinate was the same as in the groups above: she decreased her aggressive activity, and she did not become dominant over the bystander or reverse her relationship with her initial superior. The strategy taken by the winners in these triads is similar to that of the winners in the groups above; winners here directed aggressive acts toward the animal not yet dominated—that is, the winner of the initial contest and of the second contest (the bystander) battled for dominance. Initial dominators won over bystanders in three out of four cases, but no matter which won, a transitive triad was guaranteed by the initial configuration of relationships (A and C both dominated B).

The final collection of groups to be examined are the 2 triads in which an initially formed dominance relationship was later reversed. There were two extant dominance relationships at the end of the observation period in one of these triads and three relationships in the other. Figures 4A and 4B show the order of formation of relationships in these triads. In the group ending with two relationships, the

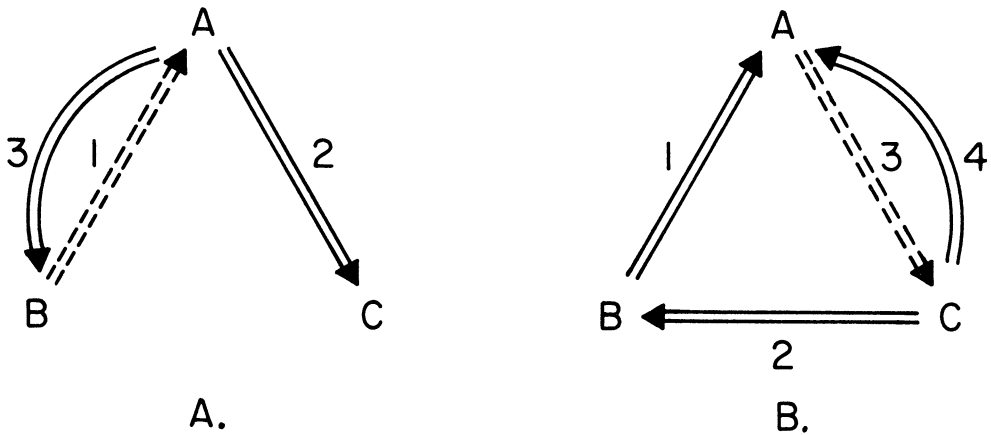


Figure 4. The Order of Formation of Dominance Relationships in the Two Triads with Reversals (Dominance Relationships Later Reversed Are Indicated by Dashed Lines)

initial subordinate became dominant over the bystander, and then reversed her relationship with the initially dominant chicken. The initial subordinate in this group did not follow the same strategy as losers of initial contests in the groups discussed above; she did not withdraw from aggressive activity. The winner of the initial contest also violated the usual strategy—she did not engage the bystander in a dominance contest. However, after the loser of the initial encounter became dominant over the bystander, she followed the usual winner's strategy of engaging the animal not yet dominated, and in this case the engagement resulted in a reversal.

In the group ending with three relationships, the initially dominant chicken was later dominated by the bystander, and the bystander was, in turn, dominated by the initially subordinate chicken. These relationships resulted in an intransitive triad until the bystander reversed her relationship with the initial subordinate to form a transitive triad lasting until the end of the observation period (see Figure 4B). In this triad, the bystander came to dominate the initial dominant rather than the initial subordinate as in the other triads in which the bystander forms a dominance relationship, the initially dominant chicken lost to the bystander (a rare event, it seems—based upon the data collected for this study, anyway), and the initial subordinate withdrew from aggressive activity only briefly and then won a dominance

encounter against the bystander. At this point, each member of the triad was both a winner and a loser vis-à-vis the other triad members, and one of them (the bystander) followed a usual winner's strategy of engaging the animal not yet dominated; that engagement then resulted in a reversal and the formation of a triad with transitive relationships.

The usual strategies of both winners and losers (discovered here) help to explain the high proportion of triads with transitive relationships and triads guaranteed to be transitive. First, the withdrawal strategy of the initial subordinate guarantees that she will not be the dominant animal in the next relationship formed. Her withdrawal, therefore, obviates the possibility of a configuration of the type in which A dominates B and B dominates C. Without a configuration of this type there is no possibility for the formation of a triad with intransitive relationships (with a configuration of this type a transitive triad could still result, depending upon the direction of the third relationship). Second, the strategy of the initial winner—to engage the animal not yet dominated—guarantees the formation of at least two relationships in a triad. There are three subcases to be examined here. In the first subcase, the bystander does not win a dominance contest against either the initial subordinate or the initial dominant, and the initial dominant wins against the bystander. This results in a triad with a dominance configuration of the type in

which A dominates both C and B, and such a triad is guaranteed to have transitive relationships, regardless of which of the subordinates later comes to dominate the other. In the second subcase, the bystander wins a dominance contest against the initial subordinate, and then both the initial dominant and the bystander follow the winner's strategy and engage in a dominance contest with each other. No matter which wins, a transitive triad will result; the transitivity is guaranteed by the configuration formed by the first two dominance relationships—A and C both dominate B. The third subcase is a residual collection in which, for example, a loser violates the usual strategy and wins against the bystander or a bystander wins against the original dominant in forming the second dominance relationship in a triad. In these situations the eventual employment of the usual winner's strategy of engaging the animal not yet dominated can result in a reversal and a transitive configuration or a configuration which guarantees transitivity (see the analysis of the triads with reversals, for examples).

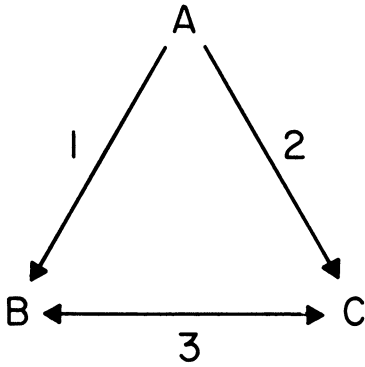
2. *Short-term Processes.* Sequences of two successive aggressive actions can involve either just two, or all three, members of a triad. There are two possible kinds of sequences involving just two members: one animal attacks another twice in a row (Repeat sequence) or one animal attacks another and the receiver returns the attack (Interchange sequence). Acts numbers 1 and 2 in the Data Excerpt given in Table 4 are an example of a Repeat sequence, and acts numbers 2 and 3 are an example of an Interchange sequence.

These two pairwise sequences, in contrast to the triadic sequences that will be defined below, have no implication, in and of themselves, for the formation of transitive or intransitive triads. Therefore, although the pairwise sequences are interesting in their own right, the analysis here will concentrate on the triadic sequences.

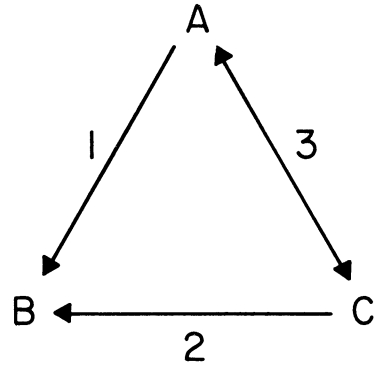
There are four possible sequences involving all three members of a triad. At some point, one member of the triad attacks another member—almost without

exception in experimental groups of chickens, attacks involve only two individuals at a time (the problem of coordinated attacks involving three or more individuals at a time, in such animals as primates, will be discussed later). The attacker in this encounter is labeled as A, the receiver as B, and the bystander as C. After A attacks B there are four *and only four* possible sequences involving C. C and A can interact and there are two possibilities here: A can attack C or C can attack A. Or C and B can interact, and there are also two possibilities here: C can attack B or B can attack C. The resulting total of four possible sequences of attacks is shown in Figure 5. Pattern I is the Double Attack sequence: A first attacks B and then A follows with an attack on C. Pattern III is the Attack the Attacker sequence: A attacks B and then A is attacked by C. Pattern II is the Double Receive sequence: A attacks B and then C attacks B. Pattern IV is the Pass On (the Attack) sequence: A attacks B and then B attacks C. In the Data Excerpt of Table 4 acts numbers 3 and 4 form a Double Attack sequence; acts numbers 8 and 9, a Double Receive sequence; acts numbers 7 and 8, a Pass On sequence; and acts numbers 6 and 7, an Attack the Attacker sequence.

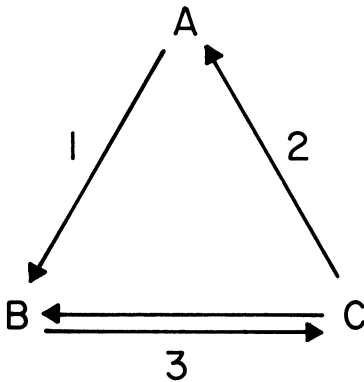
Two of these sequences have a different implication for the formation of transitive and intransitive triads based upon attack relationships than do the other two. (The reader should understand that transitivity and intransitivity are properties of relationships in general, not just of dominance relationships. Thus, if A dominates B, B dominates C, and A also dominates C, a transitive triad based on dominance relationships results; and if A attacks B, B attacks C, and A also attacks C, a transitive triad based on attack relationships results.) Patterns I and II, the Double Attack and the Double Receive sequences, guarantee the presence of a triad with transitive attack relationships—no matter what the direction of attack in the third pair of the triad. This lack of dependency upon the attack in the third pair is indicated by the double-headed arrows in Figures 5I and 5II. For example, in the Double Attack sequence, if B later attacks C,



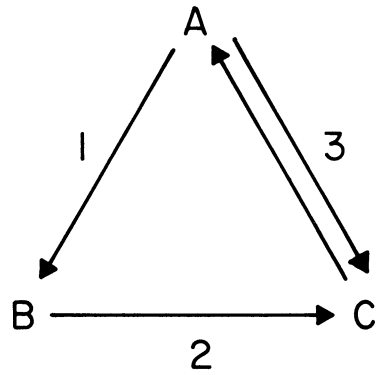
I. Double Attack



II. Double Receive



III. Attack the Attacker



IV. Pass On

Figure 5. The Four Possible Triadic Attack Sequences (Attacks Are Numbered in Order of Occurrence)

the transitive triad in Figure 6A results; or if C later attacks B, the transitive triad in Figure 6B results. The problem of going from transitive triads based upon attack relationships to transitive triads based upon dominance relationships will be treated later.

In direct contrast, the Attack the Attacker and Pass On sequences can give rise to triads with either transitive or intransitive relationships, depending upon the direction of attack in the third pair. For example, in the Attack the Attacker sequence, if C attacks B, the transitive triad in Figure 7A results, but if B attacks C, the intransitive triad in 7B results. This dependency is signified by separate arrows in either direction for the third pair in Figures 5III and 5IV.

Given this difference in attack se-

quences, a question naturally arises: Are chickens favoring one or both of the sequences that guarantee transitivity over those not favoring transitivity? An analysis was performed to answer this question by determining the usage of the four triadic sequences. In this analysis, the first and second aggressive actions occurring in a triad were examined. If these two actions involved only two members of the triad, then the sequence was categorized as either a Repeat or an Interchange pattern as described above. If, however, the two actions involved first two members of the triad and then the third member, the sequence was categorized as one of the four triadic patterns. After comparing the first and second aggressive actions, the analysis continued by comparing the second and third

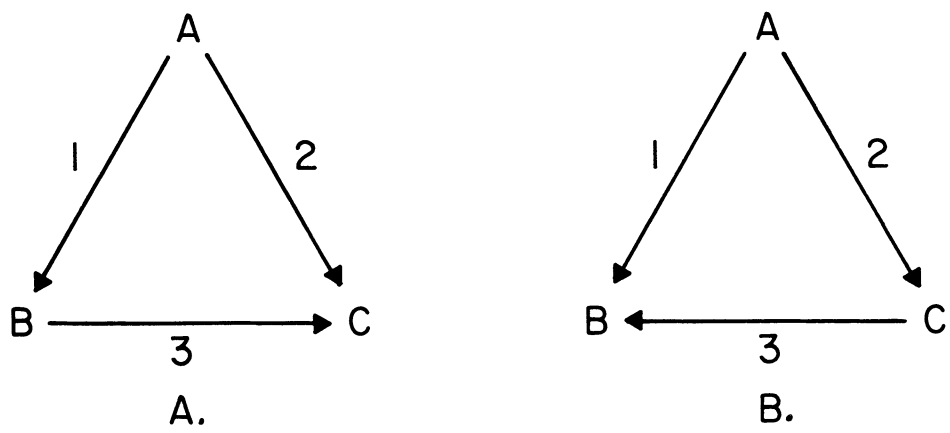


Figure 6. The Two Possible Transitive Triads Resulting from a Third Attack Following the Use of a Double Attack Sequence

actions, the third and fourth, and so on. As a result, in this method of analysis each action is considered once as the first act in a sequence and once as the second act. In addition, this method of analysis reidentifies the initial attacker, the initial receiver, and the bystander for each two-act sequence. Using this method of analysis on the data in Table 4, the first three sequences would be counted in this way: acts 1 and 2 are a Repeat sequence, acts 2 and 3 an Interchange sequence, and acts 3 and 4 a Double Attack sequence.

Distribution of the four sequences as frequencies as well as percentages of all triadic sequences observed in 23 triads combined are given in Table 5. (One triad was omitted from this analysis; this triad

had no incidences of triadic sequences and showed only a single Repeat pattern.) Column 6 of the table indicates the total usage of the four sequences not broken down by time between the initial and following acts of the sequence. The Double Attack sequence composes the overwhelming majority of all triadic patterns—86.6%. The Double Receive, Pass On, and Attack the Attacker sequences account for comparatively small percentages—2.7, 5.3, and 5.4, respectively—of all triadic patterns. If attacks are at random, each of the four patterns has an equal (.25) probability of occurring. The actual distribution of sequence patterns is, however, markedly different from that expected by chance

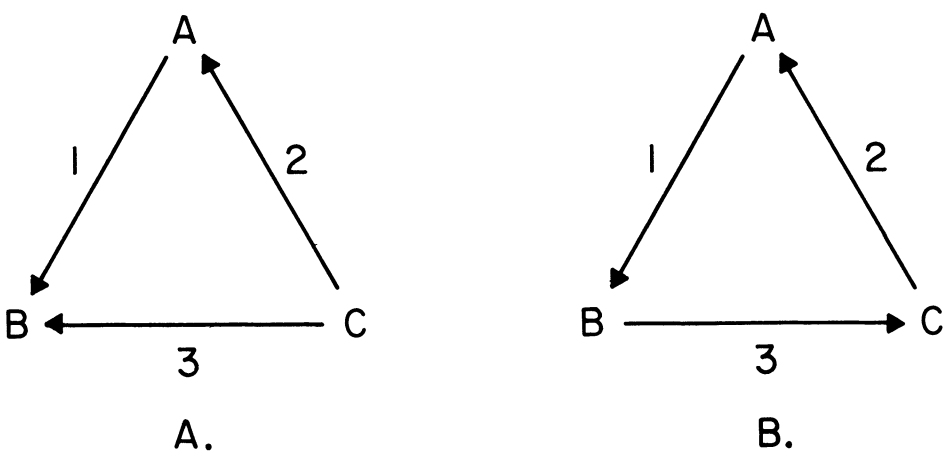


Figure 7. The Possible Transitive (A) and Intransitive (B) Triads Resulting from a Third Attack Following the Use of an Attack the Attacker Sequence

Table 5. Percentage and Frequency Distribution of Triadic Sequences by Time Interval between First and Second Acts (Frequencies Are in Parentheses)

Triadic Sequence	Time Interval (in sec.)					Total
	0-9.9	10.0-29.9	30.0-59.9	60.0-299.9	Over 300	
Double Attack	87.9 (123)	90.3 (102)	88.0 (73)	88.4 (137)	76.8 (76)	86.6 (511)
Double Receive	1.4 (2)	2.7 (3)	2.4 (2)	2.6 (4)	5.0 (5)	2.7 (16)
Pass On	7.1 (10)	.9 (1)	4.8 (4)	4.5 (7)	9.1 (9)	5.3 (31)
Attack the Attacker	3.6 (5)	6.2 (7)	4.8 (4)	4.5 (7)	9.1 (9)	5.4 (32)

(significant at the $p < .001$ level, using a multivariate normal test).

The finding that the Double Attack pattern comprises the large majority of all patterns is robust across sequences, with different time periods between initial and following acts. This can be seen by examining the first five columns of Table 5 in which sequences are broken down by the time, in seconds, between the initial and following acts. For the first four time periods, the proportion of Double Attacks hovers around 90%, and in the longest period of separation, 300 seconds (five minutes) or more, the proportion drops somewhat to 76.8%.

The finding that most triadic sequences are Double Attacks is also robust across individual experimental groups. Of the 24 experimental triads, there were 10 triads (41.7% of all triads) in which Double Attacks composed more than 90% of all sequences, four triads (16.7%) with between 80% and 89% Double Attacks, five triads (20.8%) with between 70% and 79% Double Attacks, and five triads (20.8%) with 43% or lower Double Attacks. (Considering the distribution of triadic sequences in each triad as a sample point, the vector of mean percentages for the patterns is significant at the $p < .001$ level, using a multivariate normal test.) In 79.2% of the triads, then, Double Attacks composed 70% or more of all triadic sequences, and the mean percentage of Double Attacks in the triads was 74.6%.

These data indicate that: (1) in most triads, most of the time, the chickens use the Double Attack pattern—a kind of sequence that guarantees triads with transi-

tive attack relationships, and (2) in most triads, they only rarely use the Pass On and Attack the Attacker sequences that could possibly lead to intransitive triads. These findings suggest that the extremely high proportion of transitive triads and triads that are guaranteed to be transitive (one animal dominates the other two but the relationship between the subordinates is not settled), based on *dominance* relationships, results from the short-term interaction process of chickens in two ways. First, one chicken in a triad tends to repeatedly enact Double Attacks and, in so doing, she fulfills the dominance criteria vis-à-vis the two other members of the group. Second, although chickens may on occasion use the Pass On and Attack the Attacker sequences, all three chickens in a triad do not enact these sequences in a sufficiently consistent and frequent manner so that dominance criteria over the animals being attacked are actually met. That is, in order to have a triad with intransitive *dominance* relationships there must be sufficient and consistent Pass Ons and/or Attack the Attackers to such a degree that a configuration of the sort in which A dominates B and B dominates C results *and*, further, sufficient and consistent Pass Ons and/or Attack the Attackers to such a degree that C comes to dominate A. Pass On and Attack the Attacker sequences are rare, to begin with, in most triads; and the few that do occur are not used consistently enough by the animals to meet the dominance criteria over their fellows in the proper pattern to form a triad with intransitive *dominance* relationships.

THE FORMATION OF LINEAR AND NEAR-LINEAR HIERARCHIES

I now present two empirically testable hypotheses based upon generalizations from the triad study. I propose that the hypotheses can help to direct research efforts and to explain the formation of linear and near-linear hierarchies—not only in groups of chickens larger than triads but also in other animal species and humans. (Data for some primate species will also be reviewed.) The first hypothesis originates from the long-term structure of the interaction process and the second from the short-term structure.

The first hypothesis is as follows:

A) the winner of a dominance contest tends to subsequently engage and dominate other individuals not yet dominated, but not individuals to which it is already subordinate;

B) the loser of a dominance contest tends not to attack any bystanders until the individual who has defeated it becomes dominant over the bystanders; and

C) if either or both of the two above conditions are violated, so that either a triad with intransitive dominance relationships or an initial configuration that could lead to an intransitive triad arises, then one individual will reverse an existing relationship in such a manner that a transitive triad or an initial configuration guaranteeing a transitive triad will result.

This necessarily somewhat complicated way of verbally stating the hypothesis simply implies that the initial configuration of dominance relationships (in most of the possible triads making up a large group) will be of the type in which A dominates both B and C or in which A and C both dominate B but not in which A dominates B and B dominates C. If either of the first two configurations is present, a triad is guaranteed to be transitive; and if all or most of the possible triads in a group have transitive dominance relationships or are guaranteed to be transitive, the hierarchy formed by the concatenation of the triads will be linear or near-linear. One possible scenario of hierarchy formation arising from this hypothesis—and which I predict to occur very frequently—is as follows: One individual in a group wins successive dominance contests with all

the other group members and each loser, in turn, withdraws from aggressive activity. After this first member has finished, one of the subordinates initiates and wins contests with all the other subordinates who again temporarily withdraw from aggressive activity. Then, a second of the original subordinates gains dominance over all but the initial dominant and the first subordinate, and so on, until a complete linear hierarchy is established. In another likely scenario, two individuals each win one or more dominance contests with other group members. After this, the two winning individuals meet in a dominance encounter, and the winner goes on to dominate any remaining group members not yet dominated, while the loser withdraws temporarily from aggressive activity according to part B of the hypothesis.

As indicated, intransitive triads and initial configurations that could lead to intransitive triads do arise when the usual strategies of winners and losers are not followed. Part C of the hypothesis suggests that (1) these structures are not as stable as actual transitive triads or configurations which guarantee transitivity, and (2) previously formed dominance relationships will be reversed to give transitive structures. Part C, in effect, indicates how individuals respond when there is an exception to parts A and B. Other researchers have also found that intransitive triads are not as stable as transitive ones in animals and tend to be converted to transitive structures (Murchison, 1935; Tordoff, 1954). Similarly, Hallinan (1974) and Holland and Leinhardt (1971) postulate that humans have a strong tendency to transform initially intransitive configurations of preference relations to transitive ones.

The second hypothesis states: The Double Attack pattern will be the most frequent of all sequences of two successive attacks involving more than two individuals. In other words, this hypothesis suggests that, of the four possible triadic sequences and the one possible tetradic sequence (A attacks B followed by C attacks D), the most frequent sequence will be the Double Attack pattern. If this hypothesis is supported, then most se-

quences that occur will generate configurations of attack relationships that guarantee transitivity and those that generate configurations that do not guarantee transitivity will be rare. I would like to hedge (somewhat) my bet on this hypothesis by suggesting that in groups larger than three and which remain together for longer periods there might be a considerable occurrence of Double Receive sequences. This hedge is based upon preliminary observation of larger groups of chickens and on some data for primates which will be reviewed below. In some groups there is what might be called "scapegoating"—several members successively attack one low-ranking individual. These successive attacks on the "scapegoat" generate large numbers of Double Receive patterns. In any event, the Double Receive pattern, like the Double Attack, guarantees a transitive attack configuration, and either one or both patterns working together would help produce linear and near-linear hierarchies.

AGGRESSIVE SEQUENCES IN PRIMATES

The hypotheses presented above are derived from my own observational studies of chickens, and one might question the applicability of these hypotheses to other animal species and to humans. Are there indeed similar long- and short-term processes in the interactions of humans and other species that help to explain the reported prevalence of linear and near-linear hierarchies? As I mentioned earlier, animal behaviorists, sociologists, and social psychologists have provided relatively few studies of the dynamics by which hierarchies are formed. It is, therefore, not possible at the present time to rigorously test the validity of these hypotheses for human and other animal groups. There are, however, some suggestive reports in the primate literature and these shall now be reviewed. These studies give information about sequences of aggressive acts in primate groups with previously established relationships rather than sequences during the formation of dominance relationships as in the chicken

experiment.¹ I have found no quantitative studies of the strategies used by winners and losers during the formation of relationships in primate groups.

Each of the four triadic sequences described has also been reported in various primate species. For example, the Double Receive sequence is reported in rhesus monkeys, Java monkeys, baboons, and langurs (Varley and Symmes, 1966; De Waal et al., 1976; Cheney, 1977; Hall and DeVore, 1965; Jay, 1965). Although the Double Attack sequence figures prominently in the results reported here, it has received relatively little recognition as an explicit sequence in primates (which is not to say that it is rare). It is, however, reported in Java monkeys, baboons, and langurs (De Waal, et al., 1976; Hall and DeVore, 1965; Jay, 1965). The Pass On pattern is most recognized as an explicit sequence in primates, and it is referred to by a variety of terms including "redirected," "transferred," or "displaced" aggression. Pass On sequences are reported for rhesus monkeys, Java monkeys, and baboons (Altmann, 1962; Kaufmann, 1967; Jay, 1965; De Waal, et al., 1976; Hall and DeVore, 1965). In some cases an animal attacked redirects the aggression to an inanimate object (Hall and DeVore, 1965). The Attack the Attacker sequence is frequently observed in primate groups when an individual aids a related animal being attacked, but it also occurs among nonrelated animals. This sequence is reported for pig-tailed monkeys, Java monkeys, and langurs (Tokuda and Jensen, 1968; De Waal, et al., 1976; Jay, 1965).

Of these studies, only the one by De Waal et al. (1976) on Java monkeys, close

¹ A particular aggressive sequence used during the formation of dominance relationships may have a different implication than the same sequence used after dominance relationships have been formed. For example, if A attacks B, and B passes on the attack to C, then there is at least a logical possibility that C might later attack A to form an intransitive triad if A does not already dominate C. On the other hand, if A already dominates both B and C and B dominates C, then the same Pass On sequence would not make an intransitive triad possible because C, in all probability, would not later attack A.

cousins of the more familiar rhesus monkeys, reports the actual frequencies of occurrence of the four triadic sequence patterns.² Their study group was considerably different from those in my experiment; it consisted of 17 animals of both sexes and of varying ages from infants to adults. The individuals had been together for a relatively long time, and it is probably safe to assume that most dominance relationships were firmly established rather than in the process of being formed. Their methods of counting triadic sequences were also different from those used in the chicken study. In order to count as a triadic sequence, A had to attack B and one of these two had to be involved in an attack with C less than 15 seconds later. If the second attack took more than 15 seconds, the interactions counted as separate dyadic attacks rather than as one triadic sequence.

Their data indicate that as proportions of all triadic sequences there were 39.7% Double Receives, 22.2% Double Attacks, 20.6% Pass Ons, and 17.5% Attack the Attackers (De Waal et al., 1976:273). In these data, the Double Receive pattern was used most frequently, with Double Attack a relatively distant second, followed closely by Pass On and Attack the Attacker. Although the Double Attack pattern does not make up the majority of all sequences in the Java monkeys as it did in the chickens, in both groups sequences which guarantee triads with transitive attack relationships are considerably more frequent than those which can lead to either transitive or intransitive triads. That is, the Double Receive and the Double Attack patterns, together, account for 61.9%, a majority of all triadic sequences in the monkeys. There is, then, agreement on the high proportion of sequences guaranteeing triads with transitive attack configurations between the experiment for chickens and one for a primate group under quite different conditions.

² Although Kummer (1975) does not count frequencies of behavioral sequences, he does present a stimulating analysis which suggests that interactions in mixed-gender triads can help to explain dominance relationships and sexual alliances in larger groups.

These data provide partial corroboration of the second hypothesis proposed above, but they also suggest certain refinements may be necessary for primates. Additional experiments under controlled conditions for both chickens and primates are required to ascertain the extent of the refinements. One necessary refinement concerns the presence of coalitions in primate groups. By coalition in this context I simply mean two or more individuals directly coordinated, interspersed aggressive acts toward another individual. Coalitions in primate groups are mainly of two sorts: (1) two or more animals join in attacking a third, and (2) one or more animals come to the defense of an animal being attacked and attack the original aggressor. These kinds of coalitions are commonly observed, for example, in baboons, rhesus monkeys, vervet monkeys, langurs, and Java monkeys (Cheney, 1977; Southwick et al., 1965; Varley and Symmes, 1966; Struhsaker, 1967; Jay, 1965; De Waal et al., 1976). The first kind of coalition can be considered as a modified type of Double Receive sequence; in this case the successive attacks are made by animals actively coordinating their aggressive actions. In a similar fashion, the second type of coalition can be considered as a variant of the Attack the Attacker sequence. Thus, the hypothesis proposed above concerning the short-term structure of aggressive interactions can be tested in socially complex species like humans and primates as well as in socially simpler animals using both the simple and modified forms of the triadic sequence patterns.

CONCLUSION

For both social scientists and animal behaviorists there are, arguably, three central issues in the study of social structure in small, face-to-face groups: formation, delineation, and consequence. Confronted with a small-group social structure, a researcher in either field might ask how the relationships came about, what the pattern of relationships was like, and what privileges or liabilities were associated with various positions in

the structure. Both social scientists and animal behaviorists have made considerable progress with the last two of these issues, but neither group, as I have shown here through the example of hierarchy studies, has dealt satisfactorily with the formation of social structures. An analysis of the extant research demonstrates that common conceptual and methodological problems underlie the inadequacies of each field in dealing with the formation of hierarchy structures. Although it takes many different outward appearances, the conceptual machinery in both fields mainly tries to explain the formation of dominance hierarchies by differences in individual characteristics (including differences of ability in pairwise encounters). Given this conceptual machinery, social scientists and animal behaviorists have developed a variety of sophisticated techniques to measure differences among individuals along a variety of dimensions. I have indicated here that, no matter how sophisticated the techniques of measurement or the models using individual differences, stringent mathematical conditions must be met before this approach can satisfactorily explain the empirically common linear and near-linear hierarchies. This emphasis on measuring things about individuals before they join a group, and correlating these measurements with their subsequent positions, leaves out what happens in between: the behavioral process by which individuals come to take their positions. Thus, the present theoretical approach in both human social sciences and animal behavior has led to a relative absence of empirical studies of the dynamics of hierarchy formation.

Herein, I offer a new and more satisfactory conceptual and methodological framework for the study of hierarchy formation. Here, the structure of the interaction process is seen as explaining the formation of a hierarchy, and the associated methodology deals with recording and analyzing the interactions among group members. Here, also, this approach is shown to view social structure as emerging from the web of interactions, and it naturally requires studies of the dynamic processes which result in hierarchy formation.

The application of this alternative approach led to the discovery of a short-term process, the predominant use of the Double Attack sequence, and a long-term process (usual patterns of behavior by winners and losers) that helped to explain the presence of actual transitive triads and configurations guaranteeing transitivity. These findings generated two hypotheses which proposed explanations for the presence of linear and near-linear hierarchies in animal and human small groups. A review of the primate literature offered partial support for one hypothesis, and it suggested modifications to make the hypothesis more generally applicable.

The results presented here suggest three major implications for future research on hierarchy formation, in particular—and on other kinds of social structures, in general.

The first implication is that the explicit and implicit assumptions made by explanations for the formation of various kinds of social structures should be critically examined. Other explanations based upon individual differences may also suffer from inherent liabilities similar to those for dominance hierarchies. This critical examination would, in appropriate circumstances, include explanations in both human social science and animal behavior. For example, profitable areas of investigation are likely to be wealth and income distribution in humans, resource distributions (mates, territories, etc.) in animals, and leadership and role structure in human small groups (see Chase, 1980, for a criticism of population genetics models as proximate explanations of cooperative and noncooperative behavior in animals).

The second implication is that dynamic studies of dominance and other kinds of relationships can greatly increase our knowledge of small-group phenomena. The lack of such studies is partly explained, as discussed above, by the conceptual framework of present approaches and, partly, it seems likely, by the previous lack of efficient equipment for the recording, storage, and analysis of the necessarily large volumes of interactional data. The growing availability of microcomputer systems and computer-

assisted devices for dealing with interactional data is rapidly alleviating this problem.

The third implication is that there is a certain "lawfulness" in the structure of interactions that can explain the configurations of social relationships in small groups. This article demonstrates "lawfulness" in the interactions of chickens in triads, and it goes on to suggest the units of interaction that are responsible for hierarchy formation in larger groups across species. The model developed here indicates how interactions at a micro level—among individuals—can be cumulated to explain how a macro level structure—a dominance hierarchy—is produced.

I suggest that this kind of approach has applicability beyond hierarchy research to the study of other types of social structure in human and animal groups. Future research is needed to assess the validity of this implication.

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