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GRADUATE COLLEGE

SOCIAL ORGANIZATION IN CAPTIVE CHIMPANZEES: THE EFFECTS OF SPACE, ESTRUS AND COALITIONS UPON THE DOMINANCE HIERARCHY

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SOCIAL ORGANIZATION IN CAPTIVE CHIMPANZEES: THE EFFECTS OF SPACE, ESTRUS AND COALITIONS UPON THE DOMINANCE HIERARCHY

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TABLE OF CONTENTS

Page

LIST OF TABLES v

LIST OF FIGURES vi

Chapter

I. INTRODUCTION 1

II. PROBLEM 29

III. METHOD 33

IV. RESULTS 43

V. DISCUSSION 64

VI. SUMMARY 105

REFERENCES 107

APPENDICES 117

LIST OF TABLES

Table		Page
1.	Different Theoretical Predictions of Coalitions in the Triad	17
2.	Chi-square Values for Dyads in the One Cage Condition	45
3.	Chi-square Values for Dyads in the Two Cage Condition	47
4.	Chi-square Values for Triads in the One Cage Condition	57
5.	Chi-square Values for Triads in the Two Cage Condition	59
6.	Dominance Hierarchies for the Four Conditions	63
7.	Social Distance Scale	78

LIST OF FIGURES

Figure — Page

1. Relationship between the % of resources contributed and the number of grapes acquired when the middle status S is varied 52

2. Relationship between the % of resources contributed and the number of grapes acquired when the low status S is varied 53

3. Changes in the dominance hierarchy as a function of space and the number of animals 66

4. Relationship between combined power of the coalition and the number of grapes acquired by the middle status member when the low status member is varied 72

5. Relationship between combined power of the coalition and the number of grapes acquired by the middle status member when the middle status member is varied 73

SOCIAL ORGANIZATION IN CAPTIVE CHIMPANZEES: THE EFFECTS OF SPACE, ESTRUS AND COALITIONS UPON THE DOMINANCE HIERARCHY

CHAPTER I

INTRODUCTION

Whether referred to as the study of social organization, group behavior or collective psychology, man has for centuries been interested in the study of how groups of people live and interact with each other. Thus, historians have attempted through the writings of the early philosophers and statesmen to piece together a picture of the forerunners of contemporary societies in order that the latter may be better understood. The idiosyncrasies of contemporary societies are even more apparent in the anthropological and social-psychological investigations of Benedict (1946); DuBois (1944); Havighurst (1954); Malinowski (1927) and Mead (1930). More recently, attention has turned to the study of small groups which has reached such great heights during the present decade that it would not be surprising for future historians of psychology to refer to the study of small groups as the "Zeitgeist" of the 60's.

The motivation underlying this upsurge of interest in the study of social organization has not been only to accumulate a body of knowledge in this area but also to find solutions to

several ever increasing, realistic problems. Kummer (1968) states that:

> Remaining together without mutual destruction is a problem which every society must solve on the level of its individuals. In the multi-level society, i.e., in a 'group of groups', the theme is merely repeated on the level of component units. In both cases, spatial separation is no longer a permanent preventive against mutual aggression; at least in part, aggression must be controlled by inhibitions (p. 156).

That "spatial separation" is not the answer is amply demonstrated by our history of two world wars and the numerous "police actions" around the globe in which many nations have taken part over the past twenty years. Separation on the basis of prestige or power seems also not to be a deterrent as evidenced in the current rioting on campuses, strikes by laborers, and professional walk-outs. It is realities such as these which place a burden upon the social scientist to refine his understanding of various forms of social structure and the part played by the individual within that structure.

Once investigators began to study animals in their search for the fundamental laws governing human social behavior, attention turned to the study of the social organization of various animal societies. As a result of these endeavors, there now exists a substantial body of knowledge regarding the social behavior of a variety of species. Of all the animals studied, however, by far the group that has stimulated man's curiosity the most has been the non-human primates, particularly the great apes, since, after the publication of Darwin's "The Expression of the Emotions

in Man and Animals" in 1872, they supposedly were the link between man and the animals. Although this notion has not gone uncontested, it has been known for some time that man and the chimpanzee share many common anatomical, endocrinological, sociological, and psychological attributes (Riopelle & Rogers, 1965).

It has been almost 100 years since Darwin published his famous book, and one would expect that there would be little that man does not know about the chimpanzee. This does not, however, turn out to be true. In fact, very little is known when compared to what is known about the macaque and baboon. Most of our knowledge regarding chimpanzees stems from the experimental investigations of Yerkes, beginning in the 20's and summarized in his 1943 book, and the field studies of Goodall (1963; 1965a; 1965b; 1967; 1968), Kortland (1962) and Reynolds (1965; Reynolds & Reynolds, 1965).

Our relatively limited knowledge about the chimpanzee seems to be due, in part, to the cost, limited accessibility, and intensive care needed in the housing of chimpanzees. But, and perhaps more important, embellished tales of early world travelers and natives made it appear that they would not be usable subjects in experiments even if they could be captured. The writings of Bingley (1813) and Buffon (1775) included tales of chimpanzees having succeeded in repulsing whole armies of soldiers, pillaging and destroying native villages and swallowing small animals whole. They were also described as probably lacking in modesty or morals since they unashamedly exposed their naked

bottoms to anyone happening to pass by.

In view of these anecdotes, it is not difficult to see why they might not have been looked upon as ideal subjects for experimentation, and why it is only recently that modern science has been able to begin extricating truth from fiction regarding the chimpanzee.

The purpose of the present study, thus, will not only be to enhance our understanding of the social organization of chimpanzees but also to demonstrate how fruitful the study of chimpanzees can be in our search for knowledge about man as a socialized primate. It is also hoped that the results will suggest, perhaps, a direction in which other investigators can go in solving some of the realistic problems with which man is faced today.

Contributions from Animal Research

Animal research has contributed to a better understanding of man in almost all areas of psychology including perception, developmental, learning, motivation and the development of psychopathology. Beach (1960) and Hebb and Thompson (1954) have emphasized the necessity of studying non-human animals to arrive at a better understanding of human behavior. Similarily, Beach (1950) has stated: "Only by encouraging and supporting a large number of comparative investigations can psychology justify its claim to being a science of behavior" (p. 123). The problem in generalizing from non-human animals to the human animal is not, as at least two investigators (Sherif & Sherif, 1956) argue, the

"difference in capacity and hence in underlying organizational processes between man and other animals" (p. 10). The problem does not reside within the animal but in the observer who makes the generalizations.

Some investigators (Kavanau, 1964; Willems, 1965) seem skeptical of generalizations from the animal in the laboratory to the same species of animal in the wild. Kavanau, for example, views the laboratory rat as an "atypical species" (p. 490). Willems draws attention to the "discrepant findings" (p. 31) between Washburn's laboratory and field studies of dominance in pairs of baboons. With laboratory animals, dominance was achieved mainly through aggressive intimidation and physical power, whereas in the field, dominance was the result of "superior cunning, sexual expertise and, apparently, attractiveness" (p. 31). To suggest from results such as these that an animal in the laboratory may not be the same as an animal of the same species in the wild (Kavanau, 1964), or that another research method would yield more valid results (Willems, 1965), is to ignore the basic principle of survival of the species. The assumption underlying conclusions such as those above seems to be that an animal's "natural" behavior is rigid and fixed, an assumption contrary to the abundant evidence in support of the flexibility in animal, including human animal, behavior.

Chance (1963) stressed that "always to be kept in mind is the possibility that monkeys living under one set of circumstances may rely on one facet of the individual's behaviour to provide

the required sociability and that other facets come to the fore in other circumstances" (p. 2). Observations of captive animals are not necessarily inapplicable to wild animals "because there are conditions in the wild where monkey colonies are circumscribed within territories which are closely contiguous with others . . ." (p. 2). It would seem, therefore, that many biased views, false assumptions and erroneous conclusions could be avoided by a synthesis of the findings regarding a specific species in a variety of conditions. In this way, differences between the behavior of non-human and human animals, wild and captive animals, would become supplementary rather than conflicting (Washburn, et. al., 1968).

Of the multitude of studies in comparative psychology, the studies concerned with imprinting and the critical period hypothesis have added much to our understanding of man. In the ethological investigations of imprinting (a form of social learning) in birds by Lorenz (1937), he noted that there exists only a short period of time when imprinting can occur, and this period of time was called the "critical period". Studies on the critical period hypothesis gained impetus through the post World War II work of McGraw (1946) on the critical period for optimal learning of motor skills in the human infant and Hebb (1949) on the effects of stimulus deprivation upon perception and cognition in infant animals. The concept gained status, however, mainly through the efforts of Scott (Caldwell, 1962).

Scott theorized that dogs can form strong attachments to

people with only a minimum of contact. In his first experiment the behavior of puppies who had experienced no human contact was compared to that of puppies who had experienced minimal human contact. The results indicated that the puppies who had not had human contact "went wild" (Scott, 1969).

In a follow-up study (Scott & Marston, 1950), individual puppies were removed at different ages from an open field where they were housed with their litter mates, given human contact for a week and then placed back with their litter mates. The results supported a critical period hypothesis for the formation of primary social attachments in dogs. The critical period was found to extend from between about the third to the twelfth week of age. Before and after this time period the puppy is too immature or fearful of strangers, respectively, to form strong social attachments. A later study (Cairns & Werboff, 1967) demonstrated that during the early phases of the critical period a puppy can form an emotional attachment to an object with only 24 hours of contact and that the puppy will cry if separated from that object.

As a result of his early studies, Scott hypothesized that there exists in the development of the organism a limited time interval during which the presence of certain types of stimuli result in profound effects upon the behavior of that organism. If these stimuli occur beyond the critical time period, they will have little if any effect. Also, a non-specific stimulus occurring during the critical period can produce an irrevocable effect.

Other investigators (Caldwell, 1962; Denenberg, 1964)

have interpreted the critical period hypothesis in a somewhat different manner. They have suggested that there are periods of maximum susceptibility in the development of the organism during which the identical stimulus will have different effects.

Related to Scott's studies and occurring at about the same time was the work of Harlow on the effects of maternal deprivation during infancy upon the adult behavior of rhesus monkeys (Harlow & Zimmerman, 1958; Harlow, 1958, 1962; Harlow & Harlow, 1962). For a while it appeared that none of his monkeys were able to overcome the early experience and develop normal social, heterosexual and maternal behavior. Great effort and ingenuity on the part of humans as well as "normal" monkeys was needed. Scott would probably explain Harlow's difficulty in making "abnormal" monkeys "normal" on the basis of his corollary to the general theory of critical periods: "organization inhibits reorganization" (Scott, 1969, p. 67). In other words, once an animal develops an organized pattern of social behavior during the critical period, even if that means developing an abnormal pattern for the species, it is most difficult to change that behavior. Just as this was true of Harlow's monkeys, it was true of Scott's dogs who had experienced no human contact during the critical period. When these puppies matured, they always preferred dogs to humans and were difficult to change into good house pets.

The existence of critical periods for a variety of behaviors has been supported by an abundance of animal studies

(Beach & Jaynes, 1954; Denenberg, 1964; Fuller, 1967; Hess, 1959; Lemmon & Patterson, 1964). Studies such as the above have contributed to our understanding of Freudian and neo-Freudian theories of psychopathology (Erickson, 1963; Freud, 1949; Sullivan, 1953), the extensive series of experiments on maternal deprivation in children (Bowlby, 1952; Goldfarb, 1955; Rhiengold & Bayley, 1959; Spitz, 1945; Yarrow, 1966), theories of educational development (Havighurst, 1952, Hunt, 1964), and the development of sexual identity and behavior (Stoller, 1968). In view of the apparent fruitfulness of comparative research, it is quite likely that in the future scientists will depend more and more upon the knowledge gained from the study of sub-human organisms in their search for the fundamental laws governing human behavior.

The Study of Social Organization in Human Societies

An unusual amount of interest in and study of social organization has occurred within the last two decades particularly in the study of the social organization of prisons (Cantine & Rainer, 1950; Cloward, 1960; Driscoll, 1952; Harper, 1952; McCleery, 1960; Rubenfeld & Stafford, 1963, Sykes & Messinger, 1960) and mental hospitals (Belknap, 1956; Dunham & Weinberg, 1960; Salisbury, 1962). In order to facilitate an understanding of the individual behavior that occurs in social settings, the most basic and relevant concept is that of role behavior, i.e. patterns of learned behavior. Indeed, Mead (1934) explained the construction of societies on the basis of roles that all the members must take.

Several other investigators and theoreticians (Cumming & Cumming, 1962; Kelly, 1955; Murphy, 1947; Sarbin, 1954; Wolman, 1960) have also emphasized the importance of role behavior. Roles, however, are always interpersonal in the sense that they are intimately linked to the conduct and expectations of others. Stainbrook (1965) states that "adequate role learning and behavior not only imply knowing how oneself is expected to act but also entail an awareness of how others are going to behave in complemental action and reaction" (p. 219).

The mutual interdependence between roles and expectations has been emphasized recently in the writings of Berne on transactional analysis as a form of psychotherapy (Berne, 1961, 1964, 1966). Briefly, the major idea is that in a situation involving two or more people, one person's behavior is intimately linked to how he expects another person(s) to respond. Communication between the two parties involved will occur only if the expected behavior is manifested. Berne has also emphasized that inherent in the social structure are the elements which determine whether a particular sequence of behavior is appropriate or inappropriate.

Communication theorists (Watzlawick, et. al., 1967) have adopted a similar theory in that the process of communication is viewed as containing a series of messages among the participants which have the effect of defining the interpersonal relationships between the individuals. In order for an interpersonal relationship to remain stable and communication to occur, patterns of interactions emerge which maintain acceptable deviations in behavior

within the system. Jackson (1965) has coined the term "rule of the relationship" to define these acceptable limits.

Roles and expectations are even more important where the social structure involves larger groups of people. Several investigators (Cantine & Rainer, 1950; Harper, 1952; McCleery, 1960; Sykes & Messinger, 1960) have noted that it is common in a prison for the inmates to acquire nicknames which determine guidelines for the behavior of the inmate in his relationships with fellow prisoners as well as communicating the behavior one may expect from this individual. If the inmate does not behave in the expected ways, it is not uncommon for the others to ostracize or physically abuse him (Cloward, 1960). Knowing one's role and the roles of others and abiding by the social structure maintains equilibrium in what has the potential for chaos.

A similar phenomenon exists in mental hospitals wherein patients are assigned to various wards on the basis of the administrators knowing the type of behavior to be expected. A typical organization of a hospital would be to place all "chronic schizophrenics" on Ward "A". On Ward "B" would be housed acting out, rebellious adolescents since the ward is better equipped to handle this type of behavior. Ward "C" would house patients with ground privileges or town privileges. The unwritten rule which permits the efficient, ongoing functioning of the system is that as long as a patient behaves in the ways expected, he stays on that particular ward. But, as soon as his behavior deviates significantly from the "norm" and, thus, becomes inappropriate to his surroundings,

he is transferred to a ward where his new behavior is more in keeping with the "norm" or expected.

In society at large each individual is a member of multiple groups or institutions demanding somewhat different roles and having different expectations. One may be a psychology professor, head of a family, Catholic, etc. What may be considered appropriate role behavior in one situation is not necessarily appropriate in the other. It becomes, thus, crucial to one's efficient functioning in society to know not only the role he chooses to play but also what is expected of him in the various groups of which he is a member (Murphy, 1947).

Knowing what is expected is highly related to one's knowing his relative position in the social structure because the authority of parents, supervisors, commanding officers, and high ranking officials in the clergy determine, at least in part, how the members in these institutions will behave. Thus, there exists an apparent hierarchy of power and prestige which, in order to be maintained, requires obedience and deference from those at the lower levels. In a prison society those at the lower levels, i.e. "fish", "squealers", and "toughs", must defer to those at the top, i.e. the "right guys" and the "real cons" (Sykes & Messinger, 1960, p. 10). Cloward (1960) has pointed out that in recently admitted inmates, the "new identity assigned to the individual is always of a lower order in the social scheme; he is defined as having been all along in essence of a 'lower species'" (p. 20). The patterns of learned behavior, or role of an individual in a social system,

are, therefore, dependent upon the relative status or position he occupies in that system. Too frequently administrators make the error of explaining the behavior of incarcerated individuals as being due entirely to their idiosyncratic personality dynamics, or diagnosis, without ever taking into account the behaviors related to the social structure and the individual's position in that structure (Stainbrook, 1965)

Similarly, Whyte's (1943) study of the Norton Gang disclosed that once the group structure was defined, a consistent set of expectations from each other and to each other emerged which were a result of the relative statuses of various members of the gang.

The existence of hierarchies of power and prestige have been evident in human societies throughout history: bourgeosie and proletariet, royalty and peasants, white collar and blue collar workers, upper, middle and lower socio-economic levels. History has also shown that these hierarchies are not always maintained because those at the lower levels have been known to rebel, or behave in unexpected ways, when feeling unjustly or arbitrarily ruled by tyranical leaders who leave them nearly no freedom or when the hierarchy of power is in a state of flux or decline and there is too much freedom due to a loss of structure (Wilson, 1968).

It is rare, however, that an individual will take it upon himself to overthrow the hierarchy. Success is more probable if several low ranking individuals form a coalition, or alliance

of power, as has happened in revolutions, mutinies and such more contemporary groups as N.A.A.C.P., S.D.S. and C.O.R.E.. A most impressive example of the power of a coalition is that of the white business men in black ghettos who have been recently overthrown by coalitions of ghetto negroes in Watts, Detroit, Chicago, New York, New Jersey, etc. (Wilson, 1968).

Prison officials are very sensitive to the power of such coalitions and continually attempt to dissolve them by frequent rotation of prisoners working together on job assignments, interprison transfers and shuffling of cell mates (Cloward, 1960). Coalitions which enhance the prison social structure and contribute to the efficient functioning of the institution, however, are maintained because "order and control depend upon the power structure maintained by covert and often unwitting collusions" (Wilson, 1968, p. 146).

A Theory of Coalition Formation

In all accounts of revolutions, riots, mutinies and similar overthrows of those at the top by those at the bottom, implicit, if not explicit, mention is always made of the coalitions which initiated the action and guaranteed success. Although von Neumann and Morgenstern's (1944) "theory of games" provided a theoretical approach to the understanding of coalition behavior, Simmel's (1950, 1955) theory of three-person interaction systems and Caplow's (1956, 1959) refinement and extension of the theory are usually considered the classic articles in the area. In fact,

the highly rational approach of game theory was found to be a poor predictor of coalitions in a triadic situation (Vinacke & Arkoff, 1957).

Caplow's stated purpose in his 1956 paper was to "examine the model of the triad whose members are not identical in power and call attention to a neglected feature, namely, that the formation of given coalitions depends upon the initial distribution of power in the triad and, other things being equal, may be predicted under certain assumptions when the initial distribution of power is known" (Caplow, 1959, p. 488). The underlying assumption is that in a triadic situation where one member initially is stronger, the others will unite against him and, therefore, he must also join a coalition to insure winning.

Borrowing directly from Simmel's theory of tertius gaudens, Caplow added that in the triadic situation consisting of one weak member and two equally strong members, the weakest member stands to gain the most by joining in a coalition because without membership in a coalition, he would have no chance of winning. Also, where one member has more initial power than that of the other two members combined, no coalitions will form.

From this theoretical basis Caplow described eight triadic situations in which the two-person coalitions were predicted on the basis of the initial differential strength of the members (Caplow, 1959). For example, if the members of the triad are labeled A, B, and C, and A's initial power is greater than that of B and C except when B and C form a coalition, the predicted

coalition will be between B and C or A and C (see Table 1).

Several investigators have found support for the theory as well as adding new information. Kelly and Arrowhead (1960) and Stryker and Psathas (1960) supported the theory of tertius gaudens. Turk and Turk (1962) found that in a situation where one member has more power than the other two members combined (Type 4), the triad is dissolved into a dyad and an isolate and, as Caplow predicted, no coalitions form. Vinacke (1964) found very interesting sex differences between members of a coalition. Males more often use "exploitative strategies" and are "characterized by an orientation toward winning on the most favorable possible terms, by intensive competition, and an apparently rather ruthless attitude towards one's opponents" (p. 26). On the other hand, females use an "accomodative strategy" in which they "seem to be oriented towards the social-interaction aspects of the game, to be less competitive, and to seek for ways to equalize conditions as if they were trying to be fair to all participants" (p. 26). Also, triple alliances, or a lack of coalitions, were more common in female groups.

In 1961, Gamson noted that the results of the Vinacke and Arkoff (1957) study only generally supported Caplow's theory as opposed to an analysis by the more rational game theory. For the type 5 triadic situation wherein $A>B>C$, $A<(B+C)$, Caplow predicted that coalitions of AC or BC would occur with equal probability. Vinacke and Arkoff predicted that any coalition could occur with equal probability. Gamson predicted that only the

Table 1

Different Theoretical Predictions of

Coalitions in the Triad

Type	Distribution of Resources	Predicted Coalitions		
		Caplow	Vinacke & Arkoff	Gamson
1	A=B=C	any	any	any
2	A>B, B=C, A<(B+C)	BC	any	BC
3	A<B, B=C	AB or AC	any	AB or AC
4	A>(B+C), B=C	none	none	none
5	A>B>C, A<(B+C)	BC or AC	any	BC
6	A>B>C, A>(B+C)	none	none	none
7	A>B>C, A=(B+C)	AB or AC		
8	A=(B+C), B=C	AB or AC		

coalition BC would form (see Table 1). The results indicated that coalitions of AC and BC occurred more frequently than the coalition AB and, thus, supported Caplow's prediction. However, the coalition BC occurred three times more often than did AC, a result not explainable by Caplow's theory alone, thus necessitating a revision of the theory.

In Gamson's (1961) revision of the theory of coalitions it was hypothesized that "participants will expect others to demand from a coalition a share of the payoff which is proportional to the amount of resources which they are contributing to it" (p. 382). He reasoned that in the Type 5 situation, C is the crucial member of the triad since both A and B would be attempting to enlist C, the weakest member of the triad, in a coalition. But, since C contributes more resources to the coalition BC than AC and, therefore, can expect a larger share of the winnings according to the above hypothesis, BC should, as it did, occur more frequently than AC. Psathas and Stryker (1965) found a positive correlation between the amount of resources contributed to the coalition by the weakest member and the percentage of rewards received.

Gamson's addition to the theory of coalitions in the triad has added much to our understanding of this phenomenon, particularly as regards the highly controversial Type 5 situation. What was needed in this area, however, was an extension of the theory to groups larger than three. Willis (1962) and Sears (1965) have extended the theory to coalitions in the tetrad. Their results were consistent with those found in the triadic situation.

Studies of Social Organization in Non-Human Primate Societies

The anecdotes and casual observations of various primate societies prior to the 20th century contained many exaggerated accounts of non-human primate behavior (Yerkes & Yerkes, 1929). The early field studies of Bingham (1928, 1929), Carpenter (1934), and Nissen (1931) helped in the separation of fact from fiction, but the information gathered in these early field studies has, for the most part, been supplanted by those of the late 50's and 60's. In fact, most of our present knowledge of the social organization of non-human primate societies is based upon information gathered within the last fifteen years (Schaller, 1965).

Several field investigators (Altmann, 1962; Chance, 1963; Collias & Southwick, 1952; Hall & De Vore, 1965; Jay, 1965; Washburn & Hamburg, 1965) have noted inter- and intra-species differences in group structure. Baboon, langur, macaque, howler monkey, and gorilla groups are organized primarily around a male dominance hierarchy (Altmann, 1959; Carpenter, 1934; De Vore, 1962; Hall & De Vore, 1965; Kummer, 1968; Schaller, 1963, 1965). In the relatively small, cohesive gibbon family, there are no apparent sex differences in dominance (Carpenter, 1940). Neither Goodall (1965) nor Reynolds and Reynolds (1965) found evidence of a male or female dominance hierarchy in chimpanzee groups, but males were dominant over females and mature females were dominant over immature females. Female dominance hierarchies have been

observed in a few species (Carpenter, 1964) as well as a troop of macaques which was dominated by a female (Kawamura, 1958), but the female hierarchy is usually found to be rather loosely defined and unstable (Carpenter, 1934, 1964; Jay, 1965). In a study of the determinants of social status in a group of captive female macaca speciosa, however, Oakes (1967) found that a linear hierarchy did emerge. The linear dominance hierarchy was, at least in part, determined by aggressive behavior and remained stable for over one year. Once the hierarchy was established, aggressive behavior diminished considerably.

Goodall (1965) described the social organization of chimpanzees as follows:

> The temporary nature of chimpanzee groups results in a loose social structure within the community, and aggressive and submissive interactions between individuals are infrequent. This is in marked contrast to the rigid social structure found among some primates, such as baboons and macaques, in which each individual has its own rank in a "dominance hierarchy." However, although it is difficult to apply the dominance concept to the local chimpanzee population as a whole, it is useful when describing certain interactions between individuals. For instance, when two chimpanzees meet along a branch one of them normally gives way, and can be referred to as the subordinate animal; the subordinate chimpanzee may make a detour or may approach the other and either present or reach out to touch the dominant animal on the lips, thigh, or genital area (p. 453).

Reynolds and Reynolds (1965) similarly observed:

> Although there was some evidence of differences in status between individuals, dominance interactions formed a minute fraction of the observed chimpanzee behavior. There was no evidence of a linear hierarchy of dominance among males or females; there were no observations of exclusive rights to receptive females; and there were no permanent leaders of groups (p. 415).

The above field studies clearly indicate that a linear dominance hierarchy is not found in free ranging chimpanzee groups and dominance interactions are rather infrequent. A slightly different type of social organization, however, was found by Wilson and Wilson (1968) in a captive group of semi-free ranging chimpanzees. These investigators observed that "certain animals had a higher status" (p. 11) and "aggressive behavior is more frequent...than in the wild, free ranging chimpanzee populations observed by Goodall and Reynolds" (p. 41). Also, observations of females attacking males were more common, and there was an obvious dominant male, never seen to copulate with a female, who was the leader of the group. (Aggressive interactions were even more frequent with a previous dominant male leader who exhibited normal sexual behavior.)

High status was found to be associated with size (large animals and very small animals had high status), sex (males had higher status than females), and estrus (females with maximum perineal swelling had high status). Animals with high status also consumed more food relative to their body weight, had priority access to food and preferred locales, and were able to take food and various objects from others with little, if any, threat of retaliation. Status level was found to be most "ambiguous" for middle size animals, particularly larger juveniles who were competing for status among themselves.

Just as limited space or increased population density in the wild usually leads to an increase in aggressive behavior

(Hediger, 1964), Wilson and Wilson (1968) observed that aggressive interactions increased at feeding time when several animals were congregated in a small area. Increased aggression or anti-social behavior due to crowding has been observed by numerous investigators of primate behavior (Goodall, 1965; Hall, 1963; Jay, 1965; Southwick, et. al., 1965) and has often been referred to as "socially conditioned fighting" because it is known to occur in captivity in warm as well as cold blooded animals and from rodents to monkeys (Zuckerman, 1932).

Yerkes (1943) refuted the concept of equality of ability or opportunity in a group of captive chimpanzees "for what the individual may do and what is expected or demanded of it depend in the first place on its ability to achieve and defend social status or position in the dominance hierarchy" (p. 49). Yerkes considered the seeking of a higher position in the dominance hierarchy to be one of the basic underlying principles in the social structure of captive chimpanzees. Yerkes noted also that changes in estrus were correlated with changes in female social status.

The Study of Coalitions in Non-Human Primate Societies

In contrast to the apparent interest and detailed investigation of the dominance hierarchy in non-human primate social structure, there exists an obvious paucity of experimental investigation of behavior in coalitions. Jay (1965) criticized laboratory studies of dominance behavior for not taking into

account the information gained from field studies, namely, "that the presence of other individuals may influence status, and that the dominance system of the group is a combination of individual status and status in association with others" (p. 562). Yet, Henshel (1963) noted that there was only one experimental investigation of the effects of coalitions upon the dominance hierarchy (Maslow, 1936) prior to 1963.

In Maslow's study, five rhesus macaques were paired with each other in a food-getting situation until a linear dominance hierarchy was established. After determining the dominance hierarchy in pairs, larger groups of animals were placed together to determine the effects upon the dominance hierarchy. The results indicated that "the dominance hierarchy which emerged in the larger groups was distinctly different from that found in the pairings" (Henshel, 1963, p. 80). In one instance the dominance struggle which emerged became so intense that one monkey, when placed with animals that were formerly subordinate to him, had to be removed from the situation or he would have been killed. Henshel interpreted the results as being due to the formation of coalitions among subordinates.

More recent investigations (Kawai, 1965a, 1965b; Kawamura, 1958) with Japanese monkeys (Macaca fuscata) have supported Maslow's findings. These writers differentiated between "basic rank" and "dependent rank." Basic rank was determined by observing which of two monkeys spatially isolated from the group takes a piece of food dropped between them. The monkey which takes the food is considered

dominant over the other monkey, i.e. A> B. Dependent rank is based on "very intimate relations between two individuals...common interests...kinship" (Kawai, 1965a, p. 83). Kawai (1965a) observed that the relationship established between two monkeys on the basis of basic rank, i.e. A>B, can be reversed, because of dependent rank, when a third monkey is present, i.e. C /B> A/. Kawai (1965b) concluded that "the positions of members in a troop are fixed by basic ranks, but what carries more weight in a troop society is the behavior of monkeys depending on groups as a whole-groups of individuals which tolerance and dependent ranks have brought together.... Thus, specific relations between individuals have become more important..." (p. 103). Also, this phenomenon appears to be peculiar only to the more highly developed animals such as the Japanese monkey since it has not been found in societies of rodents and ungulates (Kawai, 1965a; Kawamura, 1956).

Although coalitions are not specifically referred to in the field studies, behavior of this sort is frequently observed but referred to in an inconsistent manner. Mason (1965), for example, referred to "friendships", "attachments", and "companionship preferences." Kummer (Chance, 1963) used the term "protected threat", referring to a subdominant animal who succeeds in escaping the attack of a dominant animal by placing himself in the proximity of an animal that has higher status than the attacking animal. Wilson and Wilson (1968) referred to the same phenomenon by the phrase "protective behavior." Hall and De Vore (1965) referred to "enlistment of threat" and "simultaneous

threat." Both of these behaviors involve two animals threatening a third. But, in enlistment of threat one animal signals another for support whereas in simultaneous threat the coalition occurs spontaneously. Kawai (1965), as already noted, differentiated between "basic" and "dependent rank." The similarities between these various behaviors would be more apparent if they were subsumed under one major category, i.e. coalition behavior.

There have also been several references to a coalition of male animals, rather than one dominant male, functioning as the group leader(s). In a very detailed study of a particular baboon troop, Hall and De Vore (1965) found that "the dominance pattern that emerges is one that cannot be reconciled with the model of a strictly linear hierarchy" (p. 59). It was found that three of the six dominant males frequently supported each other or acted in concert in dominance interactions. The three were referred to as the "central hierarchy." They concluded that a male's dominance status was a combination of his position in the linear dominance hierarchy and "his ability to enlist the support of other males ("proximity to the central hierarchy")" (pp. 61-62).

Kortlandt (1962) and Reynolds and Reynolds (1965) observed that when a large group of chimpanzees was traveling, several graying adult males often took the lead. This was a particular group of graying adult males, and not all graying adult males behaved in this manner.

Goodall (1965) studied the dominance interactions of

the three most dominant male chimpanzees, David, Goliath and William, in the Gombe Stream Reserve. David was the dominant animal of the three. Goliath and William appeared to be of equal status except when David was present. On these occasions Goliath gained status and became dominant over William. Goodall hypothesized that there was a "greater degree of mutual attraction between Goliath and David" (p. 454).

In 1968, van Lawick-Goodall differentiated dominance interactions between pairs of chimpanzees from another type of dominance situation which "is more complex since the behaviour of the individuals involved is influenced by the presence, or absence, of other individuals" (p. 212). Goodall concluded that the "dominance hierarchy in baboon troops appears to be similar to that in chimpanzees" (p. 213) The similarity would seem to be not in the kind of social structure, or dominance hierarchy, but rather that coalitions play an important role in the rigid social organization of the baboon as well as the flexible social organization of the chimpanzee.

Conclusions

A review of the literature indicates that status differences and dominance interactions are more prevalent in semi-free than free ranging chimpanzees and distinct differences in the social organization of the two groups (Wilson & Wilson, 1968). Since aggressive behavior increases as the number of animals in a fixed amount of space is increased (Goodall, 1965; Jay, 1965;

Southwick et. al., 1965; Wilson & Wilson, 1968), the differences in the amount or kind of space confining the two groups of chimpanzees may be the variable responsible for the differences in social organization. Limited space can produce a problem for group survival because of the difficulties in avoiding contact with more aggressive group members and escaping attacking animals. Just as the conditions of prisons and mental hospitals demand a social structure which clearly defines an individual's role and status in order that a high degree of equilibrium can be maintained, so may the conditions of captive chimpanzees demand a similar social structure. A rigid social structure organized around a dominance hierarchy would not be needed in the benign environment of free ranging chimpanzees because this would place too many restrictions upon the behavior of group members (King, 1964).

The literature also indicates that various types of human and animal coalitions are a common phenomena, but there is a paucity of experimental animal research concerning this type of behavior. The present study was designed particularly with the hope of gaining more knowledge in this area.

Although our knowledge of non-human primate social organization and behavior has gained considerably within the last fifteen years, the following questions can not be adequately answered on the basis of prior research. Is the social organization of captive chimpanzees organized around a linear dominance hierarchy? Is this hierarchy effected in any way when females are in

estrus? By the amount of space in which the animals are confined? Does a different hierarchy emerge when three chimpanzees are placed together rather than two? Do coalitions appear? Between which animals? Are they effective? Are the coalitions affected in any way when females are in estrus? By the amount of space in which the animals are confined? Does a female's behavior in a coalition differ qualitatively from that of a male? The present study was designed to answer these questions.

CHAPTER II

PROBLEM

The present study was designed to investigate the interpersonal behaviors and social organization of captive chimpanzees. The study consisted of three parts. The initial problem was to observe and record the social interaction among a group of captive chimpanzees of different ages and sex. Observations were made daily over a period of 18 months under specified conditions. From these observations a taxonomy of interpersonal behaviors similar to that available for other non-human primates (Altmann, 1962; Bobbitt, et. al., 1964; Chance, 1956; Freedman, et. al., 1962; Kummer, 1968; Plutchik, 1962) was developed.

The second purpose of the study was to determine the presence or absence of a linear dominance hierarchy in the social organization of captive chimpanzees. This was determined by pairing animals together in a food-getting situation similar to that used by Yerkes (1943). The literature indicated that status differences and dominance interactions were more prevalent in semi-free than free ranging chimpanzees (Wilson & Wilson, 1968), and aggressive behavior increased when several animals were congregated in a small area (Goodall, 1965; Jay, 1965; Southwick, et. al., 1965; Wilson & Wilson, 1968). If it is assumed that

changes in surrounding conditions necessitate changes in social organization, it follows that the social organization of captive chimpanzees confined to small areas may necessitate establishing a linear dominance hierarchy to control the potential for mutual destruction. Since Wilson and Wilson (1968) and Yerkes (1943) noted that a female's status varies with changes in estrus, it was necessary to control for this variable. The hypotheses in the second part of the study were as follows.

Hypothesis I. The social structure of captive chimpanzees is organized around a linear dominance hierarchy which includes both males and females.

Hypothesis II. The linear dominance hierarchy is not as apparent when the amount of space in which the two chimpanzees are confined is enlarged.

Hypothesis III. The linear dominance hierarchy is temporarily disrupted when a female in estrus manifests maximum perineal swelling.

The final purpose of the study was to investigate the effect(s) of coalitions, if manifested, upon the dominance hierarchy which would be established if Hypothesis I was supported. This was determined by increasing the number of experimental animals in the same food-getting situation from two to three. Maslow (1936) found that when several rather than two macaques were placed together in a food-getting situation, a hierarchy emerged which was distinct from that found in the two animal situation. His study, however, was not based upon a substantive theory.

In contrast, the present study was designed to test a theory of coalitions (Caplow, 1956, 1959; Gamson, 1961) which has been supported by numerous human studies but never investigated in animal studies (Henshel, 1963). Chimpanzees were chosen for subjects because of their substantiated similarities to humans (Riopelle & Rogers, 1965). If coalitions were found to exist, the effects of space and estrus upon the new hierarchy were to be investigated. The hypotheses in the final part of the study were as follows.

Hypothesis IV. In a triadic situation where A> B> C, two chimpanzees will unit, i.e. form a coalition, against the third.

Hypothesis V. In a triadic situation where A> B> C, the two subordinate chimpanzees will form the coalition.

Hypothesis VI. When the dominant chimpanzee in the triad has more initial power than that of the other two chimpanzees combined, i.e. A> B> C; A> (B+C), the coalition will be ineffective; but, when the dominant chimpanzee in the triad has less initial power than that of the other two chimpanzees combined, i.e. A> B> C; A< (B+C), the coalition will be effective.

Hypothesis VII. In a triadic situation, the rewards acquired by the member with lowest status will increase as the amount of resources contributed to the coalition by that member increase.

Hypothesis VIII. In a triadic situation a female's behavior differs qualitatively from that of a male.

Hypothesis IX. The dominance hierarchy which emerges in a triadic situation is distinct from the dominance hierarchy

which emerges in a dyadic situation.

Hypothesis X. The dominance hierarchy which emerges in a triadic situation is not as apparent when the amount of space in which the three chimpanzees are confined is enlarged.

Hypothesis XI. The dominance hierarchy which emerges in a triadic situation is temporarily disrupted when a female in estrus manifests maximum perineal swelling.

CHAPTER III

METHOD

History of Subjects

The subjects consisted of 13 chimpanzees, Pan troglodytes, of varied age and sex which, except for one, were wild caught at estimated ages of one to two years. They were housed as two separate groups but inter-group experiences were always possible because the two groups were separated by only a woven wire, heavy industrial gauge.

Group I consisted of one adult male, Mutzie (M), and three adult females, Carolyn (C), Ella (E), and Maude (Ma). All four were acquired in October, 1966, from a large mid-western zoo where they had been on display together for 11 years. M, the oldest and most human-oriented of the four, was born in captivity and raised in a human environment. He wore diapers until he was about six years old. M was the only subject manifesting atypical sexual behavior in that he was never seen to copulate or masturbate in his present environment. Penile erection, however, was observed on numerous occasions, and he reportedly had a history of coitus interruptus.

The three females arrived at the mid-western zoo in May, 1955, and were placed on display with M. They were about one year

old at the time. During the course of the present study C and Ma gave birth to infants sired by the male, Pan, in Group II. Neither were assisted in delivery. C's delivery was normal, but Ma's delivery was complicated by a retention of the placenta for 36 hours beyond the birth of the infant. Ma's infant was taken from her at three days because she did not care for him adequately. For example, she carried him too low to nurse, often carried him upside down and rarely groomed him. C's infant was taken from her at about two and a half months in order that he could take part in another study. The three females, in contrast to M, were quite unpredictable in their response to humans, particularly C who was the least friendly.

Group II had the following composition: one young adult female, Pampy (Pa); two pubertal males, Pan (P) and Melvin (Me); two pubertal females, Susie (S) and Mona (Mo); and four prepubertal females, Wendy (W), Mimi (Mi), Carrie (Ca), and Peggy (Pe). (W had her first menses during the latter part of the present study.) P and W, acquired in November, 1962, when they were about one and a half and one year old, respectively, were the initial members of this group. Although both received abundant human contact and were trained to wear diapers, P took more readily to humans and was eventually toilet trained. P also matured sexually more rapidly and, by the end of the present study, had impregnated five females, four of which delivered normal, healthy infants. The fifth, S, died from eclampsia in about the sixth or seventh month of pregnancy. The infant was delivered by caesarian section at the

time of her death but could not be saved.

S was acquired in February, 1965, and estimated to be about seven or eight years old. She was wild caught when she was approximately two years old and cared for by a family in Africa who taught her to eat with them at the table. Sometime later she was purchased by an animal trainer in the United States who trained her to wear clothes, dance, and perform various tricks. She was described as "silly" and "clownish" by her previous owner, but in her present environment she was more withdrawn and a "loner." On February 24, 1968, when S was about 10 or 11 years old, she died from eclampsia.

Mi and Ca were acquired in October, 1965, when they were about one year old. They were not integrated into the group until December, 1965, because they were heavily infested with parasites and manifested serious respiratory infections. Although both received considerable human contact, Mi received the most because she was more responsive to humans than was Ca. Mi was eventually toilet trained and frequently taken for car rides or played with outside of her cage. Ca, who was more independent and shy in her relationship with humans, obviously followed the leadership of Mi and would cry whenever they were separated.

Pa was acquired in June, 1966, when she was about nine or ten years old. It is assumed that she was wild caught at about one year old. She was kept as a family pet in a small backyard cage for about six years and then purchased by a zoo on the west coast where she was placed on display for about two years. She

reportedly was fond of young chimpanzees in the zoo but had to be taken off display because she threw feces at the visitors, a "habit" which she still manifests from time to time. On February 5, 1968, Pa delivered a male infant whom she cared for in an unusually adept manner for a primiparous mother. They were housed separately from the group throughout most of the present study.

In May, 1967, Mo was acquired and estimated to be about seven years old. She had been a rodeo performer for the previous six years and was trained to wear clothes, ride a mule, shoot a pistol, and open locks with a key or a piece of wire. She had to be removed from the rodeo show because she reportedly became too aggressive to handle safely in front of live audiences. Mo's infant was taken from her at about four months because she was reluctant to allow the infant to eat solid food.

A male, Me, and female, Pe, were acquired from a family in Africa in June of 1968. Me was wild caught in July, 1963, and estimated to be about nine to eleven months old. Pe was wild caught in August, 1964, and estimated to be about one year old. During the year prior to Pe's capture, Me was housed with two older female chimpanzees, one of which assumed a mother surrogate role. She frequently protected him and allowed him to cling to her whenever he pleased. When Pe arrived, Me seemed to become jealous of the attention she received from the older female chimpanzee, and he began to bully her. He eventually became the dominant one of the two. Pe responded to his aggression by pulling her hair out in patches. Me, the more human-oriented of the two,

had a particular fondness for objects as well as humans. He reportedly played with hoes, brooms and knives for hours at a time. Pe was described as shy and timid around humans. At the time of their arrival in their present environment, both appeared small for their estimated ages of seven and six, and Pe was missing a lot of her hair. Pe was integrated into the existing colony with little difficulty. Me, however, sustained rather severe beatings and bites on a frequent basis to which he responded with screams and tantrums. His behavior seemed only to aggravate the others and to solicit their aggression.

Treatment of Subjects

The initial stage of the study consisted of observing and recording the interaction between the chimpanzees over a period of eighteen months and under a specified set of conditions. For 12 months they were observed daily for one hour. For six months they were observed for at least one hour a day, on random days, three to four days a week. The time of the observations varied from day to day so that the chimpanzees would not become accustomed to the arrival of the observer. The observer at no time participated in the feeding or cleaning of the cages and at no time reacted to or solicited reactions from the chimpanzees. The purpose of these conditions was to eliminate, as much as possible, recording behavior that was possibly motivated by the presence of a human.

Experimental Design

Ss. Only the members of Group II, excluding Pa, were

used in the experimental stage of the study. This group was the larger and more heterogeneous of the two groups in terms of age and sex, and it was believed that the status of the individual members was more ambiguous. The estimated ages of the Ss at the time of the experimental stage of the present study are in Appendix I.

Apparatus. The apparatus consisted of three major components: the Coin Receiver-Ejector Unit (CREU): the Feeder; and the Switching Unit-Remote (SUR). The CREU was housed in an enclosure measuring 48" x 40" x 20" of plywood construction, which contained a coin (nickel) ejector, Gerbrands Model B; a 28 volt, direct current, 4 amp power source; an automatic switching unit; an annunciator; and a coin receiver taken from an old cigarette machine and modified to accomodate wet nickels.

The Feeder was a Davis Universal Feeder, Model Number 320.

The SUR consisted of four non-locking pushbutton switches and a ready light to indicate to the operator that the system was ready for another cycle. The four switches performed the following functions: the first switch initiated the cycle; the second switch ejected a coin without the annunciator in the event that the ejector failed to function properly; the third switch operated the Feeder in case a malfunction in the coin receiver failed to actuate the feeder automatically; and the fourth switch cleared the coin receiver if a coin happened to lodge somewhere in the coin receiver while in transit.

Schematics for the entire apparatus are included in Appendices II, III and IV.

Two experimental cages (C1 and C2) located adjacent to each other were used during the experiment. Since the entire experiment was conducted in the living environment of the Ss, these cages were not foreign, and transportation from living area to experimental area was not required. Transportation of Ss to foreign surrounds could have created variables with unknown and possibly confounding effects. C1 and C2 were identical in size, their dimensions being 8'9" x 10'4" x 7'. Both were constructed of woven wire, heavy industrial gauge. Access from C1 to C2 was through an adjacent cage with dimensions 17'6" x 10'4" x 7'.

The CREU was permanently attached to C1. A four inch lead cup was welded to the inside of C1 and used to catch the coins ejected from the CREU. A metal plate with a one and a half inch slot to receive coins was welded to the inside of C1. The Feeder was mounted on a plywood platform and suspended from the ceiling. The Feeder could be moved from C1 to C2 when needed.

Moving of the Ss from one area to another was handled by the regular animal keeper with whom they were familiar. Throughout the experiment the behavior of the Ss was recorded on standard notebook size paper.

Procedure. Following the initial observational stage described above, the experimental Ss in Group II were trained to use the apparatus. The sequence followed in training the Ss to use the apparatus consisted of two parts: (1) E entered C1 and

demonstrated the taking of a coin out of the lead cup, placing of the coin in the appropriate slot, and the acquiring of a reward (one grape) from the Feeder above the cage. All experimental Ss observed from the adjacent cage for five demonstrations. (2) Each S was placed individually in Cl and prompted by verbal commands and gestures to complete the sequence outlined above. P and Mo were trained within three attempts by verbal commands and gestures. W, Mi and Ca had to be successively rewarded as they acquired parts of the sequence and needed two days, one half hour to 45 minutes a day, to learn the complete sequence. Pe was trained by having the regular animal keeper enter Cl with her and lead her through the sequence. Even though she had the benefit of the animal keepers tutoring, she also needed two days, one half hour to 45 minutes a day, to learn the complete sequence. Me seemed not to be motivated by rewarding him with a grape. After five days of training, one half hour to one hour a day, he still had not learned the sequence. On the sixth day the reward was changed to M&M candies, and he learned the sequence in about fifteen minutes.

To determine the presence or absence of a linear dominance hierarchy, the Ss were divided into all possible combinations of two, and each pair was placed in the food-getting situation. In order to control for the effects of space and estrus, the Ss were confined to Cl and Mo was used only when she was in anestrus. Each pair was given 12 trials. The series of trials, if needed, was not begun until a pair had been in Cl for 30", i.e. an acclimating period. A trial was terminated when one of the pair ate the grape.

A tally was kept of the number of grapes acquired by each member of the pair. The member who acquired a significant portion of the 12 grapes, as determined by the statistic chi-square (Walker & Lev, 1953, p. 85), was considered the dominant member of the pair, i.e. A>B. Mo and P were given 12 additional trials when she was in estrus to determine what effect, if any, estrus had upon one's status.

To determine the effect of coalitions upon the previously established linear dominance hierarchy, the Ss were divided into all possible combinations of three. Each triad was placed in the same food-getting situation. The effects of space and estrus (using the triad P, W and Mo) were controlled by following the same procedure used in the dyadic situation described above.

The Feeder was then positioned above C2, and the Ss were trained to receive their reward in C2. All Ss learned this minor procedural modification within a few trials. The procedure outlined above, first with pairs and then with triads, was replicated using two cages instead of one. When Mo was in estrus, 12 additional trials were given to the pair P and Mo and the triad P, W and Mo to determine what effect, if any, estrus had upon one's status in a triadic situation.

Because of the possibility of satiation with regard to the reward, a matrix of pairs and triads was devised wherein no S was used in two pairs or triads consecutively on the same day. The Ss were used more than one time in one day but only after a break of at least one other pair or triad. During the two cage

part of the study, however, several Ss manifested diarrehea. P became so ill that he was temporarily eliminated from the study. When his appetite returned, he showed no interest in grapes. This was not true, however, of the other Ss. A variety of rewards was used, including M&M candies, monkey biscuits and banana slices. The only reward that seemed to interest him was banana slices, and this was the reward used for 15 triads in the two cage condition. It was also necessary to use P in consecutive pairs and triads on the same day. This did not, however, lead to any apparent satiation.

CHAPTER IV

RESULTS

The initial stage of the present study was observational rather than manipulative. The spontaneous behavior of 13 captive chimpanzees was observed under specified conditions for a period of 18 months. From these observations a comprehensive taxonomy of interpersonal behaviors for captive chimpanzees was developed (see Appendix IX). Specific observed behaviors were placed in general categories on a judgmental basis. The general categories were the same as those used by Klein (1968) in The Adaptation Index, a cross-species behavioral inventory devised "by the listing of behaviors which ten observers had noticed over an aggregate of many years of primate observation" (p. 2). Behaviors listed in The Adaptation Index which were applicable to chimpanzees were included in the present taxonomy.

The dependent variable throughout the manipulative stage of the study was the number of grapes acquired by each S under the various conditions. The statistic chi-square (Walker & Lev, 1953, p. 85) was used to determine whether or not the number of grapes acquired by the individual members of the pair differed significantly from that which could be expected purely on the basis of chance. In the triadic conditions, the number of grapes acquired

by the previously established dominant member and the combined number of grapes acquired by the previously established sub-dominant members were compared to that which could be expected purely on the basis of chance. An effective coalition was operationally defined as a situation wherein (1) the combined number of grapes acquired by the two sub-dominant members of the triad was significantly greater than that which could be expected purely on the basis of chance; or (2) the number of grapes acquired by the dominant member of the triad and the combined number of grapes acquired by the two sub-dominant members did not differ signficantly from that which could be expected purely on the basis of chance. The alpha level chosen for all statistical analyses was $p<.10$ (one-tailed tests) because if a difference did exist, i.e. something other than chance was operating, the writer wanted to be sure that this was reported. The number of degrees of freedom was n=1.

The first hypothesis tested was that the social structure of captive chimpanzees is organized around a linear dominance hierarchy. The effects of space and estrus were controlled by confining the Ss to one cage and using only anestrus females. The chi-square values for all possible pairs of Ss in the one cage condition are presented in Table 2. Since all of the chi-squares were significant, it was concluded that something other than chance was operating.

A linear dominance hierarchy was determined by ranking each member of the experimental group in the following manner. The

Table 2

Chi-square Values for Dyads in the

One Cage Condition

Critical Values

X^2=12.00; p<.001; X^2=8.32; p<.005; X^2=5.32; p<.025; X^2=3.00; p<.10

	P	W	Mo	Mi	Pe	Ca	Me
P		12.00	12.00	12.00	12.00	12.00	12.00
W			3.00	5.32	5.32	8.32	12.00
Mo				8.32	12.00	12.00	12.00
Mi					12.00	3.00	12.00
Pe						5.32	12.00
Ca							12.00
Me							

S who acquired the largest proportion of grapes out of a possible total of 72 was assigned the status of the number one, or alpha, animal. The number two animal was that S who acquired the next largest proportion of grapes. The relative rank of each S was determined in this manner until the following hierarchy was established: A>B>C>D>E>F>G. The resulting linear dominance hierarchy was found to be transitive, i.e. each S in the hierarchy was significantly dominant over all Ss having relatively lower status and significantly sub-dominant to all Ss having relatively higher status. It was concluded that the social structure of captive chimpanzees is organized around a dominance hierarchy which was found to be both linear and transitive, and the null form of Hypothesis I was rejected. The linear dominance hierarchy for pairs in the one cage condition is presented in Table 6.

The second hypothesis tested was that the previously established linear dominance hierarchy would not be as apparent if the amount of space confining the Ss was enlarged. Table 3 presents the chi-square values for all possible pairs of Ss in the two cage condition. In contrast to the chi-square values obtained in the one cage condition, only 13 were significant in the two cage condition.

A dominance hierarchy for the two cage condition was determined in the same manner as described for the one cage condition. The resulting hierarchy is presented in Table 6 for comparison with the hierarchy for the one cage condition. Although a hierarchy based on the total number of grapes acquired out of a

Table 3

Chi-square Values for Dyads in the

Two Cage Condition

Critical Values

X^2=12.00; p<.001; X^2=8.32; p<.005; X^2=5.32; p<.025; X^2=3.00; p<.10

	P	W	Mo	Mi	Pe	Ca	Me
P		12.00	5.32	1.32	12.00	12.00	12.00
W			3.00	1.32	1.32	.32	12.00
Mo				5.32	12.00	.32	5.32
Mi					1.32	.32	12.00
Pe						12.00	0.00
Ca							12.00
Me							

possible total of 72 could be established, the resulting hierarchy is, in effect, meaningless because, except for the alpha and beta animals, a S was not found to differ significantly in relative status from neither the S above or below him in the hierarchy. The status of an individual S in relation to those Ss nearest him in the hierarchy, therefore, is ambiguous. Inspection of the two hierarchies also indicates that four of the seven Ss have a different rank in the hierarchy for the two cage condition. Thus, Hypothesis II was accepted.

The third hypothesis tested was that a state of estrus temporarily disrupts the linear dominance hierarchy. P and Mo were given 12 additional trials in the one cage and two cage conditions when she manifested maximum perineal swelling. The chi-square values for this pair in the one cage and two cage conditions when Mo was in the phase of anestrus, were 12.00 ($p<.001$) and 5.32 ($p<.025$), respectively. When Mo was in the phase of estrus, however, the chi-square values for both the one cage condition and the two cage condition were 1.32 ($p>.10$). Since the relationship between these two Ss changed from one in which P was the significantly dominant animal to one in which no significant difference is found between the two animals, the null form of Hypothesis III was not confirmed.

Hypotheses IV through VIII were derived from a theory of coalitions based upon human behavior in a triadic situation. Hypothesis IV states that in a triadic situation where A>B>C, two chimpanzees will unite, i.e. form a coalition, against the

third. Hypothesis V states that the two subordinate chimpanzees will form the coalition. Since the ways in which a coalition form and function may be either overt or covert, openly aggressive or covertly manipulative, it is very difficult to test adequately these two hypotheses. In fact, in most of the triadic situations wherein the conclusion was that a coalition, as operationally defined above, existed and was effective, there were few if any overt signs of aggression or gang-like behavior in the series of 12 trials. In order to avoid the use of data based upon an inference as to the presence or absence of a coalition, it was decided that Hypothesis IV and Hypothesis V would be accepted or rejected only on the basis of overt coalitions. The reader is asked to keep in mind, however, that perhaps only part of the data was used in testing these hypotheses. This problem will be discussed in detail in the following chapter.

In the one cage condition two Ss were observed to unite against the third S in 16 out of a possible 420 trials. Application of a one sample proportion test (Walker & Lev, 1953, p. 67) resulted in a z of -4.6 ($p > .10$). Also, in only one of the 16 coalitions observed did the two sub-ordinate Ss comprise the coalition. On the basis of this data, the null form of Hypothesis IV and Hypothesis V was accepted.

The most frequent coalition observed was the Ss with the highest and lowest status uniting against the middle status S. This occurred in 14 out of the 16 coalitions observed ($z=10.26$, $p < .00003$). Five of the 16 coalitions were effective which

resulted in a z of 2.80 ($p<.003$).

In Hypothesis VI the predictive validity of the linear dominance hierarchy established in the one cage condition was tested. The question to be answered was whether or not the effectiveness, or lack of effectiveness, of a coalition could be predicted from knowledge of the relative status of the various members of the triad. In order to be consistent with Hypothesis IV, it was assumed that in a triadic situation where $A>B>C$, the two sub-dominant members of the triad would form a coalition against the dominant member. Predictions were made on the basis of the "scores", i.e. total number of grapes, acquired by each S in the dominance hierarchy for pairs in the one cage condition (see Table 6). For example, P, W and Mo had scores of 72, 52 and 50, respectively. Since P's score is less than the combined scores of W and Mo, the prediction was that a coalition of W and Mo would be effective against P. In contrast, W, Pe and Ca had scores of 52, 24 and 18, respectively. Since W's score is greater than the combined scores of Pe and Ca, the prediction was that a coalition of Pe and Ca would not be effective against W. A prediction was made for every possible triad, and a phi coefficient (Walker & Lev, 1953, p. 272) was calculated. The correlation was .354 ($x^2=4.38$, $p<.05$), and the null form of Hypothesis VI was not confirmed.

Hypothesis VII, adapted from the theory of tertius gaudens, states that the reward received by the low status member of a coalition will increase in proportion to an increase in the

amount of resources the low status member contributes to the coalition. Since the lowest status S in the group (Me) acquired only ten grapes throughout the entire study and only two grapes in the triadic conditions, adequate data upon which to evaluate the hypothesis was not available if Me was included. Similarly, so few coalitions were effective against the alpha male (only two) that an adequate test of the hypothesis could not be made if he was included. In both cases the null form of Hypothesis VII would obviously be accepted. Data on the other Ss was not analyzed statistically because the total n was so small as to make it unlikely that valid results could have been achieved. The data, however, is presented in graphic form in Figures 1 and 2.

Hypothesis VII was evaluated in two ways. First, the low and high status Ss, i.e. W and Ca, were held constant and the middle S was varied from Mo to Mi to Pe. As the middle S changed, the amount of resources contributed to the coalition by Ca changed in the following manner. With Mo, Ca contributed 18/68 or 26%; with Mi, Ca contributed 18/54 or 33%; and with Pe, Ca contributed 18/42 or 42%. Inspection of Figure 1 shows that in the one cage condition Ca acquired one grape in the coalition Mo/Ca and no grapes in the coalitions Mi/Ca and Pe/Ca. In the same sequence of coalitions in the two cage condition Ca acquired 0, 6 and 9 grapes.

Hypothesis VII was then evaluated by keeping the high status Ss, i.e. W and Mo, constant and varying the low status S from Ca to Pe to Mi. As the low status S changed from Ca to Pe to Mi, the amount of resources contributed to the coalition by

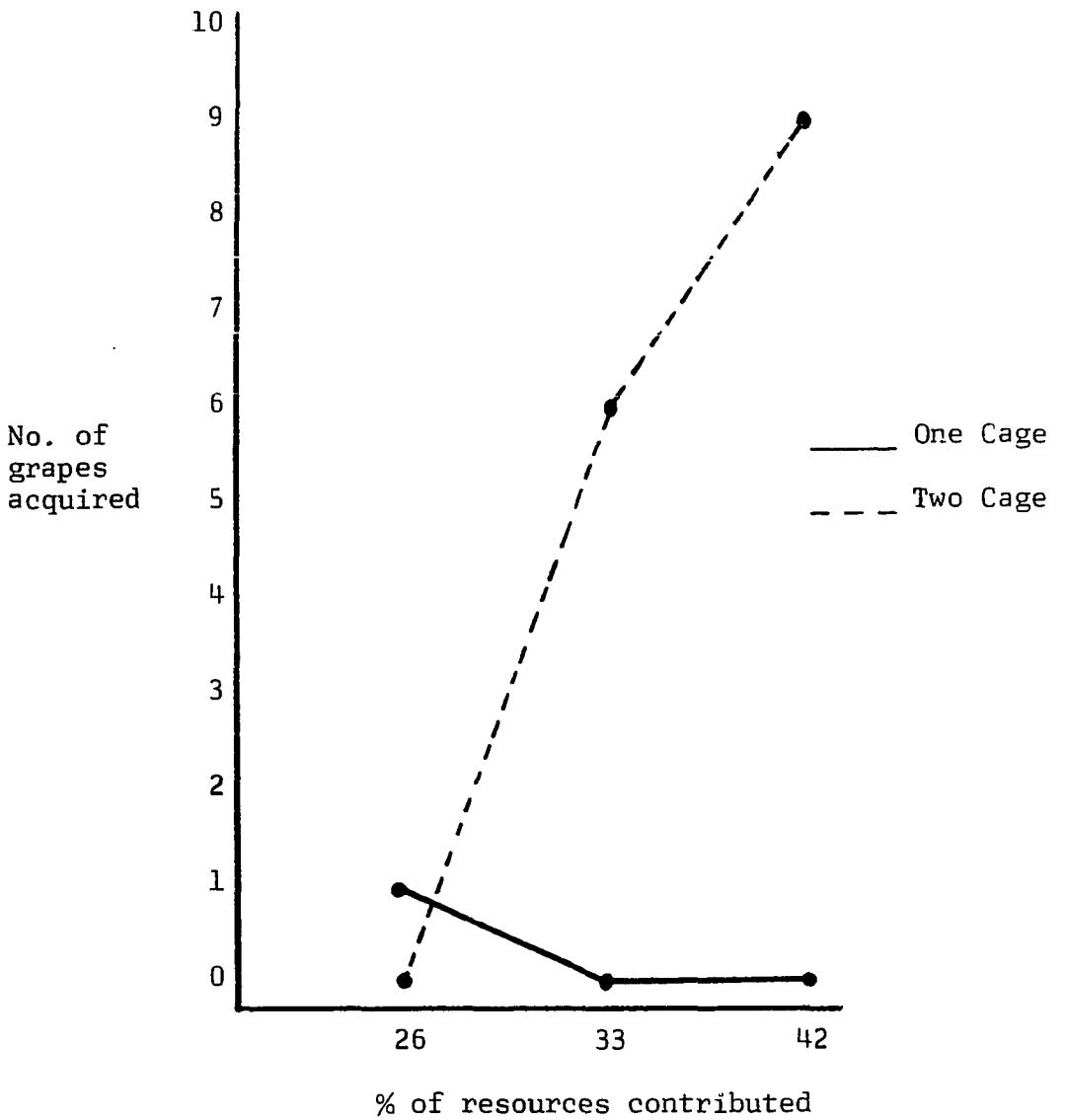


Fig. 1. Relationship between the % of resources contributed and the number of grapes acquired when the middle status S is varied.

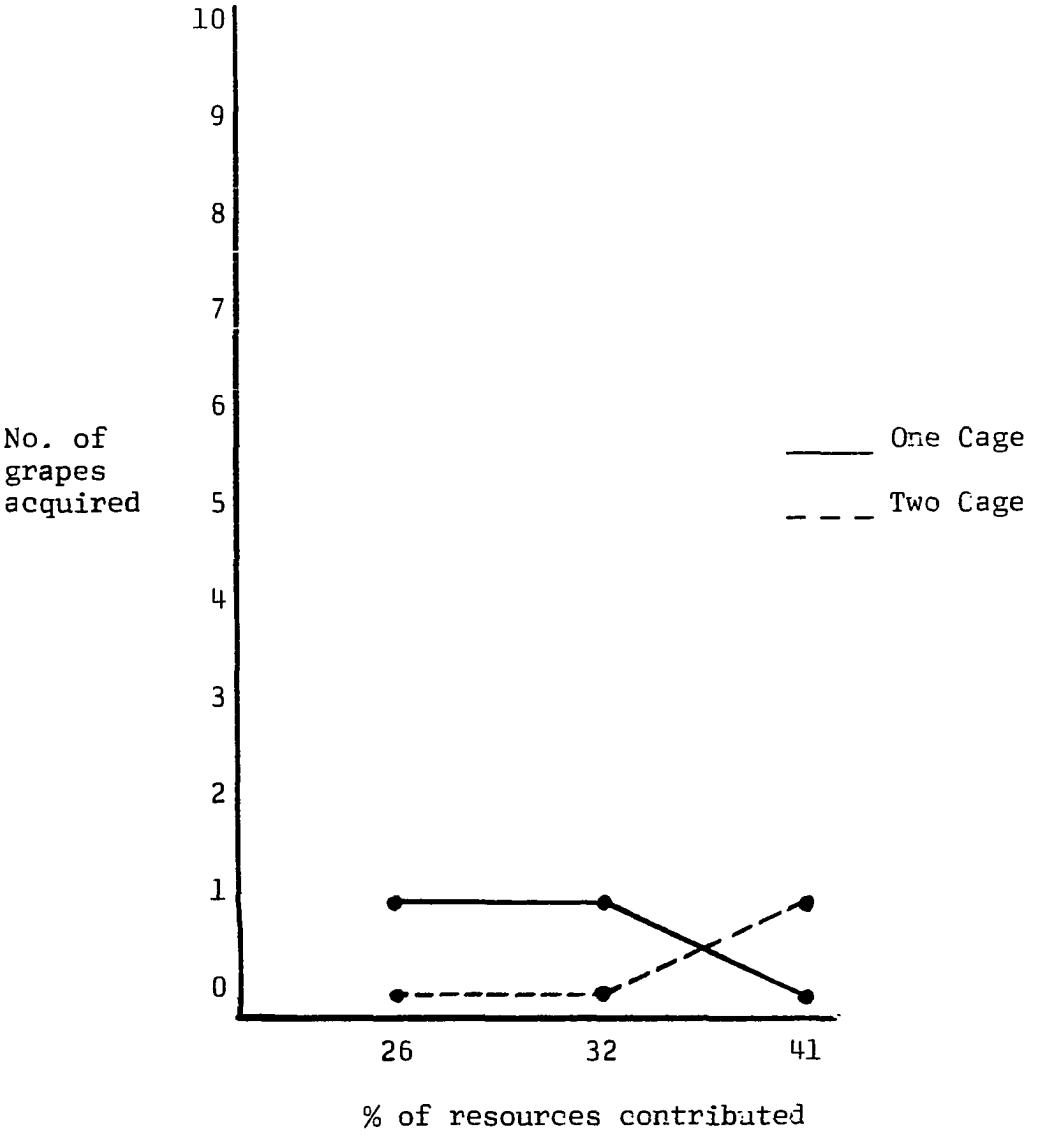


Fig. 2. Relationship between the % of resources contributed and the number of grapes acquired when the low status S is varied.

the low status S changed from 18/68 or 26% for the coalition Mo/Ca to 24/74 or 32% for the coalition Mo/Pe to 36/86 or 41% for the coalition Mo/Mi. Inspection of Figure 2 indicates that in the one cage condition the low status member of the coalition acquired 1, 1 and 0 grapes in the coalitions Mo/Ca, Mo/Pe and Mo/Mi, respectively. In the same sequence of coalitions in the two cage condition the low status S acquired 0, 0 and 1 grapes. Since the low status S acquired so few rewards, a trend was difficult to establish. In the one condition where a trend was apparent (two cage, middle status S varied), it was in the direction of the hypothesis as stated. In general, however, the theory of tertius gaudens did not seem plausible with this group of Ss, and the null form of Hypothesis VII was confirmed.

Hypothesis VIII states that in a triadic situation a female's behavior will differ qualitatively from that of a male. Although a statistical test of this hypothesis was not applied, the differences in behavior between male and female Ss were apparent in dyadic as well as triadic situations. In general, the males seemed to use more aggressive means to reach their desired goal. When needed, P used his status and power to threaten other Ss. Usually, however, the other Ss deferred to him. On two occasions he retrieved a grape from the mouth of another S who had taken the grape before he could get to the Feeder. These occurred in the two cage condition with triads. The other male, Me, frequently threatened other Ss by barking and screaming, waving his arms while in a bipedal position, and participating in aggressive,

gang-like behavior whenever the occasion arose. Me was involved in 11 of the 16 observed coalitions.

Females, on the contrary, more often used trickery, cunning and various forms of subtle manipulation to reach their desired goal. For example, it frequently took 10-15 minutes to run one trial in the two cage condition when the dyad or triad consisted of only female Ss. Each would engage the other in what appeared to be play seemingly for the purpose of enticing the other away from the Feeder. Once all Ss were quite far from the Feeder, the "play" ceased as spontaneously as it had begun. Interest in acquiring nickels or rewards was replaced by self-grooming, laying down in a corner, getting a drink of water, etc. Eventually one of the Ss would casually walk over to the apparatus and insert a nickel. As soon as the sound of the nickel dropping into the apparatus was heard by the other "disinterested" Ss, there was a sudden "renewed" interest in grapes and all Ss would race to the Feeder.

This sequence of behavior, with various embellishments, was very common throughout the study and is discussed in detail in the following chapter. It is important to point out, however, that it is not the intent of the writer to differentiate sex-specific behaviors. In fact, the most aggressive interaction observed in the study occurred between the three females W, Mo and Pe rather than between males or males and females. Although Mo never retrieved a grape from the mouth of another S, she did take nickels from them on several occasions. Also, when Me was in a

dyad or triad with lower ranking females, he occasionally tried to manipulate them away from the Feeder through the kind of play described above. Thus, females do on occasion behave as aggressively as do males; and males do on occasion use the more subtle methods of females. But, since the behavior of males and females was, in general, qualitatively different, and each sex seemed to have preferred methods of acquiring their goal, Hypothesis VIII was accepted.

Hypothesis IX states that the dominance hierarchy which emerges in a triadic situation is distinct from the dominance hierarchy which emerges in a dyadic situation. The effects of space and estrus were controlled as in the dyadic situation. The chi-square values for all possible triads of Ss in the one cage condition are presented in Table 4. The resulting dominance hierarchy is presented in Table 6 for comparison with the hierarchy for dyads in the one cage condition. Inspection of the two hierarchies indicates that the only change which occurred was W and Mo reversing ranks. It was concluded that the differences in the two hierarchies were minimal, and Hypothesis IX was rejected.

In Hypothesis X it was stated that the dominance hierarchy which emerged in the triadic situation would not be as apparent if the amount of space confining the Ss was enlarged. Table 5 presents the chi-square values for all possible triads of Ss in the two cage condition. The resulting hierarchy is presented in Table 6 for comparison with the hierarchy for triads in the one cage condition. Inspection of the two hierarchies indicates that

Table 4

Chi-square Values for Triads

in the One Cage Condition

	Critical Values x^2=12.00,p< .001; x^2=8.32,p< .005; x^2=5.32,p< .025; x^2=3.00,p< .10										
	W/Mo	W/Mi	W/Pe	W/Ca	W/Me	Mo/Mi	Mo/Pe	Mo/Ca	Mo/Me	Mi/Pe	Mi/Ca
P	12.00	12.00	12.00	12.00	5.32	12.00	.32+	12.00	12.00	12.00	12.00
W						12.00+	12.00+	12.00+	3.00+	5.32	5.32
Mo										12.00	8.32
Mi											
Pe											

Note. A + sign following a chi-square value indicates an effective coalition.

Table 4 (cont'd)

Chi-square Values for Triads

in the One Cage Condition

Critical Values

$x^2=12.00, p < .001$; $x^2=8.32, p < .005$; $x^2=5.32, p < .025$; $x^2=3.00, p < .10$

	Mi/Me	Pe/Ca	Pe/Me	Ca/Me
P	12.00	12.00	12.00	12.00
W	8.32	12.00	8.32	5.32
Mo	5.32	8.32	3.00	12.00
Mi		1.32+	12.00	5.32
Pe				.32+

Note. A + sign following a chi-square value indicates an effective coalition.

Table 5

Chi-square Values for Triads

in the Two Cage Condition

	Critical Values $x^2=12.00, p< .001$; $x^2=8.32, p< .005$; $x^2=5.32, p< .025$; $x^2=3.00, p< .10$										
	W/Mo	W/Mi	W/Pe	W/Ca	W/Me	Mo/Mi	Mo/Pe	Mo/Ca	Mo/Me	Mi/Pe	Mi/Ca
P	5.32	5.32	1.32+	12.00	8.32	12.00	12.00	12.00	12.00	5.32	12.00
W						12.00+	1.32+	12.00+	8.32+	.32+	.32+
Mo										1.32+	12.00
Mi											
Pe											

Note. A + sign following a chi-square value indicates an effective coalition.

Table 5 (cont'd)

Chi-square Values for Triads

in the Two Cage Condition

Critical Values

$x^2=12.00, p< .001$; $x^2=8.32, p< .005$; $x^2=5.32, p< .025$; $x^2=3.00, p< .10$

	Mi/Me	Pe/Ca	Pe/Me	Ca/Me
P	12.00	12.00	12.00	12.00
W	0.00+	5.32+	1.32+	3.00
Mo	.32+	8.32	8.32	12.00
Mi		1.32+	12.00	12.00
Pe				1.32+

Note. A + sign following a chi-square value indicates an effective coalition.

four of the seven Ss have a new rank in the hierarchy for triads in the two cage condition. It was concluded that the hierarchies were significantly different, and Hypothesis X was confirmed.

In the one cage triadic condition there were seven out of a possible 35 coalitions as operationally defined above. Application of a one sample proportion test resulted in a z of 2.00 ($p < .02$). In the two cage triadic condition there were 14 effective coalitions. A one sample proportion test, with the population parameter increased from the alpha level of .10 to the observed level in the one cage condition of 7/35 or .20, was applied to the data. The resulting z of 2.98 ($p < .002$) indicates that there was a significant increase in the number of effective coalitions when the amount of space confining the Ss was increased. Overt coalitions, however, decreased from 16 in the one cage condition to one (which was effective) in the two cage condition. Thus, there was an inverse relationship between the incidence of overt aggression and the amount of space confining the Ss.

In order to determine the effect of this significant increase in the number of effective coalitions in the two cage condition upon the predictive validity of the hierarchy for pairs in the one cage condition, a phi coefficient was calculated. The resulting correlation was .337 ($x^2=3.97$, $p < .05$). Predictions based upon the hierarchy for pairs in the two cage condition resulted in a non-significant correlation of .179 ($x^2=1.12$, $p > .10$).

Hypothesis XI states that a state of estrus will temporarily disrupt the hierarchy which emerged in the triadic conditions.

The triad P, W and Mo were given 12 additional trials in the one cage and two cage conditions when Mo manifested maximum perineal swelling. The chi-square values for the triad in the one and two cage conditions when Mo was in the phase of anestrus were 12.00 ($p<.001$) and 5.32 ($p<.025$), respectively. When Mo was in the phase of estrus, the corresponding chi-square values were 0.00 (p=n.s.) and 5.32 ($p<.025$). Hypothesis XI was not clearly confirmed or unconfirmed on the basis of the data. However, in three out of the four conditions estrus did result in a change in the relationship between P and Mo which would support rejection of the null form of Hypothesis XI.

Inspection of Table 6 indicates that each condition resulted in a unique hierarchy. Combining the number of grapes each S acquired in all four conditions resulted in an additional hierarchy which was referred to as the composite hierarchy. Since this hierarchy is based on four samples of behavior under different conditions rather than one, it is logical to assume that the composite hierarchy is a better approximation of the relative status of each S in the colony. Two observers, in addition to the writer, who have accrued many hours observing this group of Ss, stated that the composite hierarchy was consistent with their observations.

Table 6

Dominance Hierarchies for the Four Conditions

Rank	Dyads				Triads				Composite	
	One Cage		Two Cage		One Cage		Two Cage			
1.	P	72	P	66	P	171	P	169	P	478
2.	W	52	Mo	50	Mo	115	Mo	103	Mo	318
3.	Mo	50	Ca	41	W	69	Mi	57	W	196
4.	Mi	36	Mi	35	Mi	37	W	45	Mi	165
5.	Pe	24	W	30	Pe	16	Ca	29	Ca	98
6.	Ca	18	Pe	22	Ca	10	Pe	17	Pe	79
7.	Me	0	Me	8	Me	2	Me	0	Me	10

CHAPTER V

DISCUSSION

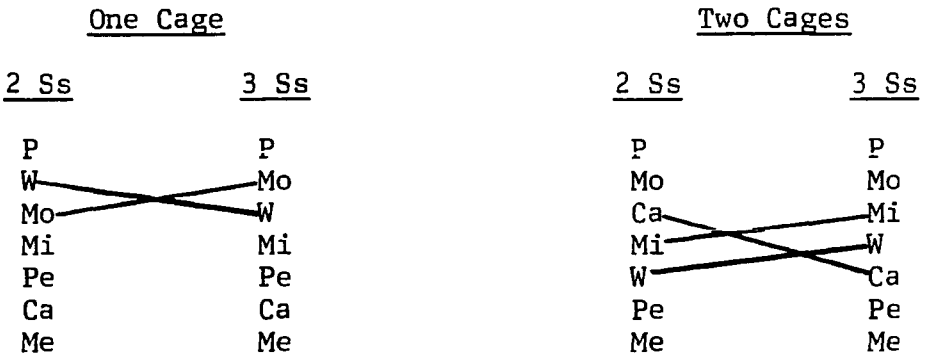
The results of the present study suggest that the social structure of captive chimpanzees is organized around a linear dominance hierarchy. These results are consistent with the observations of captive chimpanzees by Yerkes (1943). Just as Willems (1965) noted supposedly conflicting results between Washburn's laboratory and field studies of dominance in pairs of baboons, these results could be construed by some as conflicting with the conclusions of Goodall (1963, 1965a, 1965b, 1967), Kortlandt (1962) and Reynolds (1965; Reynolds & Reynolds, 1965) regarding the social structure of wild chimpanzees. It would seem more correct to conclude that the obtained differences in social structure between captive and wild chimpanzees, as well as captive and wild baboons, is more an indication of the flexibility in non-human primate behavior and their capacity for readily adapting to different conditions (Chance, 1963; Zuckerman, 1932). The real question, therefore, is not whether or not a dominance hierarchy exists in a group of captive chimpanzees, but rather what conditions seem to necessitate what types of social structure.

The hypotheses that space, coalitions and estrus effect changes in the social organization of captive chimpanzees were

supported. Figure 3 portrays the changes which occurred in the original dominance hierarchy when space was fixed and the number of animals varied as opposed to the changes which occurred when the number of animals remained fixed and the amount of space was varied. Inspection of Figure 3 makes it readily apparent that the effect of variations in space is greater than that resulting from varying the number of animals. When space was fixed, the most extreme shift in relative status occurred in the two cage condition. Ca dropped from rank three in the dyads to rank five in the triads. When space was varied, however, the relative status of four animals shifted in both the dyadic and triadic conditions.

The dominance hierarchy for pairs in the one cage condition was transitive, i.e. each animal in the hierarchy was significantly dominant over all animals having relatively lower status and significantly sub-dominant to all animals having relatively higher status. This was not true of the dominance hierarchy for pairs in the two cage condition. Except for the alpha and beta animals, an animal was not found to differ significantly from those nearest him in the hierarchy. Because of these ambiguities, the hierarchy for the two cage condition is, in effect, meaningless. It would appear, however, that the two cage condition yields a better approximation to the type of social structure observed with wild chimpanzees. In wild chimpanzee groups, dominance interactions are observed but a clear-cut linear dominance hierarchy has been impossible to discern. Again, the flexibility in the adaptive behavior of this primate is to be stressed. It should

Space Fixed, No. of Animals Varied



No. of Animals Fixed, Space Varied

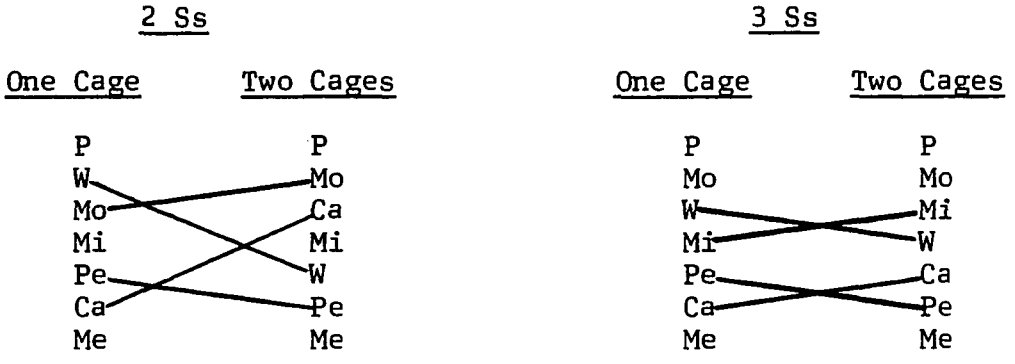


Fig. 3. Changes in the dominance hierarchy as a function of space and the number of animals.

also be noted that these differences were found with the same group of animals. The overused and, perhaps, sometimes abused captive versus wild dichotomy does not apply in this situation. Undoubtedly these same animals would manifest a different kind of social structure if placed in an even different situation. Changes in physical and social maturity with the passing of time would also yield a different social organization than the one found at this particular point in time. The social organization of captive as well as wild chimpanzees is not rigid or fixed but a reflection of spatial-temporal relationships.

Inspection of the total number of grapes acquired by each animal in the four conditions indicates that a more even distribution of grapes was obtained in the two cage conditions. The pattern which emerged was one in which the upper half of the hierarchy showed a decrease in the number of grapes acquired in the two cage conditions when compared with the number acquired in the one cage conditions. The opposite is generally true of the lower half of the hierarchy. It was also apparent that the situation most beneficial to the lowest status member of the group was one in which the population density was low and the amount of space confining the animals was large. Me acquired more grapes in the one cage, dyadic condition than in the other three conditions combined.

Although coalitions have been observed and described under the rubric of various synonyms by field as well as laboratory investigators, this phenomenon was usually explained on the basis

of post hoc theorizing. In the present study a theory of coalitions based upon human behavior in triadic situations was used to predict coalitions in the triad with non-human primates as subjects. The theory is based upon the assumption that coalitions may be predicted in triadic situations where the members of the triad are not identical in power and these relative differences in power are known. The intent of the present study was to determine the applicability of this theory to non-human primate behavior. As expected, more questions than answers arose.

One of the major methodological problems was to define a coalition. Since the ways in which coalitions form and function may be either overt or covert, openly aggressive or subtly manipulative, it is highly probable that coalitions exist but go undetected because of limitations in the human senses. Inferences made by the observer as to the presence or absence of a coalition could be used as data, but scientific principles must be based on inferences drawn from observations, not inferences about inferences. Because of these problems, two types of coalitions were distinguished. Covert coalitions were operationally defined and their presence or absence was determined statistically. Overt coalitions, where two animals were observed to gang-up and attack a third, were analyzed separately.

The results indicated an inverse relationship between the two types of coalitions when the amount of space confining the animals was manipulated. Overt coalitions decreased from 16 to one when space was increased; whereas covert coalitions in-

creased from seven to 14 when space was increased. The decrease in overt coalitions is most likely a function of the relationship between space, population density and overt aggression which has been a known fact to keepers of wild animals for several decades (Hediger, 1964) Zuckerman (1932) spoke of the relationship between anti-social behavior and space in terms of "socially conditioned fighting." He pointed out that the social behavior of captive and wild animals is not changed, but differences in the intensity of some behaviors, particularly aggressive and sexual behavior, are common occurrence. It might be added, parenthetically, that since only 17 overt coalitions occurred in 840 trials, this group of chimpanzees surely can not be characterized as overly aggressive or hostile in their interpersonal relationships. They seem to know quite well their place or role in the group. With a more aggressive group of chimpanzees, a group comprised of strangers who as yet do not know their various roles, or another species of non-human primate, a very different picture than the one described would probably result.

The increase in covert coalitions is a more complex issue and may, in fact, have little relationship to coalitions. It may be that an individual animal is more willing to take a risk when competing with a more dominant animal for food when there is 20 instead of five feet separating the animals. Also, when the sub-dominant animal has space in which to run, he can escape the dominant animal's aggression. However, since covert coalitions did increase significantly when the amount of space confining the

animals was increased, it is possible that an increase in space results in an increase in the power of the coalition and, thus, an increase in the sub-dominant animal's willingness to take these kind of risks.

An analysis was made to determine which members of the triad more frequently united in an overt coalition. Three theories from which to make predictions existed. Caplow (1956) theorized that in a triadic situation where the combined power of the two subordinate members was greater than that of the dominant member, i.e. $A>B>C$; $A<(B+C)$, coalitions of either BC or AC would occur. Gamson (1961) theorized that since C contributes more power to the coalition BC than AC, C can expect a greater share of the rewards by entering into a coalition with BC. The coalition BC, therefore, should occur with greater frequency than the coalition AC. Gamson's theory was supported in a study by Vinacke and Arkoff (1957) where the coalition BC occurred three times more often than did AC. Vinacke and Arkoff, basing their predictions on the rational approach of game theory, had hypothesized that any coalition could occur with equal probability. In the present study, Gamson's theory was chosen but not supported. Of the 17 coalitions observed, 14 were of the form AC whereas in only one coalition were the members BC. The results were the reverse of Gamson's theory and the observations of Vinacke and Arkoff. Before discussing what these unexpected results may mean, the results regarding the theory of tertius gaudens will be discussed. The theory of tertius gaudens, which was also not supported, seems to be intimately related to

the above theory.

The theory of tertius gaudens states that the weakest member stands to gain the most by entering into a coalition because without membership in a coalition, he would have no chance of winning. Gamson reasoned that the weakest member will demand a share of the payoff, or rewards, proportional to the amount of resources he contributes to the coalition. The theory was supported in a study by Psathas and Stryker (1965) in which a positive correlation was obtained between the amount of resources contributed to the coalition by the weakest member and the percentage of rewards acquired by that member. These results were not, however, obtained in the present study. Even when the highest and lowest status animals in the group, P and Me, were excluded from the analysis because the former almost always and the latter almost never acquired grapes, the theory was not supported. This is due to the fact that the low status member in a triad only rarely acquired a grape.

The theory of tertius gaudens focuses upon the rewards acquired by the low status member of the triad. In Figures 4 and 5 the number of grapes acquired by the middle status member of the triad, including triads in which Me was a member, are presented. In both figures, W was the high status member in all triads. Inspection of the figures clearly indicates that as the combined power of the sub-dominant members of a coalition increased, so did the rewards acquired by the middle status member of the triad in three out of four conditions. (Compare these figures with

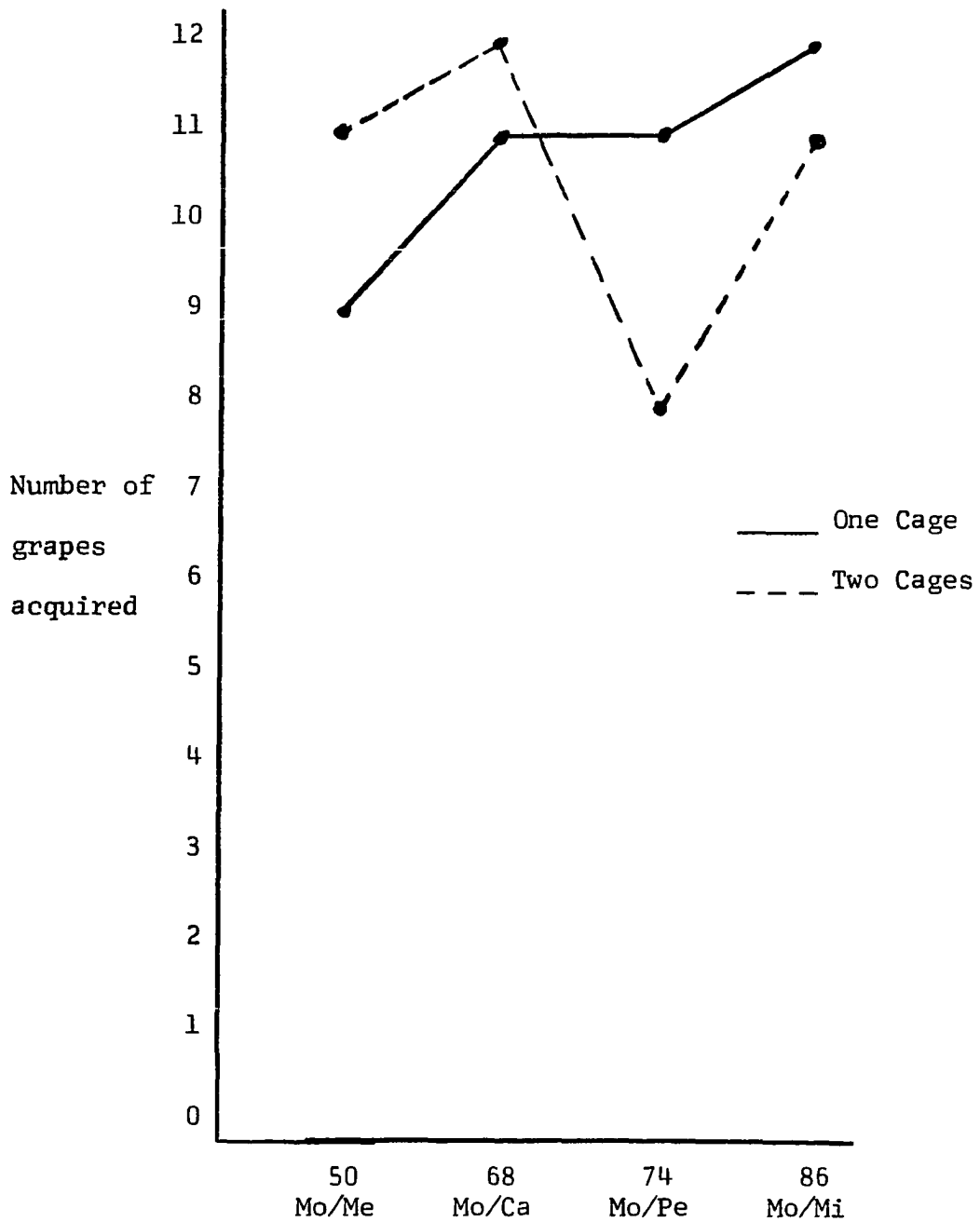


Fig. 4. Relationship between combined power of the coalition and the number of grapes acquired by the middle status member when the low status member is varied.

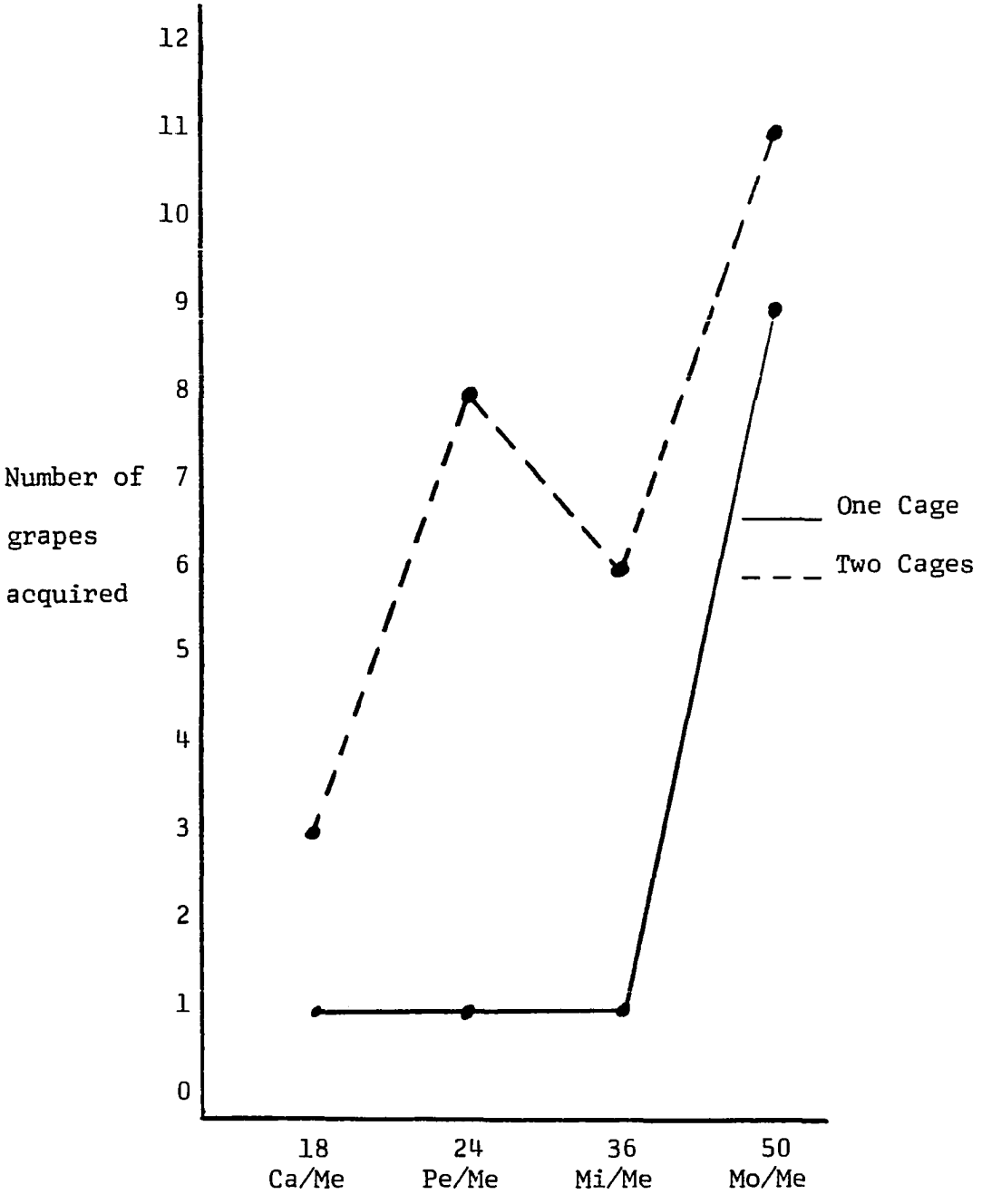


Fig. 5. Relationship between combined power of the coalition and the number of grapes acquired by the middle status member when the middle status member is varied.

Figures 1 and 2 in Chapter IV.)

An analysis of overt coalitions to determine which member of an effective coalition acquired the grape was consistent with that found for the covert coalitions. The dominant rather than the sub-dominant member of a coalition gained the most from entering into a coalition.

These results do not really refute the theory of tertius gaudens for it is true that the low status member of a triad can expect nothing unless he enters a coalition. It is also true that the middle status member of a triad can expect nothing unless he too enters a coalition. It seems, however, that with chimpanzees the low status member gets little in return for his support in a coalition. Almost always it is the dominant member of the coalition who stands to gain the most. It would appear, therefore, that a theory of secundus gaudens is needed and might be more fruitful than the theory of tertius gaudens when studying the behavior of non-human primates in coalitions.

In view of the above results, it is tempting to conclude that the low status member of a triad does not enter into a coalition with the intent of acquiring rewards for his efforts. Instead, he enters a coalition because it is appropriate for him to do so under certain circumstances. This is particularly true when the middle status animal in the triad tries to take food from a more dominant animal. This behavior can be described as inappropriate or anti-social since it is a violation of the social structure of the group. When an animal behaves inappropriately, animals below

as well as above him in the hierarchy are apparently behaving appropriately if they attack the "rule breaker." Thus, coalitions of AC against B would occur with greater frequency than other coalitions where, as with this group of chimpanzees, the middle status member is usually the "rule breaker."

The question can be raised as to why it is the middle status member rather than the low status member who behaves inappropriately so often. Figures 3 and 4 indicate that he acquires grapes which he would not acquire unless he violated the social structure of the group. But, it is more common for animals of nearly equal status to compete than for those of highly different status. The middle rather than the low status member, therefore, can be expected to compete more often with the dominant member of the triad.

A more difficult question concerns the factor responsible for the variation in the number of grapes acquired by the middle status member in the various triads. According to the hypothesis, the factor is variation in the combined power of the coalition between the sub-dominant members. It appears, therefore, that although the low status member rarely enters into a coalition with the middle status member, the mere presence of certain low status members has an effect on the middle, and possibly the high, status member of the triad. Certain low status members, e.g. those relatively high in the dominance hierarchy, may serve to increase the aggressiveness with which the middle status member competes, decrease the intensity of the dominant members defense of his rights,

or both. Other low status members, e.g. those relatively low in the dominance hierarchy, have little or no effect on the other two members of the triad. Thus, a dyad and an isolate result rather than a triad, and the regular dominance relationship for the dyad, i.e. A>C, would determine the way in which the available food is divided. The validity of this theory must, of course, depend upon future studies wherein the appropriate controls are applied.

The applicability of Caplow's theory of coalitions rested mainly on its usefulness as a tool for predicting coalitions in the triad comprised of non-human primates. Since the predictions were based upon the relative status of each animal in the linear dominance hierarchy for dyads in the one cage condition, the predictive validity of this hierarchy was also being tested. If the hierarchy was not a valid predictor, the theory would not be supported. In both the one and two cage triadic conditions the predictions agreed with the data to a significant degree. Predictions based on the dominance hierarchy for dyads in the two cage condition, however, were not upheld. Thus, the predictive validity of the original dominance hierarchy and the applicability of Caplow's theory were supported.

Inspection of Tables 4 and 5 (Chapter IV) indicates that coalitions were frequently effective against W even when the prediction was that they would not be effective. In the one cage triadic condition, every coalition in which Mo was a member was effective against W. This is to be expected, however, since the difference in status between these two animals was negligible.

W and Mo's scores in the linear dominance hierarchy for dyads in the one cage condition were 52 and 50, respectively. (See Table VI in Chapter IV.) In contrast, coalitions were rarely effective against P even when the prediction was that they would be effective. The difference between the scores for P and W, who was second only to P in the hierarchy, however, was greater than the difference between any other two animals in the hierarchy. The difference was 20 points (grapes). Since so few coalitions were effective against P throughout the entire study, his obtained score was obviously an underestimate of his status and power. The next largest difference in scores was between Mo and Mi where the difference was 14 points. No coalitions were effective against Mo in the one cage condition although the predictions were that two would be effective. Only one of these was effective in the two cage condition.

A fact which must be taken into consideration when applying Caplow's theory to triads comprised of non-human primates is that the intervals between the various members of the dominance hierarchy are not equal and, at times, the obtained interval will be an underestimate of the difference between the two animals. This is particularly true of the alpha animal. Since coalitions are so rarely effective against the alpha animal, the score assigned to that animal will almost always be an underestimate of his status and power. In order for his status and power to be more accurately reflected in his score, an arbitrary score will probably have to be assigned. For example, Table 7 lists the scores of the

Table 7

Social Distance Scale

P	110 (at least)
W	55
Mo	54
Mi	30
Pe	23
Ca	18
Me	6

animals in the dominance hierarchy after being adjusted so that they correlate almost perfectly with the data obtained in the one cage triadic condition. It is probable that P's score is still not an accurate representation of his status because, if all members in the hierarchy were placed in the same cage with P, it is still quite likely that he would acquire most if not all of the rewards. These scores, however, are a more accurate representation of the social distance between the various animals in the dominance hierarchy than were those obtained in the study.

The last hypothesis derived from research on the theory of coalitions was that the behavior of male and female chimpanzees in triadic situations would differ qualitatively. Qualitative differences between the sexes were apparent in dyadic as well as triadic situations. In general, the males seemed to use more aggressive means in acquiring grapes whereas the females more often used trickery, cunning and various forms of subtle manipulations. The section below on individual differences describes in detail the behavior of each chimpanzee in all four conditions and gives ample evidence to support the hypothesis as stated.

It is important to point out, however, that support of the hypothesis is not meant to imply that these behaviors are sex-specific. In fact, the most aggressive interaction observed in the study occurred between the three females W, Mo and Pe. In this particular interaction, a prolonged fight emerged in which W was bitten by both Mo and Pe several times and W lost a canine tooth. Also, when Me was in a dyad or triad with females ranking low in

the dominance hierarchy, he occasionally was observed trying to manipulate them away from the feeder in rather subtle ways. When the female was strategically positioned under the feeder, he would initiate a playful interchange in which the female was lured away from the feeder. He would continue playing for a brief period of time and then stop to put the nickel which he was holding in his hand in the apparatus. When the female rushed back to the feeder and acquired the grape, Me frequently protested vocally and gesturally and, sometimes, entered into physical combat. Since the other female always ranked above him in the hierarchy, his attacks were usually aborted when the female aggressed against him. Thus, females do on occasion behave like males; and males do on occasion use the subtle methods of females. In general, however, each sex seemed to have preferred methods with which to gain the advantage over their competitors and, frequently, acquire the rewards.

Yerkes (1943) has made similar observations in his studies of dominance with male/female pairs of chimpanzees. He described the methods used by males as the following: gestural or vocal begging and threatening; vocal complaint; active conflict with the use of limbs, teeth, or both; and attempts to initiate play. Of the females, he remarked:

> As for the females, wiles, trickery, or deceitful cunning, which are conspicuous by their absence in the male list, are favorite resources. But even more so are sexual allure and varied forms of solicitation, some of which might better be classified under motor suggestion; petting, by means of grooming, physical contacts, and manipulation of body parts, bodily pressure, and crowding. Only highly dominant females, or unusually courageous ones, ordinarily use, as do males,

> gestural and vocal commands, physical threats, or assault (p. 83).

Yerkes stressed the "biological basis of prostitution of sexual function" (p. 86) as the primary feminine trait. Manipulation of others by sexual allure was rarely observed in the present study except between Me and the high ranking females. The other females, mostly because of their youth, did not manifest this behavior when with either of the two males. Overt sexual behavior between females was, of course, absent. However, if tickling, wrestling and other behaviors involving intense and prolonged body contact are viewed as having sexual undertones, the females in this group are very feminine. By far the activity in which the females engaged the most was play.

A female in estrus effects the dominance hierarchy through changes in her relationship with males. Yerkes (1943) described these changes as follows:

> A male who previously has completely controlled the situation and taken the food time after time as if it were a matter of course yields without protest, although possibly somewhat reluctantly, to the female when, at the beginning of genital swelling and willingness to mate, she claims the food. Thereafter as long as she is sexually receptive and also acceptable to her mate, she may if she so desires continue to control the food-getting situation without competition or conflict (p. 76).

However,

> if...there is dislike or antagonism between them, the contributory influence of sexual status may be entirely overshadowed by physical conflict in which the more dominant individual gains control. Mating under these conditions may not occur (p. 75).

The latter describes the situation between P and Mo. During the

couple of months prior to the experiment, copulation between them was not observed although she was seen to copulate frequently with Me, the low dominance male.

In three of the four conditions the relationship between P and Mo changed from one of significant to no significant differences from chance in the number of grapes acquired in a series of 12 trials. The hypothesis that estrus would effect changes in the dominance hierarchy was, therefore, supported. When in the phase of anestrus, P was significantly dominant over Mo. In the phase of estrus, the difference in status between the two can not be determined. However, Mo did not "control the food-getting situation without competition or conflict." Each grape acquired was acquired through outmaneuvering P or persisting in spite of his gestural threats. Physical conflict did not occur, but Mo protested his demands with cries and screams. Mo's protests intensified in the two cage dyadic condition. Mo had placed a nickel in the apparatus, and P, who was in the cage with the feeder, took the grape just as she came running into the cage. She returned to the other cage, assumed a bipedal position, vocalized loudly at him, waved her arms about in the air, and banged on the wire mesh separating them. P made no apparent response to her protests. Mo's display impressed the observer as an admixture of frustration and anger with P for not deferring to her as he should.

In summary, the results of this study support the hypothesis that the social structure of captive chimpanzees is organized around a linear dominance hierarchy. This hierarchy, however,

is not rigid and fixed but changes with changes in the conditions in which the chimpanzees are confined. At least the three conditions manipulated in this study, space, number of animals and estrus, can effect changes in varying degrees in the dominance hierarchy. Thus, the social organization of captive chimpanzees is quite complex and can not be understood by the simple pairing of animals in a food-getting situation. A theory of coalitions based upon research with human primates was found to be applicable, with certain changes, to a group of non-human primates and should prove fruitful in future research.

An Analysis of Individual Differences

In most experimental investigations, the results are discussed in terms of overall group behavior because of the assumption that individual differences tend to cancel each other out with a large number of subjects. The opposite is found in field studies where the uniqueness of certain individuals is described, thus enriching the knowledge gained from the overall results of the study. Since a small number of subjects were used in this study, considerable space will be devoted to a description of each animal's behavior throughout the experiment. It is hoped that the analysis of similarities and differences between these particular chimpanzees will add to the understanding of chimpanzee behavior, in general, as well as the results of this study.

Pan (P)

Throughout most of the study P worked enthusiastically.

He appeared to enjoy putting nickels in the apparatus as much as getting the grapes. At times he would place himself under the feeder and take the grapes while the others worked seemingly for him. Several of the others fed him in this manner at various times in both the one and two cage conditions. Unlike the others, he played very little except for brief periods of time with W, Mi and Me. However, as soon as a nickel was ejected into the cup, he would stop playing to put the nickel in the apparatus. Not one overt coalition against P was observed. There is no doubt of his status as the alpha animal in the group since he acquired more grapes than any other animal in every condition.

In the one cage conditions the others, except for Pe, rarely tried to get the nickels or grapes when with P. Pe, however, seemed never to defer willingly to him. She positioned herself under the feeder over and over again only to move as soon as P started for the grape. One time he reached up and gently touched her on the side before putting the nickel in the apparatus. She quickly moved out from under the feeder. On other occasions, Pe would get a nickel and P would bob his head or slap his foot on the floor to which Pe responded by immediately surrendering the nickel. She once refused to give up a nickel even though P chased her around the cage. She kept it for the next two trials. Suddenly P started towards her, jumping up and down and slapping both hands and feet on the floor. Pe threw the nickel onto the floor and ran to a corner of the cage. Although W and Mo were not as aggressive as Pe, they occasionally whimpered softly as P reached

for grapes. Neither did Ca try to steal grapes from P. But, during one trial a grape happened to roll beyond P's reach outside the cage. P seated himself on the opposite side of the cage. Ca went over and, while keeping a close watch on P, began to retrieve the grape. Me, who was in the cage with them, began vocalizing softly as Ca was retrieving the grape. Once she had the grape in the cage, P came over to her. She extended her hand, palm up, and P took the grape out of her hand.

In the two cage conditions P frequently positioned himself under the feeder while the others worked the apparatus. Whenever they decided not to cooperate, he would resume operating the apparatus. The others would quickly run to the feeder and wait for the grapes. They rarely, however, competed in this way with P in the one cage conditions. In this way W, Mo, Ca and Mi were able to get grapes.

Possession of the grape did not always mean that they got to keep it. P usually forced them to surrender the grapes by begging or gesturally threatening them. Ca, for example, was most persistent in her efforts. Usually she would let the grape fall through her fingers to the floor when P came running into the cage. One time a grape landed on her stomach. She froze, and P came over and took the grape. Another time she had a grape in her mouth. As P came running into the cage, she again froze, giving no indication that she had a grape. P went to her, placed one hand under her jaw causing her to open her mouth, and retrieved the grape. Ca's persistence ended when, on one occasion as P was

leaving the cage, he stopped, turned toward her and stared for a few seconds. Ca whimpered a little and crawled off the wire onto the floor where she stayed for the remainder of that set of trials.

In contrast, W, Mo and Me were able to keep a few of the grapes that they managed to get their hands on before P entered the cage. Mi managed to keep them by running away from him. W and Mo stayed in the cage and, when P would gesture for them to give the grape to him, they would cry and move further away from him. He never took a grape out of their mouths as he did with Ca.

Wendy (W)

W's interest and cooperation vacillated throughout the study. She spent most of the time playing, coming to the experimenter and protruding her lips through the wire for a kiss, and playing with the nickels. Although the others also played with the nickels initially, the nickels lost their novelty value quite quickly for them. Her behavior may, however, be explained, in part, by her physical condition. She had her first menses just prior to the beginning of the experiment and also lost two teeth during the experiment. Her behavior is best described as hyperactive with a co-existant short attention span, easy distractibility and general lack of predictability in behavior. This is quite apparent when her status in the four hierarchies is noted. Her relative status changed from hierarchy to hierarchy more than any other member of the group. Again, this may have been due to various physiological and temperamental changes which were occurring during

this period of time. Only one time was she the target of a coalition, and she lost. This was an unusually hostile interchange in which she was bitten by both Mo and Pe several times. She also lost a tooth. She was a member of four overt coalitions but did not acquire any grapes for her efforts. She acquired grapes in a triad with P and kept them in spite of his threatening gestures.

In the one cage conditions she played with the nickels much of the time. She took abuse from Mo, Pe and Mi because of this, especially Mo and Pe. Both bit her several times during one interchange, whereas Mi slapped her on the back from time to time during their scuffles. W was most aggressive with Ca when Ca tried to get a nickel or a grape. Ca usually backed down in a dominance interaction. With P, W occasionally whimpered as he took the grapes, but she did not show the aggressiveness and determination that Pe did with P. In triads with Pe and Me, W and Pe wrestled over nickels and grapes several times while Me observed from a distance. One time, while W was playing with Me, she dropped the nickel she was holding onto the floor. Pe immediately retrieved the nickel. Me barked, jumped on top of her and bit her on the shoulder. W then attacked Me, slapping him and chasing him around the cage. Although some of her play was purely for the pleasure of playing, it seemed obvious that this was not always true. With Me and Mi she was often able to acquire the grape by engaging them in play as soon as they had put a nickel in the apparatus. While they were playing with her, she would steal the grape which by this time was laying on the floor. The opposite situation, however,

occurred more often. W was easily distracted from getting the grape when one of the others engaged her in play. This seems to be how W was able to acquire more grapes than Mo in the dyadic, one cage condition. Mo, however, quickly gained insight into the way the others were using her and the effectiveness of this strategy became minimal as the study progressed.

In the two cage conditions W was frequently involved in the stalemates which were commonplace during the latter part of the experiment. Each animal had learned not to be so easily distracted by others who seemed eager to play, and the effectiveness of this strategy diminished considerably. What arose was a situation wherein each would try to outwait the other until they had the advantage. W, like Mo, did not seem to be as able to tolerate these long periods of waiting as were the other members of the group. After several minutes, she would eventually put a nickel in the apparatus and everyone would race to the feeder to get the grape. With Mo, W would attempt to position herself under the feeder, but Mo usually pulled her off the wire before leaving the cage. Mo's aggressiveness would cause W to chase her out of the cage in which the feeder was located. Mo would then put the nickel in the apparatus, and they would race back to the feeder.

Mona (Mo)

Initially Mo did not appear too interested in putting nickels in the apparatus and acquiring grapes for her efforts. This was quite unusual for Mo since she, of all the members in the group,.

is known for her insatiable appetite. In the initial dyadic, one cage condition she would place a nickel in the apparatus but, if someone else got the grape, she let them have it. Others would engage her in play and, while playing, steal the grape off the floor. It did not take long, however, for Mo to realize the strategy behind this play and she soon became very aggressive in getting grapes that she wanted. Most characteristic of Mo was her smile which was often apparent during the study. Although W was dominant over her in the dyadic, one cage condition, they are about equal in status. Mo is older and bigger, but W probably gains status through her close association with P

In the one cage condition Mo played often, usually at another's invitation, even with Me whom the others usually ignored. Once she realized that the others were taking "her" grapes while supposedly playing with her, she became quite aggressive and was seen pulling others out from under the feeder before putting the nickel in the apparatus. On one occasion, when W took a nickel from the cup, she furiously attacked her and, with the help of Pe, retrieved the nickel after biting W several times. Although her overt anti-social behavior was infrequent when compared to that of Me, the manner in which she played seemed more aggressive than that of the other females. High status females, however, are known to behave quite aggressively at times (Yerkes, 1943).

In the two cage conditions she played less and was seen to scratch, pace, rock, and elicit a variety of signs of anxiety during the stalemates. On several occasions she clapped her hands

and pointed to the apparatus while looking at the experimenter. She apparently did not want to lose her advantageous position by putting a nickel into the apparatus. But, the others would not do it for her as often as they had for P. Soon her anxiety would be so great that she would race out of the cage and chase whoever had a nickel until they dropped it onto the floor. The others patiently outwaited her and, when she came towards them, dropped the nickel they were holding onto the floor and ran to the feeder as Mo was putting the nickel in the apparatus. Most of the time, however, they were so busy watching Mo to see how close she was to them that they would miss the grape, and she would get it. Although she took nickels from several of them, she never retrieved a grape from another's mouth as did P.

Mimi (Mi)

Mi's behavior during the study was very similar to that of W She too played frequently with the others as well as with the nickels. Her fascination for the novelty of the nickels disappeared sooner than did W's, but this reappeared from time to time. In general, there was nothing really outstanding about her behavior. She used the same strategy as the others, primarily play and positioning herself under the feeder. Her stability is also apparent in the four dominance hierarchies where she was ranked fourth in three of them and third in one. In the composite hierarchy she ranked fourth, and she most likely is located in the middle of the group as far as relative status.

What was most unique about Mi was that she was infrequently involved in aggressive interactions. She was the target of only one coalition and a member of only four coalitions. She either knows her role in the group very well and is willing to accept that role, dislikes anti-social behavior, or, perhaps, is more intelligent than the others when it comes to avoiding aggression. Her intelligence was most apparent during the period of shaping prior to the experiment. It became routine for her to offer a nickel, which she had kept overnight, to the experimenter when he entered the laboratory. She once kept a nickel for two days. It was quite tarnished, suggesting that she kept it in her mouth so that one of the more dominant animals would not take it from her.

In the one cage conditions she used positioning and play to gain an advantage over her competitors. Unlike Pe and Ca, who persisted in spite of aggressive retaliations, Mi backed down quickly and, thus, avoided being bitten or hurt in some other way. One time she was the target of a coalition and was chased by Mo and Ca for taking a grape after Mo had put a nickel in the apparatus. No serious anti-social behavior occurred although it was apparent that they did not approve of her behavior.

In the two cage conditions she still played often and tried to gain the advantage by positioning herself underneath the feeder. In a triad with Ca and Pe, the period of play often lasted 15 minutes. Eventually one would do something to cause the others to chase her out of the cage with the feeder. The play would

cease, and a long stalemate would occur. Pe would get a nickel but, since the others would then return to the feeder, she would just sit with it in her hand or chew on it. As soon as the others resumed play or some other activity outside of the cage with the feeder, she would place the nickel in the apparatus, and everyone would race to the feeder. These three animals seemed to be nearly equal in status because the one who was able to reach the grape first, usually kept it without serious reprisals from the others. Mi's dominance was more apparent in a triad with Pe and Me. Pe and Me were engaged in a rather aggressive interchange over a nickel which Pe finally acquired. Mi observed this scuffle from a distance but, when it was over, she chased Pe around the cage, without physical contact between the two, until Pe dropped the nickel onto the floor.

Peggy (Pe)

Pe's enthusiasm, seriousness and persistence in the face of rather severe repercussions was equal if not greater than that of P. Throughout the study she took a risk to get a nickel or grape no matter who, including P, was in the cage with her. She was the first to use positioning to gain an advantage and continued to do so even though others pulled her out from under the feeder time after time. She was also the first to resist putting a nickel into the apparatus and, thus, initiated the many stalemates which occurred during the study. She was only second to Me in the number of overt coalitions of which she was a member

(a total of eight), but Me was the other member the majority of the time. Out of the five overt coalitions that were effective, she was involved in three and each time was the member to acquire the grape. Perhaps because of the relatively high number of aggressive interactions in which she was involved, she was bitten twice by Me and bit another female, W, one time. She also threatened others both vocally and gesturally, e.g. drumming on the cage door, slapping her foot on the floor, barking, and rocking back and forth while in a bipedal position. Many of these behaviors were characteristic of P. Yerkes (1943) would probably describe her as a "courageous chimpanzee."

In the one cage conditions she offered little resistance to Mo and Mi but was very aggressive against Ca and Me. She frequently engaged W in play as a way of gaining an advantage. Against P, she used positioning, but a look from P could make her move out from under the feeder.

In the two cage conditions several stalemates occurred when she was with Ca and Mi. When paired with P, she did not persist in trying to get grapes as she had done in the one cage condition. Towards the end of the series of trials, the experimenter dropped a free grape into the cage while P had his back to her and was running to the other cage. She quickly seized the grape. P somehow realized that she had a grape and returned. Pe froze, giving no indication that she had a grape in her mouth. P placed one hand under her jaw causing her to open her mouth and took the grape out of her mouth. As soon as he had taken the

grape from her, she ran out of the cage. Just as everyone else looked over their shoulders to see where their competitors were located before putting a nickel in the apparatus, Pe also manifested this behavior. But, rather then turn her back to put a nickel in the apparatus, she would sit in front of the apparatus and reach behind her back without turning her head. If the others ran toward the feeder, she would hold the nickel in the slot rather than letting it drop. As soon as the others left the feeder again, she would let the nickel drop and run to the feeder. Several times her timing between lifting her finger off the nickel and running became confused, and she would start running before letting the nickel drop. The nickel would then fall onto the floor. One time she began running so soon that she forgot to let the nickel go and was running with it in her hand.

Carrie (Ca)

Ca's enthusiasm and persistence ranks with that of P and Pe. Like Pe, Ca was courageous, but she was more aggressive than was Pe. In contrast to Pe, she was reluctant to give up a nickel. It was not uncommon for her to have five or six nickels in her hand or mouth at the same time. In trying to acquire grapes, she took more risks than Pe but mainly with those who ranked in the bottom half of the dominance hierarchy. Her hoarding of nickels and persistence in trying to get grapes resulted in her being the target of many coalitions and much aggression. Out of the 16 overt coalitions in the one cage condition, she was the target 11 times.

However, only four of these were effective against her. Ca has a long history of being the target of P's aggressive outbursts and is quite capable of defending herself. Like Pe, she would drum on the cage door and slap her foot on the floor from time to time when high ranking females acquired a grape.

In the one condition she used both positioning and play to gain an advantage over the others. W and Mo would pull her out from under the feeder or engage her in play to eliminate her advantage. Pe and Mi also tried to pull her out from under the feeder, but, instead of resulting in play, this usually resulted in a more aggressive interaction, frequently a fight.

In the two cage conditions she consistently tried to get grapes when with P by positioning herself under the feeder. (See discussion under Pan.) With W, Mo, Mi, Pe and Me she was so often in the position of having to defend herself against their attacks that she would not see the grape roll a few feet in one direction or another, and one of the others would get the grape.

Melvin (Me)

Although Me was probably the least involved in the sense of working the apparatus and acquiring grapes, this was probably an artifact of his being the low status animal in the group. His involvement was quite apparent when viewed from the number of overt coalitions of which he was a member. Of the 16 overt coalitions in the one cage condition, he participated in 11. In the dyadic situations, aggressive dominance interactions were frequent

between he and the three low ranking females, Mi, Pe and Ca. When he would lose, which was more often than not, he would scream, cry, and display temper tantrums in which he sat on the floor, closed his eyes, displayed his teeth (closed), and slapped his head while drumming his feet on the floor. One time he was so angry and apparently frustrated that he was drooling. When not fighting, he was usually observing the others from a distance or, in the two cage conditions, sitting alone in the cage adjacent to the experimental cages. As others raced by him on their way from one cage to the other, he frequently stood up as if preparing to defend himself. In the one cage conditions he avoided interacting with the others by engaging in stereotypical behavior, i.e. spinning circles, from time to time.

Although Me was involved in most of the aggressive interactions in the study, it is possible that he was, at times, trying to stop aggression rather than encourage it. For example, when in the triad with Mo and Ca, Ca was drumming on and kicking the wire over Mo's head while she was putting nickels in the apparatus or reaching for grapes. Me softly vocalized at Ca as if wanting her to stop her anti-social behavior. Also, in the triad with Mo and Pe, whenever Pe moved in the direction of getting a nickel, he would assume a bipedal position and softly vocalize at her. This usually caused her to leave the nickel for Mo and, thus, aborted many potentially aggressive interchanges between Mo and Pe and probably himself.

Me's behavior poses a problem for him. He is a male and

behaves like a dominant male. His low status, however, is known to the other members of the group, and they always return his aggression rather than deferring to him. His behavior has, in the past, resulted in rather serious injuries to him. This will probably continue until he matures physically and socially and has someone to dominate.

In the one cage conditions Me occasionally acquired a nickel when paired with the low status females. They usually attacked him and were successful in making him surrender the nickel. During these fights, he was often slapped and lost some hair. The few times a grape rolled near him usually caused him to move to another place in the cage.

In the two cage, dyadic condition Me acquired more grapes than in any of the other conditions. Even when paired with P, he tried to acquire grapes by positioning himself under the feeder. Once P touched him on the shoulder before leaving the cage. Me whimpered and reluctantly moved to the floor. P, however, seemed unsure of Me's willingness to defer to him. One time, apparently believing that Me had stolen a grape behind his back, P walked over to Me and opened his mouth to be sure. Me tensely endured the entire ordeal. Although Me acquired grapes when paired with Mo and Pe, he did not seem to try as often when paired with W, Mi and Ca. His relationship with Mo and Pe is, however, quite different from that which he has with the other females. Prior to entering the present colony, he was reportedly dominant over Pe and, in several dominance interactions during the present study,

he was the obvious victor. Mo on the other hand, had shown an obvious preference for him rather than P as a sexual partner during the few months prior to the experiment. In the two cage, triadic condition, he became obviously irritated when Mo took the grapes for which he had done the work. He assumed a bipedal position, cried aloud, and waved his arms about in the air while staring at her. She made no apparent response to his protests. Me's behavior with Mo on this occasion was quite similar to that of Mo's with P when she was in estrus. P had taken the grapes for which Mo had worked, and she displayed a similar irritability but in a more aggressive manner.

Implications for the Study of Social Organization in Human Societies

The quite common belief that it is cruel to take away the freedom of a wild animal and keep him in a cage is based on a false premise. The animal in the wild is by no means free to follow the whims of his impulses. Territorial rights, spacing, predators, food supply, and the social structure of the group place many restrictions upon his movements and freedom (Wynne-Edwards, 1962). This is also true of human primate societies. No human is totally free, and it may be that no one would want to be (Fromm, 1941). Also, some are less free than others, particularly those who are residents of various institutions and ghettos. It is to these human situations that the results of this study seem most applicable.

Just as the animal in captivity, although not a different animal, manifests some behaviors which are quite different from that of the animal of the same species in the wild, so does the human in captivity. Unlike the literature on non-human primate behavior, however, no one seems to doubt that humans, whether free or in captivity, are all homo sapiens. It is accepted that what changes is the role and behavior of the human as he moves from one situation to another. Unfortunately, separation of the organism from his environment still too often occurs in institutional settings. Stainbrook (1965) noted that the frequent deterioration in the behavior of institutionalized schizophrenics is, in part, due to the hospitalization process. The error being made is that a person, instead of his behavior within a specific context, is diagnosed. One is faced then with the same problem as the seemingly erroneous captive versus wild dichotomy found in the literature on non-human primates. Are there two kinds, captive and wild, of chimpanzees? Are there two kinds, pathological and non-pathological, of people? The answer to both questions is an emphatic no.

The human in captivity may have his movements and freedom restricted physically, as in prisons and mental hospitals, or psychologically, as in ghetto populations. In all captive human situations freedom is also restricted by the social structure of the group. Of prime importance to those who administrate these facilities is the control of acting-out or anti-social behavior. The phrase "socially conditioned fighting" would seem quite

applicable to these situations if the context in which this behavior occurs was taken into consideration. It is quite probable that if the relationship between population density, space and overt aggression was used as the working principle in building institutions, the incidence of anti-social behavior would diminish. An increase in the amount of space confining the residents, however, is not the only answer. (To have used one spacious cage instead of two cages separated by a wire mesh would probably not have yielded the same results as those obtained in this study.)

Sommer (1969) has documented well the essential difference between quantity and quality of space. He noted that a spacious room is not desirable because it is "the usual sort of status space that impresses parents and visitors but provides limited privacy for the residents" (p. 157). In addition, Sommer observed that spacious rooms do not afford individuals "opportunities to escape when they become tense, uncomfortable, or bored" (p. 17). All who have worked in institutional settings know how frequently feelings such as these are acted out rather than sublimated.

Unlike institutional settings, there are no bars, guards or walls restricting the movement and freedom of residents in a ghetto. Thus, increasing the physical space in which these people live is not only impractical but probably irrelevant. Moving everyone to a different area, although frequently done, will probably not give the results expected. For example, many people were moved from bombed out areas to housing projects in the

suburbs of London after WWII, but they soon returned to the bombed out slums (Sanford, 1965). This was due, in part, to the loss of the kind of social organization with which they were familiar.

The above solutions have little effect upon the problems of the ghetto inhabitant because the restrictions upon his movements and freedom are, as stated above, psychological rather than physical. Discrimination, fantasied or real, in acquiring a house, job or education outside of the ghetto greatly hampers one's movements. Thus, as in institutions, the population rises from year to year. Unlike non-human primate societies which regulate their population in a given area, man either has more needs for self-preservation than group preservation or has not yet advanced to the level of the non-human primate. The effects of crowding are probably no where so dramatically illustrated as in the study by Calhoun (1962) of crowding in a population of rats. Abandonment of young, sexual perversion and cannibalsim resulted when the population became so great that the social structure of the group collapsed. Again, the relationship between population density, space and overt aggression is apparent. Although it may unfortunately be true that ghettos will always exist, eliminating discrimination in housing, jobs and education would increase the psychological space of the ghetto resident. If the results of this study are applicable to this situation, a decline in anti-social behavior and self-destructive behavior in the form of riots and burnings would result as well as the probable decrease in the ghetto population.

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The above solutions have little effect upon the problems of the ghetto inhabitant because the restrictions upon his movements and freedom are, as stated above, psychological rather than physical. Discrimination, fantasied or real, in acquiring a house, job or education outside of the ghetto greatly hampers one's movements. Thus, as in institutions, the population rises from year to year. Unlike non-human primate societies which regulate their population in a given area, man either has more needs for self-preservation than group preservation or has not yet advanced to the level of the non-human primate. The effects of crowding are probably no where so dramatically illustrated as in the study by Calhoun (1962) of crowding in a population of rats. Abandonment of young, sexual perversion and cannibalsim resulted when the population became so great that the social structure of the group collapsed. Again, the relationship between population density, space and overt aggression is apparent. Although it may unfortunately be true that ghettos will always exist, eliminating discrimination in housing, jobs and education would increase the psychological space of the ghetto resident. If the results of this study are applicable to this situation, a decline in anti-social behavior and self-destructive behavior in the form of riots and burnings would result as well as the probable decrease in the ghetto population.

The knowledge to be gained from studying dominance patterns and coalition behavior in human societies, child and adult, does not need to be emphasized. Differences in dominance, status, or prestige are present in one's relationships at home, work, school and play. Status differences are readily apparent in both individual and group psychotherapy, but these differences are infrequently referred to as differences in dominance. By understanding the differences in status between those being observed, studied or helped, a better understanding of each individual's behavior can be achieved. The results of the present study became clearer, it is hoped, when the behavior of each chimpanzee in relation to those above and below in the dominance hierarchy was described.

Studies of coalition behavior could also begin with young children. The power of a coalition is probably learned during the oedipal period when a child experiences his first coalition. Psychoanalytic theory has demonstrated how the results of this coalition can affect a person for the rest of his life. More apparent to the man who reads the daily newspaper or listens to the news on T.V. are the coalitions between various minority factions throughout the United States. Whether the theory of tertius or secundus gaudens is applicable to these coalitions will probably not be known for some time.

Suggestions for Future Research

The results of this study demonstrate the applicability

of a theory of coalitions based on human behavior in the triad to triads comprised of chimpanzees. The study, of course, needs to be replicated with another colony of chimpanzees as well as other species of non-human primates. Various combinations of animals could also be used to determine what changes are needed in the theory when four, five, six, or all animals in a colony are used instead of triads. If the same population of chimpanzees is used, scores derived from the Social Distance Scale, rather than those derived from the dominance hierarchy, may prove to be better predictors of coalitions in tetrads and larger combinations.

The manipulation of the power of a particular coalition through drugs, mild shock or other means might be fruitful. It would be particularly interesting to study the behavior of the alpha animal over time if coalitions of sub-dominant animals were given an advantage not present in dyadic situations. This would be particularly disruptive in non-human primate colonies which are characterized by a more rigid, inflexible social structure than that of chimpanzee colonies.

Much of the data in this study was qualitative rather than quantitative. Future studies could be designed wherein, for example, the differences between the behavior of males and females in coalitions were quantified. Also, frequency counts of the various behaviors within each general category in the taxonomy are needed. It would, of course, be important to note individual differences because a given behavior may be manifested by only one chimpanzee, and another chimpanzee may be the only one in the

colony not to manifest a given behavior.

It is apparent from the results of this study that considerable knowledge can be gained about the human primate from studying his nearest relative, the chimpanzee. This is particularly true for psychologists who are interested in the socialization process and the relationship between that process and individual differences in personality development. Hebb (1969) spoke of the benefits to be gained from the study of chimpanzees as follows:

> I learned more about human beings in my five years at the Yerkes Primate Lab than I learned any other five years except, I reckon, the first five years of my life. It might do some good if all psychologists worked with chimps before they were turned loose on people (p. 22).

CHAPTER VI

SUMMARY

The social structure in groups of non-human primates, particularly dominance patterns, has been studied in the field and the laboratory. Field investigators, however, have consistently observed that dominance patterns in wild groups are more complex (involve more than two animals) than is apparent in laboratory studies where usually only pairs of animals are studied. Differences in flexibility of social structure between wild and captive primate groups have also been recorded. These differences are usually viewed as resulting from the relationship between population density, space and the incidence of overt aggression. Changes in a group's social structure also occur when a female is in estrus. The purpose of the present study, thus, was to determine the social structure of a group of seven captive chimpanzees and observe the effects of increased space, increased population density, and estrus upon that structure.

To determine whether or not the social structure of captive chimpanzees is organized around a dominance hierarchy, all possible pairs of chimpanzees were placed in a food-getting situation. A dominance hierarchy, both linear and transitive, was obtained. Increasing the amount of space confining the pairs resulted

in a different hierarchy as well as one in which status differences were ambiguous. It was concluded that increased space yielded a social structure more like that of wild chimpanzee groups, a more even distribution of rewards, and less overt aggression. The dominance hierarchy was, as in other studies, also disrupted when a female was in estrus.

Complex dominance patterns were studied by placing all possible combinations of three chimpanzees in the same food-getting situation. A theory of coalitions in the triad, based on studies with humans, was used to predict the effectiveness of a coalition in each triad. Although the theory was, in general, found to be applicable, several methodological and theoretical problems were raised. For example, overt and covert coalitions had to be differentiated and analyzed separately. In contrast to studies with humans, overt coalitions were almost always between the high and low, rather than middle and low, status members; and the dominant, rather than sub-dominant, member of the coalition usually acquired the rewards.

Increased population density produced fewer changes in the dominance hierarchy than did increased space per animal. Increased space also doubled the number of effective, <u>covert</u> coalitions, but <u>overt</u> coalitions decreased significantly.

Finally, a taxonomy of the interpersonal behaviors of 13 captive chimpanzees observed over a period of 18 months was developed. The observations were made under specified conditions and prior to the manipulative stage of the study.

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APPENDICES

Appendix I

Sex and Estimated Age of Chimpanzees

Group I

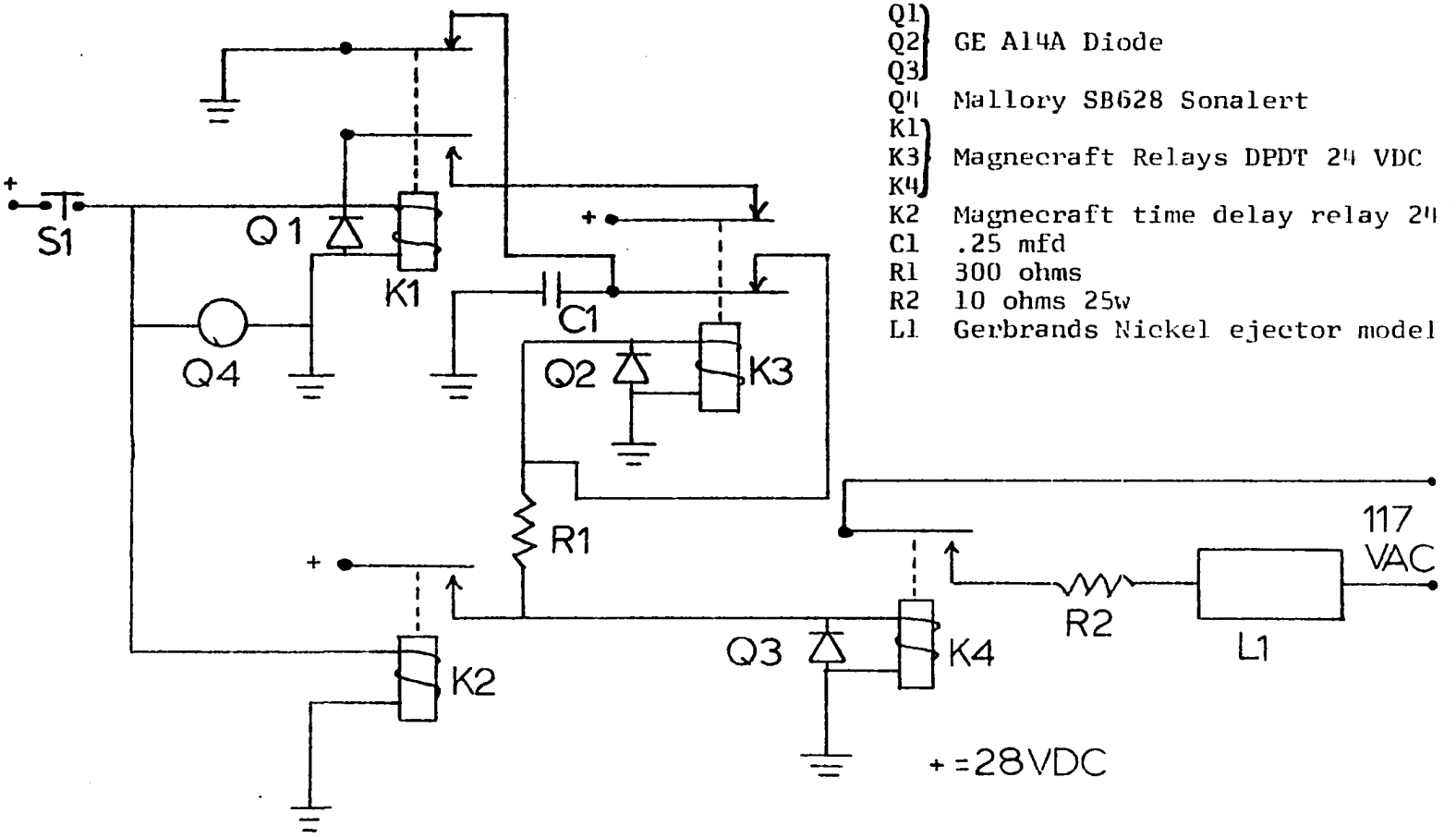
Name	Sex	Estimated Age
Mutzi (M)	M	19
Carolyn (C)	F	15
Ella (E)	F	15
Maude (Ma)	F	15

Group II

Pampy (Pa)	F	12
Susie (S)	F	11 (at time of death)
Mona (Mo)	F	9
Pandes (P)	M	8
Wendy (W)	F	8
Melvin (Me)	M	7
Peggy (Pe)	F	6
Mimi (Mi)	F	5
Carrie (Ca)	F	5

Appendix II

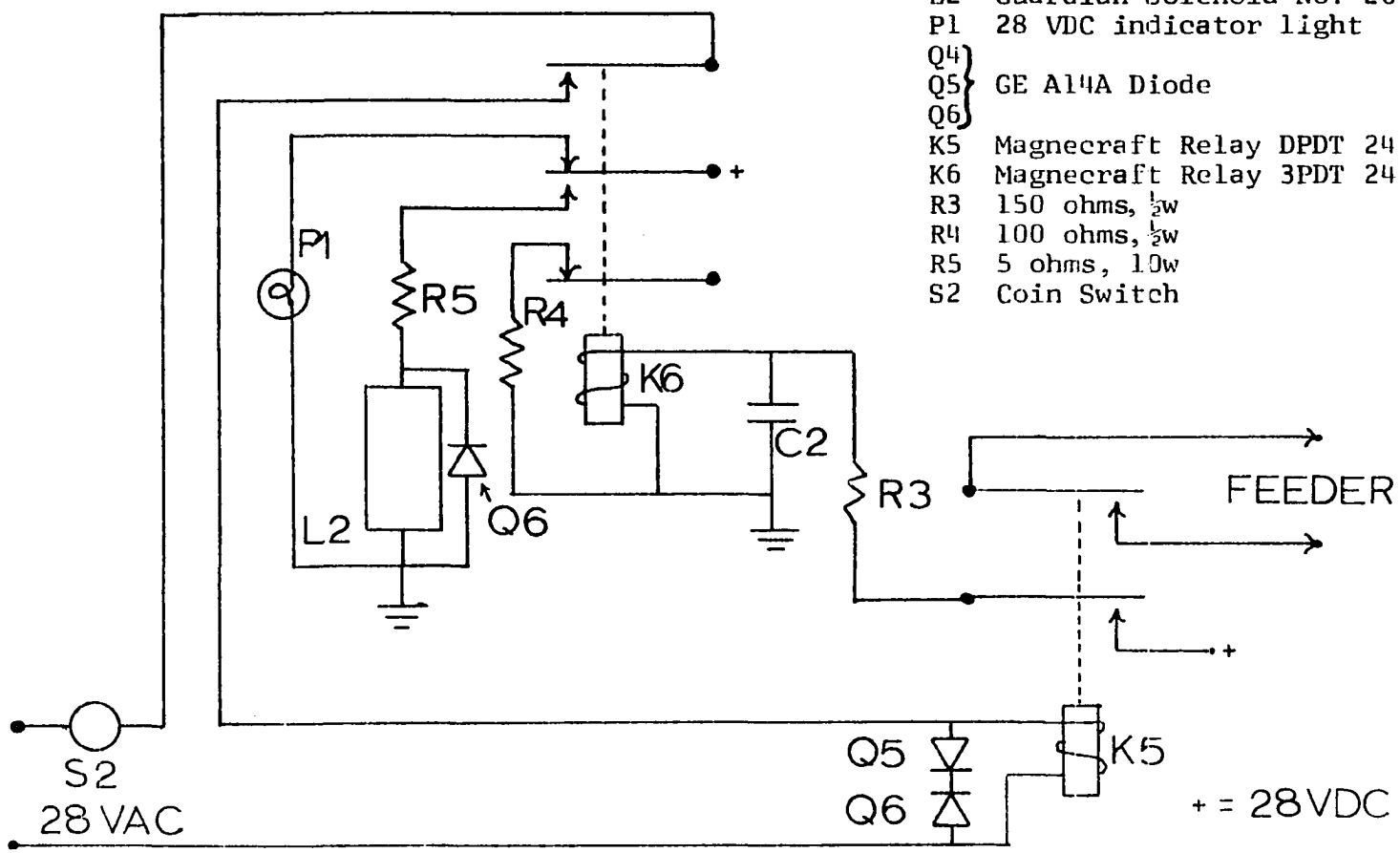
Delay - Alert - Coin Eject Circuit



S1	Non-locking push button
Q1, Q2, Q3	GE A14A Diode
Q4	Mallory SB628 Sonalert
K1, K3, K4	Magnecraft Relays DPDT 24 VDC
K2	Magnecraft time delay relay 24 VDC
C1	.25 mfd
R1	300 ohms
R2	10 ohms 25w
L1	Gerbrands Nickel ejector model B

Appendix III

Feed - Coin Release Circuit



Appendix IV

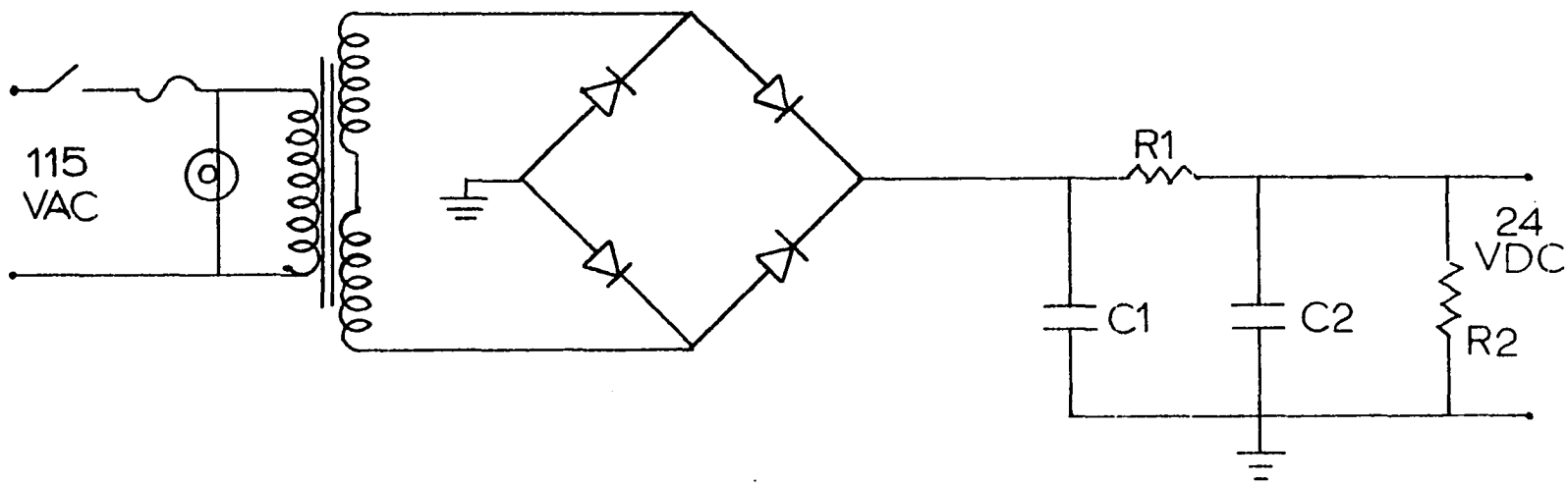
28 Volt Direct Current Power Supply

R_1 2 ohms 50 watts

R_2 50 ohms 5 watts

C_1 1500 mfd

C_2 1500 mfd



Appendix V

Distribution of Grapes in Dyadic One Cage Condition

	P	W	Mo	Mi	Pe	Ca	Me
		0	0	0	0	0	0
P		12	12	12	12	12	12
			3	2	2	1	0
W			9	10	10	11	12
				1	0	0	0
Mo				11	12	12	12
					0	3	0
Mi					12	9	12
						2	0
Pe						10	12
							0
Ca							12
Me							

Appendix VI

Distribution of Grapes in Dyadic Two Cage Condition

	P	W	Mo	Mi	Pe	Ca	Me
		0	2	4	0	0	0
P		12	10	8	12	12	12
			9	8	8	5	0
W			3	4	4	7	12
				2	0	5	2
Mo				10	12	7	10
					8	7	0
Mi					4	5	12
						12	6
Pe						0	6
							0
Ca							12
Me							

Appendix VII

Distribution of Grapes in Triadic One Cage Condition

	W/Mo	W/Mi	W/Pe	W/Ca	W/Me	Mo/Mi	Mo/Pe	Mo/Ca	Mo/Me
P	0	0	0	0	2	0	7	0	0
	12	12	12	12	10	12	5	12	12
W						12	12	12	9
Mo						0	0	0	3
Mi									
Pe									

Appendix VII (cont'd)

Distribution of Grapes in Triadic One Cage Condition

	Mi/Pe	Mi/Ca	Mi/Me	Pe/Ca	Pe/Me	Ca/Me
P	0	0	0	0	0	0
	12	12	12	12	12	12
W	2	2	1	0	1	2
	10	10	11	12	11	10
Mo	0	1	2	1	3	0
	12	11	10	11	9	12
Mi				4	0	2
				8	12	10
Pe						5
						7

Appendix VIII

Distribution of Grapes in Triadic Two Cage Condition

	W/Mo	W/Mi	W/Pe	W/Ca	W/Me	Mo/Mi	Mo/Pe	Mo/Ca	Mo/Me
P	2	2	4	0	1	0	0	0	0
	10	10	8	12	11	12	12	12	12
W						12	8	12	11
						0	4	0	1
Mo									
Mi									
Pe									

Appendix VIII (cont'd)

Distribution of Grapes in Triadic Two Cage Condition

	Mi/Pe	Mi/Ca	Mi/Me	Pe/Ca	Pe/Me	Ca/Me
P	2	0	0	0	0	0
	10	12	12	12	12	12
W	7	7	6	10	8	3
	5	5	6	2	4	9
Mo	4	0	5	1	1	0
	8	12	7	11	11	12
Mi				4	0	0
				8	12	12
Pe						8
						4

Appendix IX

Taxonomy of Interpersonal Behaviors[a]

Attack

bite

slap

pull hair

scratch

pinch

beat on back while holding another on the floor (or kick)

throw objects at (usually tires)

lift and slam on the floor

drag across floor

pinch or slap as run past

chase

lunge

kick as run past knocking other off balance

Withdraw

run away

move away (out of way)

turn back

ignore (look away or down)

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busy oneself with other activities (self-groom, play with an object)

Care Giving

groom

inspection (usually in preparation for grooming)

contact huddle (embrace)

mouthing mouth or head of another (during excitement)

all forms of protective behavior

touch (knuckles together or other part of body)

choo-choo (or mounting)

Care Receiving

groomed (passive or rigid)

choo-chooed with (mounted)

Care Receiving (cont'd)

embraced	being mouthed (when excited)
inspected (usually in preparation for grooming)	touched or held briefly

Active Sexual

ejaculation after intromission	mount with thrusting
intromission	male bipedal rocking
present in preparation for copulation	genital contact between females (mutual presenting)
genital exploration (visual, orally, digital, olfactory)	male actively places female in copulatory position
female inspects genital area after copulation (for ejaculate)	teasing (female presents but prevents male from copulating with her)

Passive Sexual

mount without thrusting	erection (no copulation)
passive present (no copulation)	male/female pair pacing
touch genital area (acknowledgement of estrus female)	look at genital area (acknowledgement of estrus female)
manipulating erect penis or clitoris (without ejaculation)	placing small objects in genital opening

Endure-Appeasement

flee	being groomed (tensely)
cringe (cower)	groom another (requested)
present	give food to another (requested)
pronate wrist	begging gesture
allow another to take food from hand or mouth	passive observation (of activity of others)
look at (head lowered)	"freeze" (response to a look)

Endure-Appeasement (cont'd)

kiss (lips or another part of the body)	touch knuckles together (or another part of body)
smile in response to a look	approach aggressor and embrace

Non-Hostile Aggression

During Play	Not During Play
play-bite	glare (or quick glance)
wrestle	stealing (objects or food)
sparring	spitting water (at or on)
tag (pull or slap and run)	throwing feces (at or on)
patty-cake (hand to hand or hand to foot)	slap (or kick) wire to another's cage
tug-of-war (usually with a tire)	drumming
chase (hide sometimes)	body jerk
butting (head in chest or stomach)	touch (causing other to move)
tickle (mouth or fingers)	rocking (bipedal or sitting)
pull (slap) another as run past	group ignores one member
clap hands (resulting in chase)	yawn (looking at another)
hold another's finger in mouth as parade around cage	begging gesture (for food) by a dominant animal
knock tire from under another as run past	slap tire on floor (looking at another)
teasing others with food or objects	bob head (once or several times, sometimes accompanied by arm raise and flick of wrist)
slap tire on floor (looking at another)	taking food from another's mouth or hand

Non-Hostile Aggression (cont'd)

suddenly assume bipedal position (sometimes with open mouth, arms over head and waved)

jumping up and down (limbs kept rigid and head down)

refusal of pronated wrist (ignore or slap hand)

sudden aggressive outburst (frustration) without contact

slap foot (or hands) on floor (with stare or head bob)

Solitary Behaviors[b]

bite (self) without tearing

stereotypical behavior (spinning circles, somersaults, etc.)

pace

self-groom

masturbation

eat

defecate

urinate

inspection of fecal material (visual, digital, oral)

drink urine

drumming or banging (to make noise)

hanging upside down from top of cage (swinging sometimes)

scratch

slap at imaginary objects (hallucinating?)

digit sucking

tongue-sucking (or toe)

sleep

play with objects

smearing of feces

buzzing lips

walk around with a tire around neck or torso

play with a tire (roll, jump off)

sudden outburst of aggressive activity (frustration?)

[a]Vocalization, excretion and pilo-erection not included although present in many of the behaviors listed.

[b]Solitary behaviors included because of the possibility of subtle, interpersonal significance.