MEASURING SOCIAL BEHAVIOR: SOCIAL DOMINANCE

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ABSTRACT

Social dominance develops more slowly when young animals are kept in intact peer groups where they need not compete for resources. Learned generalizations may cause smaller and weaker animals to accept subordinate status readily when confronted with strangers that would be formidable opponents. Sexual hormones and sensitivity to them can influence the onset of aggression and status attained. After dominance orders are established, they tend to be stable in female groups but are less so in male groups. Psychological influences can affect dominance relationships when strangers meet and social alliances within groups may affect relative status of individuals. Whether status associated with agonistic behavior is correlated with control of space and scarce resources needs to be determined for each species and each kind of resource. When such correlations exist, competitive tests and agonistic behavior associated with gaining access to scarce resources can be useful to the observer in learning about dominance relationships rapidly. Examples are given to illustrate how estimates of social dominance can be readily attained and some strengths and weaknesses of the various methods.

(Key Words: Animal Behavior, Agonistic Behavior, Aggression.)

Introduction

Traditionally, dominance relationships among animals have been determined by observations of overt aggressive and submissive behavior. When three or more animals are involved, dominance ranks may become complex because of pecking triangles (Schjelderup-Ebbe, 1922) and social alliances (Rowell, 1974; Bernstein, 1981). As Syme (1974) makes clear, many researchers, including the pioneer Schjelderup-Ebbe, have regarded overt aggression as the outward manifestation of an underlying social organization, whereby high-ranking individuals have priority of access to all resources. Syme notes further that such a unidimensional view of dominance, if correct, would have important consequences in terms of ease of researchers' ability to determine dominance hierarchies. This presentation outlines briefly what is known about social dominance organization in farm animals, consequences of relative status for individuals, methods of estimating dominance and competitive ranks, and some problems needing further attention.

Establishment of Dominance Relationships

Juveniles and adolescents typically work out their dominance relationships with each other at a much slower rate if kept in intact rearing groups than if mixed with strangers (Guhl, 1958; Bouissou and Andrieu, 1977). Ewbank (1967) and Bouissou and Andrieu (1977) provided evidence that dairy heifers reared together show long-term affiliative behavior and Bouissou and Andrieu (1977) found reduced agonistic activity between such animals later in life. Typically, young animals that do not need to compete for necessities learn their dominance relationships in mock fighting bouts and playful trials of strength. Relationships between more mature animals, brought together as strangers, are frequently determined during aggressive interactions involving physical contact. However, for animals experienced in establishing dominance relationships, threats or even mere presence may induce subordination, if one animal is much larger or appears extremely self confident or aggressive in its behavior. The passive acceptance of lower
status by an animal in the face of apparent superiority of size or fighting potential may be a learned generalization. This hypothesis is supported by the observation that juvenile rhesus monkeys, reared in isolation, often appear to ignore relative age and size in launching "suicidal" attacks on adult males (Bernstein, 1981).

Hormonal effects associated with sexual maturity appear to be of major importance in causing the onset of aggressive behavior (Guhl, 1958). Evidence from experimental stocks of chickens indicates that sensitivity to androgenic stimulation may be as important, or perhaps even more important, than endogenous levels of circulating androgens (Ortman and Craig, 1968). Earlier-maturing hens have an advantage in establishing social dominance over later-maturing ones (Bhagwat and Craig, 1977), and, once established, dominance relationships among females tend to persist, even when actual ability to win contests with strangers has altered significantly (Bellah, 1957; Lee and Craig, 1981). In contrast to female hierarchies, male social status may change more frequently.

Schloeth's observations of feral cattle are of special interest (Schloeth, 1961). With the approach of the mating season, several sexually mature bulls joined each cow-calf herd. Two-year-old males then attempted to mate, causing long periods during which heterosexual fighting occurred, as only the weaker cows would submit sexually to advances by 2-yr-old bulls. Further observations indicated that essentially three separate dominance orders were present within a herd made up of both sexes and all age groups. In another sense there was only one large dominance order, with all adult bulls in top positions, adult cows in the middle, and younger animals at the bottom. Adolescent bulls did not fit neatly into the general pattern. They began to work their way up through the adult cow hierarchy at about 1.5 yr of age and emerged at or near the top of the group at about 2.5 yr. At that time they occupied the lowest positions of the adult male hierarchy. Adult bulls seldom behaved aggressively toward cows, but adolescent bulls were in relatively frequent contests with cows as they moved up in the hierarchy. It seems likely that this kind of situation must be common among group-living species in which polygyny and secondary sexual dimorphism occur, with males being much larger and more powerful after sexual maturity.

Psychological influences also can have an important bearing on status attained. Collias (1943), working with chickens, showed that individuals have greater success in an encounter with a stranger when they are in familiar surroundings and among acquaintances. McBride (1958) found a carry-over effect from a previous encounter for hens when there was no interval between contests, but this effect disappeared when the interval between contests was at least 3 hr.

Social alliances within groups can alter dominance relationships. Such alliances are particularly important among primates, and the often temporary nature of alliances can alter relative status of individuals so much that assigning dominance ranks may give little useful information. For example, two monkeys, A and B, that individually cannot dominate a third, C, have been observed to do so when acting together. Thus A and B are either dominant to C or not, depending on their locations within the group and whether one can elicit the cooperation of the other in confronting C on any particular occasion. Because of these and other difficulties, some primatologists (e.g., Gartlan, 1968; Rowell, 1974; Bernstein, 1981) seriously question the concept of social dominance for descriptive and predictive use in primate societies. Alliances appear to be of lesser importance among farm animals. Nevertheless, Tyler (1972) observed that pony foals of high-ranking dams were especially likely to attain high rank. Dominant mares were observed on several occasions to come to the aid of their progeny. Thus, an 8-mo-old filly was observed to have higher rank than some 3-yr-olds in the near presence of her dam, but some of those relationships were reversed when the dam was absent.

Initial Pair Contests. Potential ability for dominance is often estimated in pair contests with strangers of the same sex, age and weight in a neutral area. This method may speed up the process of evaluating social-dominance potential in some cases and may avoid some of the psychological problems mentioned. Nevertheless, staged pair contests represent highly artificial situations and outcomes could be influenced by extraneous variables, such as relative fearfulness of being handled, herded, or led by the human evaluator or of the test environment. Estimated dominance potentials are relative to the particular individuals used in the test. Selected "panels" of opponents and
random samples of individuals of the same or of different genetic stocks have been used. When Guhl (1953) compared relative status of adult hens evaluated by the initial-pair contest method and by social rank in organized groups involving the same individuals, only moderate correlation coefficients were obtained, ranging from about .3 to .8.

The initial-pair-contest method was used in two bidirectional selection studies in chickens (Guhl et al., 1960; Craig et al., 1965). In each study, after a few generations of selection, genetic stocks were produced that differed markedly in social dominance ability. Differences between the stocks were present whether they were tested by the pair-contest method, or by assembling pullets of the stocks that were strangers to each other at about the time of sexual maturity (Craig et al., 1965). However, differences between stocks appeared to be larger when the pair-contest method of evaluation was used (Craig et al., 1965).

Linear and Complex Hierarchies

Social organization within groups can be relatively simple, i.e., linear or near linear, or highly complex. Some small flocks of hens studied by Guhl (1953) illustrate this, as shown in figure 1. In the linear peck order (Flock F) each individual is dominant to all those listed below it. Complexities arise when pecking triangles are present (Flocks W, G and P) and assignment of relative ranks becomes a problem. As an example, in flock P of 7 hens, individual PG was dominated by 5 others, but was found to be socially dominant to individual PP, which was dominant to all others. In the pecking triangles seen in Flocks W and G, each individual within a triangle has an equal dominance rank.

Although small groups (less than 6 to 10) of domestic animals of the same sex and of about the same size frequently have linear or near-linear social organization (Chase, 1982, McCort and Graves, 1982; Rushen, 1982), larger groups are typically complex as illustrated by figure 2 from Lee et al. (1982) for a flock of 24 hens.

Spatial Relationships, Subgroups and "Avoidance Orders"

When larger groups are kept in sizable pens or pastures in which necessities are well distributed and the locations of the individuals are plotted over time, it becomes apparent that their movements are restricted (Craig, 1981). Because of such limitations of movement,
animals presumably do not commonly associate with more individuals than can be remembered, thereby assuring the presence of organized societies. It appears that large groups may be organized on a neighborhood basis or into subgroups based on relationship, where that is allowed by man.

As stated earlier, a common assumption is that dominance confers priority of access to limited or highly localized resources. But why should animals show aggressive and submissive behavior even when resources are abundant? Typically, they do show less agonistic activity under that circumstance, but a certain baseline level of agonistic activity is usually maintained and that level tends to increase if the area in which they are kept decreases.

It appears that space itself can be a prized possession. Here we encounter the concept of personal space or individual space (McBride, 1971). This space can be thought of as if it is enclosed by a balloon surrounding an individual. A dominant animal defends its space by aggressive behavior. The personal space balloon can shrink or even collapse, as when animals rest (especially in cold weather), mate or care for their young.

In reviewing the literature on primates, Rowell (1974) cited evidence that subordinate animals play a role in determining social behavior within groups by avoiding dominants, even when dominant animals make no overt acknowledgement of the subordinates' presence. Beilharz and Zeeb (1982), working with cattle, and McCort and Graves (1982), with swine, also pointed out that it is usually subordinates that appear to monitor spacing relationships and orientation relative to dominant animals. Jensen (1982), using inter-individual sequence analysis of dry-sow behavior, concluded that an "avoidance order" was present when groups had sufficient space, and that lowering and turning the head away by subordinate sows inhibited aggression by dominants.

**Consequences of Social Status**

When resources become limited, they are not usually prorated according to dominance rank. The relationship appears to be more like one in which there may be a rich reward for the most dominant but little for the rest, or in a different situation, the majority may receive nearly equal rewards, but those that are very low in status are penalized severely. Thus, Osterhoff (cited by Blockey, 1978) learned, by blood typing, that a single bull usually sired about 60 to 80% of the calf crop, though 3 or 4 sires were present in a herd of cattle. Other studies confirm that in polygynous herds or flocks of domestic animals, one or a few dominant males typically sire most of the young, if females are concentrated in terms of locality during the breeding season and only one or a few are sexually receptive at any one time (Guhl and Warren, 1946; Wodzicka-Tomaszewska et al., 1981).

When resources are available at moderate levels, then more may share but a few may be largely excluded. Cunningham and Van Tienhoven (1983) kept six hens per cage at very high density, with limited feeding space. They found that only the lowest-ranking hen was depressed in feeding activity, body weight, and egg production. In the very different setting of flocks of 24 hens kept together in floor pens, Lee et al. (1982) showed that a markedly curvilinear association was present between a measure of dominance rank and egg produc-
tion. Low social status again was disproportionately important in depressing performance of those individuals ranking near the bottom of the social hierarchy. A similar situation was present in mature beef cows that were assembled from several herds kept on range and placed in a confinement cow-calf management system by Schake and Riggs (1972). The group categorized as being the lowest one-third in terms of social status was depressed in all items of performance, while those in the middle were depressed much less in terms of body weight and milk yield, as compared with the top-ranking group.

Most studies with farm animals that attempt to establish associations between relative status and other characteristics ignore what the animals are actually doing in terms of specific aggressive and submissive acts. Fraser (1974) showed that growing pigs have two fairly distinct types of aggressive behavior, one based on butting and the other on biting, and that the behavior of the recipient depends very much on which type of aggressive behavior it receives. Sequential analysis of interactions between pairs of animals is required for this kind of study. The availability of video recording equipment (Jensen, 1982) and computer programs (McGlone et al., 1984/85) provide means of coping with this otherwise difficult kind of analysis.

### Competitive Orders

The possibility of using competitive tests to estimate existing dominance relationships has been explored. In competitive contests, aggressive and submissive acts are not measured. Instead, gaining control of a resource is assumed to indicate dominance. A particularly informative study of this type was carried out by Sereni and Bouissou (1978) with saddle horses. Social organization was determined by extensive observations of three groups of animals while they were grazing on pasture. Dominance relations determined in that way were compared with results obtained from very brief competitive feeding trials. Groups on pasture were observed for 30, 50 or 200 h, and all agonistic acts, including different kinds of threats, bites, kicks, charges and avoidances, were recorded. Subordinate horses sometimes showed aggressive behavior while on pasture, but Sereni and Bouissou considered the one showing more aggressive behavior within the pair as the dominant member (figure 3).

Within the three groups there was a total of 46 possible pair relationships. Dominance relationships were known in 41 of the 46 pairs. Group 3 had a linear order, group 2 included a triangular relationship, and group 1 had five unknown pair relationships. In group 1, the pairs L-C and F-I had equal frequencies of aggressive acts directed towards each other, while G was not observed to interact with C, L or M and frequently remained apart from the others.

When food competition tests were carried out with the same animals, two horses were released at a time into a paddock after having fasted in a stable overnight. A bucket containing oats was placed in the paddock, and the test period, lasting 3 min, began as soon as one began to feed. Only one horse could feed at a time, and the amount of time each controlled the bucket was measured. All possible pairs within each group were tested in this way; each pairing was repeated two or three times. Almost without exception, aggressive acts while competing for feed were unidirectional.

In comparing their observations made while horses were on pasture and in feeding competition trials, Sereni and Bouissou (1978) found that dominants controlled the feed bucket for average times varying from 136 to 165 s (out of 180 s) for those pairs where the dominance relation was already known from pasture observations. The dominance order for Group 1, which had five unknown pair relationships after 50 h of observation on pasture, was determined with relative ease in the competitive feeding tests; dominance, as indicated by priority of access to feed, remained undecided in only one pair. Average feeding time of the dominant animals in those four pairs that were determined by feeding trials only was 160 out of 180 s. The undecided pair (I-F) tended to share the feed and had no aggressive interactions. Tyler (1972) also found nearly perfect agreement between dominance relationships of horses based on observations of agonistic behavior under unrestricted conditions and ability to gain access when competing for hay.

The results of Sereni and Bouissou (1978) would be predicted from a unidimensional view of dominance, i.e., that higher social rank always gives priority of access when animals are competing for scarce resources. Syme (1974) has been particularly critical of this view. He calculated correlation coefficients between
dominance orders, based on aggressive acts and competitive orders when the same animals competed for a desired resource such as food, water, mates or escape from an aversive condition. In reviewing studies involving seven mammalian species and chickens, he found correlation coefficients exceeding .70 in 11 of 17 comparisons. Therefore, in about one-third of these studies, less than 50% of the variance in one measure was associated with variance in the other.

As an illustration of the need for validation of competitive orders as indicators of dominance, the study of Banks et al. (1979) can be cited. In that study, dominance ranks were determined for chickens in pens with feed and water continuously available. Subsequently, birds were deprived of feed and water for 18 h and then placed together for 10 min in a pen with feed and water available at point sources, i.e., so that only one bird could gain access at a time. There was a significant but not perfect overall relationship between social rank and frequency and duration of feeding. However, the thirsty birds did not compete at the water source. Whichever bird arrived first was allowed to drink its fill, regardless of its dominance rank. Two possible explanations were offered. Whatever the reason, it is evident that what would appear to be a high priority item for humans may not elicit competitive behavior in another species.

Agonistic Behavior in Competitive Situations

Another technique for obtaining information on dominance relations is to deprive
animals of a resource and then observe their agonistic activity as they compete for access to it. Control of the resource itself is not measured but rather aggressive and submissive acts elicited by the situation. It is known that the frustration of a hungry animal, associated with having food present but not being able to reach it, often results in increased aggression by dominants and the continued presence of subordinates attempting to feed, even though they are subjected to aggression (Scott, 1948; Duncan and Wood-Gush, 1971).

A study by King (1965) indicates that frustrating situations may become so extreme in some cases as to lead to questionable outcomes. King determined the peck order in flocks of young cockerels. He then compared frequency of aggression and the stability of dominance relationships by depriving flocks of their feed supply for 24 h and then presenting it for a 1-h period in each of three ways. When feed was spread evenly over the floor area, the frequency of aggression was very low; all individuals were busy eating. When feed was presented in a circular feeder allowing access by all individuals provided they crowded together, aggressive acts increased to 36 times the number observed with the unrestricted area feeding and the incidence of subordinates attacking or threatening dominant penmates was 5%. This frequency of peck-order violations could presumably be tolerated by an observer wanting to evaluate dominance ranks within flocks rapidly. However, when the feed was presented so that only one individual could eat at a time, there was essentially an explosion of aggressive acts by the hungry cockerels and peck-order violations occurred at a frequency of about 50%. This level of error would totally confuse an observer as to dominance relationships existing under less competitive conditions. Interestingly, King found that the dominance relationships of these groups quickly returned to their normal state in the absence of the frustrating test situation.

**Alternative Estimates of Social Status**

In order to illustrate some alternative methods of estimating dominance rank, information that was gathered from two groups of pregnant sows (J.V. Craig and G. McBride, unpublished data) is presented. Agonistic acts were recorded on two occasions from video recordings made during and for about 1 h after feed was scattered on the floor of their pens. There were few violations of the dominance order, so those are not shown in figure 4. For Group N, a linear order was observed. There are few complications here and estimates of dominance ranks would agree for most methods of computation. Nevertheless, the quality of the pair relationships do vary. For example, only 10 aggressive acts were recorded from C to R,

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**Figure 4.** Pregnant sow groups N and S. Numbers indicate the total number of aggressive acts delivered by each dominant sow to her subordinate.
but 41 aggressive acts of F toward C were recorded during the same period.

The social organization in sow Group S is more complex because of a “pecking” triangle. How should the sows of Group S be ranked? Five methods reported in the literature for estimating relative social status within groups have been used and the results are shown in table 1. Along with each qualitative ranking is a numerical value. The simplest ranking is based on the number of individuals dominated, as shown in the first column. The second column contains social-rank indexes (Lee et al., 1982), which are comparable to values in the first column in this example. In the first two measures, pair relationships are evaluated in terms of dominance or subordination only; frequencies of aggressive and submissive acts are ignored. In the third column, the numerical value associated with each rank is the sum of all aggressive acts delivered by each animal. In the fourth column, each animal’s rank is based on the total number of aggressive acts delivered by it minus the number of aggressive acts that it received. This value has been termed a social-tension index (Craig et al., 1969). The final column contains estimates of rank based on the ratio of aggressive acts delivered by an individual to all agonistic acts in which it was involved. This measure has been termed dominance value by Craig and Guhl (1969). A similar, but not identical, estimator of social status has been described by Beilharz and Cox (1967) and Beilharz and Zeeb (1982), who advocated the use of a statistical transformation to achieve a more normal distribution of the data. It is of interest to note that in the last three methods, although W and Y are consistently the alpha and omega individuals, Z is placed second in rank by two methods but ranks third highest by the other.

Conceptually, dominance rank should not be equated to frequency of aggressive or submissive acts. Nevertheless, those frequencies should be examined to determine to what extent they may be correlated with dominance ranks. Biswas and Craig (1971) pointed out that social-tension indexes and dominance values appeared to be suitable estimators of relative status for use in larger groups where peck-order ranks would be nearly impossible to determine. They favored the use of social-tension indexes over dominance values for statistical reasons and their data indicated that “Phenotypic correlations of peck-order ranks and social-tension indexes with egg production traits of pullets were of the same sign and of the same approximate magnitude.”

It should be noted that in cases where marked antipathies, or alternately, marked tolerances exist, estimates of social rank based on frequencies of agonistic acts may distort the understanding of actual ranks. For example, an animal of intermediate dominance could be extremely abusive to one or a few individuals and thereby attain a very high numerical value by any of the last three methods of estimation shown in table 1, even though other less abusive animals were dominant to it within the group.

Which method or methods shown in table 1 are preferable? Social-rank indexes, social-tension indexes and dominance values are likely to be more valuable than measures based on aggressive acts only. These methods take into account submissive acts, as well as aggressive ones, and that provides especially useful information when estimating ranks in larger groups where all pair relationships may not be

<table>
<thead>
<tr>
<th>Sows dominated</th>
<th>Social-rank index</th>
<th>By frequency of aggressive (A) and submissive (S) acts</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
<td>A—S</td>
</tr>
<tr>
<td>W 3</td>
<td>W 4</td>
<td>W 54</td>
</tr>
<tr>
<td></td>
<td>Z 15</td>
<td>X —14</td>
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<tr>
<td>X, Y, Z 1</td>
<td>X, Y, Z 2</td>
<td>X 9</td>
</tr>
<tr>
<td></td>
<td>Y 8</td>
<td>Y —23</td>
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</table>

*Social-rank index = ½ (No. dominated — No. dominated by + group size + 1). From Lee et al. (1982).*
known. Social-rank indexes and transformed
dominance values appear to provide data having
normal distributions (Lee et al., 1982; Beilharz
and Zeeb, 1982).

Initial-pair-contests, control of resources
during competitive tests and agonistic acts
observed in competitive situations provide
potentially useful evidence as to pair relations-
ships and can be carried out with comparative
rapidity. However, in some situations, they may
be of limited value for indicating where an
animal will actually rank in group situations.

General Associations

Most applied animal scientists want to know
how dominance and competitive ranks are
associated with each other and with well-being
and production characteristics. The various
measures discussed need to be tested for such
associations. When associations are found
between social dominance ranks or behavioral
estimators of status and other traits, evidence is
provided that needed resources may not be
obtainable at desirable levels by lower-ranking
animals. Management systems, as well as
physical and social environments, are then open
to scrutiny to determine how such inequities
arise and how they may be prevented.

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