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OF MATURE, LONG-TERM ASSOCIATE, CAPTIVE
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**THE EFFECTS OF SPACE, ESTRUS, AND COALITIONS UPON THE
DOMINANCE HIERARCHY OF MATURE, LONG-TERM
ASSOCIATE, CAPTIVE CHIMPANZEES**

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SUBMITTED TO THE GRADUATE FACULTY
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**BY
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1970

**THE EFFECTS OF SPACE, ESTRUS, AND COALITIONS UPON THE
DOMINANCE HIERARCHY OF MATURE, LONG-TERM
ASSOCIATE, CAPTIVE CHIMPANZEES**

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TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF FIGURES	vi
Chapter	
I. INTRODUCTION	1
II. PROBLEM	20
III. METHOD	24
IV. RESULTS	28
V. DISCUSSION	38
VI. SUMMARY	47
REFERENCES	49
APPENDICES	54

LIST OF TABLES

Table	Page
1. Different Theoretical Predictions of Coalitions in the Triad	16
2. Chi-square Values for the Dyadic One Cage Condition	29
3. Chi-square Values for the Dyadic Two Cage Condition	30
4. Chi-square Values for the Triadic One Cage Condition	32
5. Chi-square Values and the Resulting Dominance Hierarchies in the Dyadic and Triadic One Cage Conditions	34
6. Chi-square Values and the Resulting Dominance Hierarchies for the Triadic One and Two Cage Conditions	36

LIST OF FIGURES

Figure	Page
1. Changes in the dominance hierarchy as a function of space and the number of animals	40

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**CHAPTER I
INTRODUCTION**

Organization and order are properties which characterize the physical universe itself and the diverse forms of living matter found within the universe. Indeed, it would not be remiss to conclude that wherever there is life there is organization and order. A high degree of organization exists in the social behavior of most animals. This is reflected in the division of labor and system of communication of the bee (Chauvin, 1968), the pack hunting behavior of predators such as the wolf (Erskine, 1964) and in the various types of dominance hierarchies (Maslow, 1936; Wilson & Wilson, 1968; Yerkes, 1943) of the more phylogenetically advanced primate societies. Even though these three species are separated by millions of years with respect to historical origin (Chauvin, 1968) and are basically very dissimilar, social organization serves the same adaptive function for all three animals of insuring species survival. In referring to the similarities in social organization between species Chauvin indicated that even with the insects there is "carrying out of works in common, the methodical care of the young by the community, and the division of labour among specialized groups"(p. 2) and that such organization differs from that of man only in that the "methods" of obtaining these ends are different.

The understanding of human behavior has been enriched by studies on lower order animals. The ethologists (Lorenz, 1937; Tinbergin, 1966) and other animal researchers (Harlow, 1961, 1962, 1965; Scott, 1958, 1969) have made significant contributions towards a better understanding of the effects of early postnatal experiences upon the developing

organism. Particularly fruitful in this regard has been the work of Lorenz (1937) and Hess (1959) on “imprinting”, the work of Scott (1958, 1969) and his associates Pfaffenberger and Scott (1959) on “critical periods”.

In precocial birds it has been demonstrated that there is a period early in the life of the young animal when it is maximally sensitive to stimulation and this period has been referred to as the “critical period”. The critical period hypothesis relates to the age at which stimulation is administered and the effects of such stimulation upon the behavior of the animal or bird. In summarizing the work that has been done regarding the critical period hypothesis, Scott(1969) notes that:

... evidence from behavioral and embryological research leads us to a general theory of critical periods, which is essentially a theory of organizational processes. We can state the theory this way; the time when an organizational process is proceeding most rapidly is a critical period for the resulting organization. If an organizational process proceeds at a uniform rate, there is no critical period. If the process proceeds rapidly at intermittent intervals, there may be several different critical periods. There may be a different critical period for each organizational process, and that the critical period theory should apply to processes at any level of organization (Scott, 1969, p. 66).

The hypothesis concerning the existence of critical periods has clearly been validated. Studies with guide dogs (Pfaffenberger & Scott, 1959) have shown that trainability of the guide dog is a function of the age at which such stimulation is administered. Similarly, studies with the mouse (Williams & Scott, 1953) have demonstrated that stimulation of the mouse at different ages will affect the subsequent development of behavior patterns differently.

A phenomenon associated with critical periods in animals is “imprinting”. Lorenz (1937), in his work with precocial birds coined the word “imprinting” to describe the process by or through which the bird acquires the “right” biological object with which to react socially. The importance of the concept stems from the fact that, once established, imprinting drastically affects the subsequent development of social behavior in young birds. For example, precocial birds presented with a moving object during the first few hours of life will follow this object. This following persists as the bird matures and the bird will behave towards the object as if it were a member of its own species. Lorenz called this a

special type of rapid learning in that (1) it occurs only during a very limited and definite period in the life of a young bird, (2) it is irreversible once it has occurred, (3) it profoundly affects subsequent adult behavior and, (4) it can be generalized from the specific stimulus object to others of the same class.

Hinde, Thorpe, W. Vince and M. Vince (1956) have criticized the generality of Lorenz's conception of the imprinting process. They investigated the following response of young coots and found that Lorenz's concept of a sensitive period and irreversibility were not valid in this species. Moltz (1960) was also critical of Lorenz's views with respect to the critical period in the establishment of the following response and also as to the irreversibility of the response once established. With modifications however, the concept of imprinting is still a viable hypothesis. A more recent conception of imprinting holds that it is a special form of learning which occurs in one trial, which generalizes from a specific object to objects of the same class, and which, within limits is reversible. The most salient feature of the imprinting process however, is that it clearly affects the social and sexual aspects of an animal's behavior once established and, hence, is of considerable theoretical interest.

The utility of the critical period hypothesis and the concept of imprinting has been borne out by research findings with a variety of experimental animals. However, as one moves nearer the upper end of the phylogenetic scale, evidence supporting these two concepts becomes more difficult to obtain. Part of this difficulty can be attributed to the increased flexibility and the generally slower rates of development of the more advanced species. Thus, critical periods and imprinting in mammals, if they exist at all are probably measured in terms of weeks and or months as opposed to minutes and hours in many of the precocial animals.

Most research with imprinting and critical periods has involved precocial birds and animals such as sheep and dogs which are not as phylogenetically advanced as man. Recently however, these two concepts have been utilized to account for the genesis of normal and abnormal behavior in humans. For example Bettelheim (1966) has used the concepts of critical periods and imprinting in describing the development of autistic behavior in very young children. Similarly, Bowlby (1960) has likened the imprinting process in precocial animals to the formation of "object relations" in human infants.

Money, Hampson and Hampson (1957) utilized the concepts of imprinting and

critical periods to account for the development of a sexual "gender role" which may or may not be consistent with an individual's anatomical and chromosomal sex. Stoller (1968) has contended that human sexual responsiveness to other humans may be the result of "states of readiness" resulting from being imprinted to mothers instead of some other object or animal. Going even one step further, Stoller has theorized that something very much like imprinting occurs in the development of "transsexualism"--a type of sexual aberration in which an individual believes he or she in fact belongs to the opposite sex.

In view of the work of Bettelheim (1966), Money, Hampson and Hampson (1957) and Stoller (1969), it is clear that the concepts growing out of sub-human animal research have contributed to a better understanding of the behavior of man. It is equally clear however, that with the current state of knowledge there are many gaps in the understanding of sub-human animal behavior. The social organization and behavior of animals in groups is an area increasingly receiving the attention of investigators. Of special interest are the ways in which the behavior of animals is affected by a variety of environmental conditions such as population density (Calhoun, 1962) and physical space (Sommer, 1969). The present study was designed to add to the knowledge of social behavior in animals. Specifically, the present study was designed to explore the effects of three variables (physical space, estrus, and coalitions) upon the social structure of a group of four captive chimpanzees.

Historical Review

In recent years increasing attention has been directed to the study of humans in group interaction. One indicator of this trend has been the rapid growth and development of a variety of types of group therapy (Berne, 1966). The investigations of social organization in prisons (Cantine & Raines, 1950) and in mental hospitals (Esser, Chapple, Chamberlain and Kline, 1965) also reflects the interest in group processes. In addition, the concern with understanding "group processes" can in part be attributed to the realization that man is a creature who clearly is an entity with an "identity" (Erikson, 1963) uniquely his own. He is at one and the same time a member of a group of other humans and is subject to the many influences deriving from group membership. It appears however, that the greater part of the growing interest in the study of groups is a direct consequence of major sociological changes occurring within the last century.

The early part of the 19th century witnessed the beginnings of what came to be

known as the “industrial revolution”. By the end of the 19th century the effects of the “industrial revolution” had spread throughout modern western civilization. The most obvious effects of industrialization were striking improvements in technology and a concomitant increase in the standard of living. Perhaps less obvious but equally important were the social changes brought about by industrialization. Prior to the “industrial revolution” the economies of most societies were agrarian based, a factor which necessarily affected both spatial distribution and social organization. Characteristically, population density was low and kinship and family ties formed the basis for the organization of communities.

Industrialization resulted in the concentration of large masses of people within relatively small geographical areas and changed the character of group membership. In rural communities relationships between individuals were “primary” and “personal” whereas relationships in densely populated urban centers were “secondary” and “impersonal” (Cooley, 1956). The technological improvements and higher living standards resulting from industrialism increased man’s life expectancy appreciably. This coupled with the normal rate of population growth, resulted in a sharp increase in world population.

The numerous social changes associated with the “industrial revolution” dramatize the fact that man is no longer few in number or geographically isolated from others. Prior to industrialization man’s affiliations were limited primarily to kinship groups many times numbering less than 50 and he inhabited almost literally limitless geographical space. Modern man, by contrast, is a member of a large number of groups including nuclear family groups, professional groups, and national or ethnic groups. The size of modern man’s groups range from as small as two or three in the nuclear family to as many as hundreds of millions in the more populous nations of the world. Taken in combination, these changes have in effect made the planet earth a smaller place on which to live.

Technological improvements and the social changes referred to in the preceding pages have created circumstances in which it has become impossible to ignore the many differences of opinion shared by both individuals and groups. Territorial disputes are commonplace between countries, between states and municipalities within countries, and even between groups such as gangs within neighborhoods (Thrasher, 1926). While it is clear that organization exists at every strata of human society, it is equally clear that the attitudes

and values of one group of people are not necessarily shared by another group even though both of these groups may exist side by side within the same geographical territory. In fact, a cursory sampling of opinion in a given locale might lead one to prematurely conclude that there is no such thing as “social organization” at present in human societies.

Social Organization

In his essay of “Social Organization and Disorganization” Arnold Rose (1954) outlines a theory of organization and disorganization in human societies. This theory consists of a series of assumptions and propositions which are as follows.

Assumption 1. Human behavior is in part characterized by a social factor. This social factor in human behavior can quite simply be defined as behavior in which one individual takes into account the perceived expectations of other individuals and which in itself implies expectations for certain kinds of behavior on the part of others. Assumption 2. The social group exists, not as a physical entity, a “group mind”, nor as a mere collection of individuals, but as a number of persons who have a set of perceived (not necessarily “conscious”) expectations in relation to one another. The expectations are either that others will behave in certain ways under certain conditions or that others expect one to act in a certain way under certain conditions. Assumption 3. The expectations of a number of individuals in interaction specify or refer to a number of (1) meanings and (2) folkways, or values, which together make up the culture or subculture of the group.

General Proposition 1. A person is able to predict the behavior of other persons most of the time and thereby adjust his behavior to theirs (both in cooperation and conflict), because he has internalized approximately the same meanings and values as the others have. General Proposition 2. There are circumstances under which a number of biological individuals may be in physical contact with one another over a period of time and yet do not form a group, because they can make no accurate prediction with respect to one another’s behavior (that is, they have no expectations that receive reinforcement because of behavior in conformity with expectations). This situation arises when the individuals do not have a sufficient number of common meanings and values (either through a failure in the learning process or through a loss of meanings and values once learned) pp. 6-9.

As long as individuals in contact with one another are reliably able to predict the behavior of others and adjust their own behavior, a viable social structure exists. Conversely,

“social disorganization” (Thomas & Znaniecki, 1918) occurs whenever individuals are in close contact with one another but are not able to communicate with or reliably predict the behavior of others. Durkheim (1951) referred to this loss of social structure and the concomitant personal disorganization as “anomie”.

Sub-human species of birds and animals in many ways lack the complexity of behavior characteristic of man. The ability to symbolize and the transmission of a cultural heritage are characteristics which distinguish man from the lower order animals. In spite of these and other obvious differences, there are similarities in behavior processes between man and the lower order animals. For example, social organization exists in the bee (Krogh, 1966), the rat (Calhoun, 1962), birds (Armstrong, 1942), and ants (Chauvin, 1968); all of which are species that are phylogenetically remote from man. However “remote” these species may be in terms of historical origin, it is frequently through studying such species that the adaptive significance of the group as a social unit becomes most apparent. For example, the rigid division of labor and system of communication found in bee societies are both necessary to insure survival of the species.

The mutual interdependence between animals in most of the insect societies is developed to a degree not seen in the more advanced phyla. Indeed, as Chauvin (1968) has indicated, the group rather than the individual insect is the proper “unit of analysis” and the concept of a bee or an ant as an individual apart from others is nothing more than an “abstraction”. Chauvin’s point here is that there is an “utter and absolute” dependence of the individual insect upon the rest of the group. According to Chauvin, separation of an insect such as the ant or bee from its group would inevitably result in death within a matter of hours.

As one moves up the phylogenetic scale of development the absolute dependence of the individual upon the group is tempered somewhat and becomes something less than a life and death issue. In addition, group membership takes on added dimensions in the more advanced phyla. Unlike the bee or the ant, most members of the more advanced phyla could survive for extended periods of time apart from the group. In spite of this however, group living is common in practically all species of animals. Chauvin (1968) suggests that a relationship exists between neurological development and the concomitant development of what he calls “psychicism” culminating in states of consciousness of man.

There are clearly intermediate stages between the “mechanistic” like behavior of individuals in insect societies who collectively function as one unit and the “psychically” determined behavior of the human being (Chauvin, 1968). For example, wolves typically roam in packs of seven to ten animals and function together as a unit in ways analogous to those of the insects. That is, food gathering is a cooperative activity just as it is for the bee. The wolves search for prey in packs and when they come upon an animal such as a deer they locate themselves in strategic positions so that once the chase begins the deer or prey is forced to run in a circle until it tires and one of the wolves can catch it (Erskine, 1964). The lion and other members of the cat family exhibit a similar mutual dependence and cooperativeness in their search for prey.

In spite of increased nervous system development and the trend towards “psychicism” in the more advanced species, the process of social organization is still very much a prerequisite for group living. It might be added that, in man, group membership seems to have more relevance in terms of “psychological factors” than to the issue of physical survival as it is in the lower order insect societies. Feelings of acceptance and approval contribute significantly to man’s view of himself, particularly his feelings of adequacy or inadequacy in meeting and coping successfully with the “problems in living” (Szasz, 1961). Angyal (1965) uses the terms “autonomy” and “homonomy” to conceptualize man’s strivings to master and re-relate himself to those comprising his human environment. Feelings of success or lack of success in such strivings in large measure determine man’s sense of worth and usefulness and emotional or psychological well-being. Thus, man is decidedly a “social animal”. He is simultaneously a creature with an “identity” (Erikson, 1963) independent of and different than others and one whose survival is dependent upon the assignment and his acceptance of a role or a series of roles arising out of his interaction with others of his kind.

Studies on Social Organization

Some species of animals are not “social” in that they habitually spend a good deal of time in isolation. The lemming (Chauvin, 1968) is an example of a solitary creature and one seldom observed with other lemming except when mating. Nevertheless, most species of animals are “social” and living together in close physical proximity is characteristic of most species. Animal societies are most often organized around some type

of dominance hierarchy or pecking order. Wynne-Edwards (1962) investigated population density in animal groups and indicated that dominance hierarchies function “always to identify the surplus of animals whenever the population density requires to be thinned out, and it has thus an extremely high survival value for the society as a whole” (p. 139).

A Norwegian, Schjelderup-Ebbe (1935) was one of the first to describe the “pecking order” in chickens and he indicated that there is an omega animal that is acted upon by all other animals, an alpha animal who acts upon all other animals and who is acted upon by none of the others, and intermediate stages between the alpha and omega animals. For example, in a flock of chickens the numbers of pecks administered is literally an index of an animal's social standing.

The social organization of mice very closely parallels that seen in chickens (Chauvin, 1968). That is, there is a rigid dominance hierarchy among animals occupying the same territory and this hierarchy is typically ruled by a large male. Displays of aggression are frequent occurrences in mice and typically involve a male in some type of encounter with a subordinate or less dominant animal. Males are more prone to attack other animals than females and females give up more quickly in their persecution of other subordinate animals. In the mouse there is a curious type of behavior indulged in by subordinate animals. Whenever attacked by more dominant animals, the subordinate animal turns to face the attacker, stands on its rear feet, and exposes its vulnerable abdomen to the attacker. The dominant animal ceases its attack immediately when the subordinate assumes this posture and overt aggression is thus inhibited. Lorenz (1966) observed similar behavior in the wolf and reported that the subordinate wolf assumes a posture which exposes its throat to the dominant animal. Lorenz indicated that such posturing invariably inhibits the aggression of the dominant animal and he named this behavior the “submission ritual”. It appears that in the mouse, wolf, and very likely many other species as well there is a “built in” means for inhibiting aggression and facilitating the process of organization.

Field investigators (Altmann, 1962; Chance, 1963; De Vore, 1965; Goodall, 1965; Jay, 1965) have reported many differences in the social structure of primate societies. The male dominance hierarchy seems to form the basis for the social organization of the Macaque, howler monkey, langur, and gorilla groups (Altmann, 1959, Carpenter, 1934; De Vore, 1962; Schaller, 1963). Carpenter (1940) noted there were no apparent sex differences

in dominance in gibbons. Goodall (1965) indicated there is neither a male nor a female dominance hierarchy in free ranging chimpanzees but said that males are dominant over females and mature females dominant over immature females. Field studies of free ranging chimpanzees such as that of Goodall (1965) have suggested that the social structure is "loose" and that aggressive and submissive interactions occur relatively infrequently. Goodall did indicate however, that the concept of "dominance" was useful in describing certain types of interaction between chimpanzees. She cited instances in which one animal would defer to another when two of them would meet on the same branch in a tree and that the "subordinate" might detour or avoid the dominant animal or "either present or reach out to touch the dominant animal on the lips, thigh, or genital area" (p. 453).

Reynolds and Reynolds (1965) reached conclusions similar to Goodall's with regard to the social structure of free ranging chimpanzees. In addition, these investigators found no evidence to suggest either a linear dominance hierarchy or dominance among males or females. Wilson and Wilson (1968) however, in describing social organization in a group of semi-free ranging chimpanzees, noted that certain animals seemed to have higher status than others and that displays of aggression were "more frequent" than in free ranging chimpanzee groups described by Goodall (1965) and Reynolds and Reynolds (1965). Wilson and Wilson (1968) cited instances in the semi-free ranging group where females repeatedly attacked males, a phenomenon seen very rarely in the free ranging groups. Also, these investigators reported there was a very dominant male who was never observed to copulate with females but who, nevertheless, was the leader of the group.

Wilson and Wilson (1968) also indicated that dominance or high status in the semi-free ranging chimpanzee group was associated with size of the animal. For example, both very large and very small animals were high in status. In addition, sex was also found to be an important factor in the determination of status. In general, males had higher status than females and females in estrus with maximum perineal swelling were higher in status than females in anestrus. In food-getting situations the high status animals obtained food before other animals and were able to take food from low status animals with little if any observable effort. Among middle sized animals status level was described as being "more ambiguous" and there was a greater incidence of competition to achieve higher status among these animals. Yerkes (1943) in summarizing his studies of chimpanzee groups, contended

that the dominance hierarchy was very much a part of captive chimpanzee groups and emphasized that status seeking was one of the basic principles out of which the social structure emerges.

Yerkes (1943) explored dominance and its relationship to sex by pairing chimpanzees in a food-getting situation over extended periods of time. Stable dominance hierarchies were found to exist and these hierarchies were observed to change in conjunction with changes in the estrus cycle of the females. Females in estrus with maximum perineal swelling, a condition denoting sexual receptivity, were found to gain status during the period of sexual receptivity. Yerkes indicated that when paired with males, the sexually receptive female was deferred to by the male in the food-getting situation and "comes to claim as if it were her right what previously she had allowed the male to take, while he as if in recognition of or in exchange for sexual accomodation during the mating period defers to her and unprotestingly permits her to control the food-getting situation" (p. 74). Yerkes, in referring to the temporary shift in dominance associated with sexual receptivity in the female, concluded that "the competitive food-getting test reveals that control passes from male to female at the beginning of sexual receptivity, and from female to male when receptivity ends . . . and this principle gains expression only if the mates are physically normal, mature, experienced, congenial, and at least moderately self- assertive and self-confident" (p. 75).

Maslow (1936) paired five rhesus monkeys in a food-getting situation and through this process a linear dominance hierarchy was established. He then placed larger groups of animals together in the same food-getting situation and indicated that the dominance hierarchy which emerged in the larger group situation was "distinctly different" from that obtained in the dyadic pairings. In addition, one previously dominant animal when placed in one of the larger groups with previously subordinate animals was attacked by the other animals and had to be removed from the experimental situation in order to prevent him from being killed by the previously subordinate animals. The results of this study suggest that the linear dominance hierarchy undergoes fundamental change with increased numbers of animals and that coalitions form between subordinate animals which enable these animals to overthrow the more dominant animal.

The Japanese investigators Kawai (1965a, 1965b) and Kawamura (1958) in their studies of Japanese macaques (Macaca fuscata) added still another dimension to the concept of dominance behavior. They distinguish between “basic rank” and “dependent rank” in the macaque groups. Basic rank in the social structure of these animals was arrived at by determining which of two monkeys spatially separated from the rest of the group obtained a piece of food dropped between them, i.e. the animal having higher “basic rank” obtains the reward and is dominant over the other animal. The term dependent rank is reserved to describe an “intimate” relationship between two animals, i.e. a relationship based upon either “common interests” or, “kinship”. Kawai (1965a) noted that relationships based upon dependent rank could take precedence over basic rank in that an animal with lower basic rank could become dominant over an animal with greater basic rank merely through the presence of a third animal.

While there are many similarities in the behavior and organization of the different primate groups, it is clear that there is no one single principle or axiom regulating the social life of these animals. Although dominance behavior forms the basis for social organization of primate groups, it is apparent that the concept of dominance itself is not a fixed unvarying entity but, rather, is situational and is seemingly confounded by a variety of factors including population density, physical space, and estrus (Goodall, 1965; Maslow, 1936; Wilson & Wilson, 1968).

Coalitions

Though they are by no means new in terms of historical origin, aggregates or coalitions of individuals are increasingly pooling their resources to fight for common causes. Contemporary politics at both state and national level in the United States reflects the effects of efforts by groups or coalitions of individuals uniting together to promote common causes (Wilson, 1968). Some of the most outstanding examples of such contemporary groups are the N.A.A.C.P., SDS, C.O.R.E., and even factions or splinter groups within the major political parties such as the American party founded during the presidential campaign of 1968. The effectiveness of groups such as these cited above cannot be overemphasized and such groups clearly contribute to the shaping of both national and foreign policy.

In human societies coalitions emerge whenever individuals with minority status (whether this status is by reason of racial origin, low social status, or, simply the result of

political views which are markedly different than those possessed by the majority) recognize the futility of attempting to bring about a desired change through individual effort. Success in bringing about the desired change requires large numbers of people banding together and organizing their efforts to achieve the desired goal. It might be added, that coalitions sometimes involve "strange bedfellows". For example, it is not uncommon to observe civil rights groups such as the N.A.A.C.P. and labor unions such as the AFL-CIO working for the election or defeat of a particular political candidate because of that candidate's anti-civil rights or anti-labor views. In different circumstances, these two groups might take entirely different and opposing stands on a particular issue.

The aftermath of the riots occurring in the large urban centers such as Los Angeles, Detroit, Chicago, and New Jersey (Wilson, 1968) has demonstrated the effectiveness of coalitions organized to promote economic gain. In the ghettos of each of these large cities Negroes united to overthrow the white businessman who, prior to the overthrow, controlled virtually all of the businesses in the ghetto areas. Wilson also reported that prison officials are especially sensitive to the process of coalition formation and the power of such coalitions once they are formed. Consequently, these officials exert a concerted effort to control the effectiveness of coalitions among prisoners through such means as frequent rotation of prisoners on work details and segregation or isolation of would be coalition leaders. However, not all coalitions in prison settings are regarded as undesirable by prison officials. This is particularly true of those coalitions which do not challenge the controls and disrupt the organization of the prison. Sommer (1969) has observed that:

... guards delegate to the inmate leaders the authority over certain areas of inmate life in return for the convicts maintaining order within their own groups. A convict who steps out of bounds will usually be kept in check by other convicts long before he becomes a serious problem to the guards (p. 17).

Coalition Theory

A number of investigators (Caplow, 1956, 1959; Gamson, 1961; von Neumann & Morgenstern, 1953, Simmel, 1950) have attempted to provide a theoretical framework for and specify the conditions under which coalitions form. von Neumann and Morgenstern's (1953) "rational" game theory represented one of the earliest efforts at predicting coalitions however, this "rational" approach has not been supported experimentally (Vinacke &

Arkoff, 1957) and seems to be in the process of being discarded in favor of theories emphasizing “power” (Caplow, 1959).

Simmel's (1950, 1955) description of dyadic and triadic systems of interaction in humans contributed significantly to the understanding of coalitions. He described two person interaction systems and used the institution of monogamous marriage with its conflicts and attempts at resolution of conflict to highlight some of the characteristics of two person interaction. He pointed out that “intimacy” and a “passionate craving for fusion” characterizes monogamous marriages. In the three person interaction systems Simmel (1955) indicated that the presence of a third member disrupts the “intimacy” of the dyad and, regardless of how close a triad may be, “there is always the occasion in which two of the three members regard the third as an intruder” (p. 135).

Simmel (1955) advanced the theory of tertius gaudens in which he outlined the conditions under which a third person gains or profits from the conflict of the two other members of the triad. According to Simmel, there are two forms of the tertius gaudens and the essential characteristic of each is passivity. In one instance the tertius may gain advantage because the remaining pair holds each other in check and the third member is thus able to gain from the inhibiting influence the pair exerts on one another. The other condition is one in which the tertius improves his lot by aligning himself with one of the stronger individuals.

Caplow (1959) extended Simmel's concept of tertius gaudens and directed attention to the triadic situation composed of individuals with unequal power. He emphasized that the formation of coalitions under such conditions is dependent upon the initial distribution of power and that such coalitions can be predicted “when the initial distribution of power is known” (p. 488). One assumption underlying the triadic situation is that the weaker individuals “will unite against the stronger individual so that he, too, must become a part of a coalition to insure winning” (Hodan, 1970, p. 15).

In another triadic situation, one involving one weak and two equally strong members, Caplow (1959) reasoned that the weakest individual would stand to gain the most from a coalition because of his inability to obtain any of the rewards through individual effort. Also, in triadic situations involving one individual with more power than the other two members combined, Caplow hypothesized that coalitions would not be effective. Using

these assumptions and Simmel's (1955) theory of tertius gaudens, Caplow (1959) outlined eight triadic situations in which two person coalitions were predicted based upon the initial differences in strength of the individual members. Caplow's predictions of coalition formation in the eight triadic situations and the predictions of Vinacke and Arkoff (1957) and those of Gamson (1961) are presented in Table 1.

An experimental situation was devised by Vinacke and Arkoff (1957) to test the "rational game theory" of von Neumann and Morgenstern (1953) against the theory of tertius gaudens proposed by Simmel (1955) and refined by Caplow (1959). They found "rational game theory" to be a poor predictor of coalitions in the triadic situation and the results of their experiments in general supported Caplow's predictions regarding coalition formation.

Research with humans in triadic situations has tended to support Caplow's hypotheses regarding coalition formation (Bond & Vinacke, 1961; Kelley & Arrowhead, 1960; Stryker & Psathas, 1960). In addition, Vinacke (1964) noted significant differences between males and females in coalitions. He indicated that males utilize "exploitative strategies" and their behavior is "characterized by an orientation toward winning on the most favourable possible terms, by intensive competition, and in an apparently rather ruthless attitude toward one's opponents" (p. 26). In contrast, the behavior of females involved "accomodative strategy" in that they "seem to be oriented towards the social-interaction aspects of the game, to be less competitive, and to seek ways to equalize conditions as if they were trying to be fair to all participants" (p.26). Turk and Turk (1962), in their investigations of the triad, found a situation wherein one member of the triad clearly had more power than the other two members combined. In these circumstances, the triad changed and became a dyad with an isolate. Gamson (1961), an exponent of "game" theory, revised the theory of coalitions and proposed that individuals involved in coalitions expect other participants in a coalition to demand a share of the "payoff which is proportional to the amount of resources which they are contributing to it" (p. 382).

Willis (1962) extended Caplow's theory of coalitions in the triadic situation and applied it to the tetradic situation. He explored the possibility of both two and three individual coalitions in the tetradic situation. He used a "parlor game" similar to that used

Table 1
Different Theoretical Predictions of

Type	Distribution of Resources	Coalitions in the Triad		
		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		

by Vinacke and Arkoff (1957) and found general support for three person coalitions but very little support for the extended theory on two person coalitions.

Studies of Spatial Behavior

Sommer (1969) has indicated that territoriality and dominance behavior are two concepts which have emerged from animal studies involving shared space. According to Sommer, both of these processes inhibit aggression. Territoriality inhibits aggression because one animal refrains from going into an area in which he is apt to come into contact with another animal. Dominance behavior mitigates against the expression of aggression in animals in that animals go through dominance "rituals" in which one animal defers to or threatens another animal thereby avoiding the direct expression of aggression.

Territoriality and dominance behavior seem closely related. For example, Scott (1958) observed that deer habitually graze on natural food scattered about over large areas and that fighting does not occur under such conditions. However, if the food of the deer is located within a small area, a dominance hierarchy is soon established in which the strongest animals have first access to the food. Scott's observations concerning dominance behavior in the deer closely parallels descriptions of the effects of space upon the social structure of chimpanzees. Goodall (1965), in describing the social organization of free ranging chimpanzees, concluded that the social structure of the chimpanzee was "loose" and that there is not a clear linear dominance hierarchy. There were infrequent aggressive and submissive gestures between animals and Goodall did not feel there were any indications of a "rigid" linear dominance hierarchy. Wilson and Wilson (1968) however, described a captive group of semi-free ranging chimpanzees and reported that aggression was much more prevalent in the social life of the chimpanzee than was reported in Goodall's study of free ranging chimpanzees and, presumably, there was more of a "rigid" dominance hierarchy. Thus, under spatially confining conditions there appears to be a tightening of the social structure in chimpanzee groups. Other investigators (Hall, 1963; Jay, 1965) have also noted increased aggression in overcrowded primate groups and this aggression has been referred to as "socially conditioned fighting" by Zuckerman (1932) who indicated that this phenomenon has been observed in numerous warm as well as cold blooded animals.

investigated dominance behavior in mental patients and concluded that there was a stable dominance hierarchy in mental patients and that changes in the hierarchy occur either with the addition of new patients or even changes in medication or clinical symptoms in a given patient. Altman and Haythorn (1967) studied pairs of sailors in confinement and reported that, after a period of time, each sailor gradually withdrew from the partner and "cocooned" himself in his own "personal space" and each sailor in turn respected the "personal space" of his partner. These investigators indicated that "mismatched" or equally dominant (either high or low in dominance) sailors had difficulty in accomodating one another and in such instances the pairs tended to make greater use of territoriality, i.e. consistent use of same beds, chairs and eating areas. Thus, as Sommer (1969) indicates, there is evidence to suggest that, as has been observed in animal studies, territoriality and dominance behavior both appear to facilitate social organization and failure of one system results in the ascendance of the other system and overt aggression is thus inhibited.

The studies on spatial behavior cited in the preceeding pages documents the effects of physical space upon the social structure in a variety of species. The far reaching effects of physical space upon social organization and the importance of these effects is perhaps best illustrated by the results of a series of experiments by Calhoun (1962). Calhoun investigated the effects of population density on the social behavior of Norway rats. He confined a group of Norway rats in a quarter-acre enclosure that contained an abundance of food, which was devoid of predators, and one in which disease was minimized. At the end of 27 months the size of the group had stabilized at 150 adults. Adult mortality was low and Calhoun reported that he had expected to obtain 5000 adults from this artificially healthful environment, particularly when the prolific reproductive rate was taken into account. There was not however, a mushrooming increase in the rat population as had been expected. Instead, it was observed that infant mortality was extremely high in the enclosure. Calhoun concluded that stress from social interaction between the rats led to a disruption of maternal behavior to such an extent that few of the young survived.

After Calhoun's initial experiment involving population density and social behavior, he attempted to refine his experimental procedures somewhat and initiated another series of experiments designed to explore further the effects of population density on social behavior. For the latter experiments he selected a domesticated albino strain of the

Norway and housed these animals indoors. Six different populations of rats were used in this study and each population was allowed to increase in size until it was twice the size which Calhoun felt could occupy the available space with only moderate stress from social interaction. These six populations were observed for a total of 16 months and detailed records were kept of the behavior modifications resulting from the crowded conditions.

There were a variety of alterations in the behavior of the experimental animals. The most conspicuous changes however, occurred in the behavior of the adult females. Many of these animals were unable to carry their unborn offspring to full term and many who carried to term did not survive parturition itself. A large percentage of those females who delivered at full term did not exhibit the normal repertoire of maternal behavior. The behavior of the males housed under these crowded conditions was characterized by sexual deviations consisting of indiscriminate sexual advances to males, juveniles, and females not in estrus. In addition, the males engaged in cannibalism and behavior episodes of "frenzied over activity" and "pathological withdrawal". In the withdrawn phases of these episodes the males would only eat and move about when other members were asleep. It seems clear that physical space is a variable of major importance in the social organization of animal groups and that overcrowding has many deleterious consequences for both the individual animals and the group as a whole. In fact, as Calhoun noted, extinction of the species would be inevitable under conditions of overcrowding such as those described in his experiments.

CHAPTER II

STATEMENT OF PROBLEM

A review of the literature of human and subhuman animals reveals that physical space (Sommer, 1969) is a variable of major importance in social organization. There are discrepant reports regarding the behavior and social organization of free ranging and semi-free ranging chimpanzees. Goodall reported that there was no linear dominance hierarchy evident in the free ranging animals she observed and that there was very little aggression evident. Wilson and Wilson (1968) however, indicated there were clear indications of dominance behavior and frequent displays of aggression in a group of semi-free ranging chimpanzees. There is evidence from other investigations (Sommer, 1969) to suggest that the marked differences in behavior between these two groups of chimpanzees may be attributable to the variable of physical space. That is, decreased amounts of space such as exists for captive animals seems to bring about increased overt aggression or "socially conditioned fighting" (Zuckerman, 1932). Also, Yerkes (1943) has indicated that there is a dominance hierarchy in the social structure of captive chimpanzees and that sexually receptive females temporarily become dominant over previously dominant males and that the previously existing dominance patterns are reconstituted when the female is no longer sexually receptive.

In part, the present study was designed to explore social organization in a group of captive chimpanzees with the goal in mind of better understanding the effects on social organization of increased and decreased amounts of physical space and the extent to which females in estrus modify or change the previously existing social structure. A study similar to the present one was done earlier (Hodan, 1970) using a group of eight adolescent and pre-adolescent chimpanzees. Hodan's animals were heterogeneous with respect to age and

time spent together. His animals ranged in age from four to twelve years and some of the animals had been housed together for as little as six months prior to the beginning of his study.

The animals used in the present study differed significantly from those used in Hodan's study. The four chimpanzees used as subjects in this study were homogenous in two significant respects. All were at least 20 years of age and all had been housed together almost continuously for approximately 14 years. Because of the older age of these animals and the length of time they had been housed together, it was felt that competition for status would be less apparent than in younger animals and that aggression, too, would be less apparent than in the younger animals used by Hodan. Because of these factors, a comparison was desired between the behavior of these animals and the behavior of the animals used in Hodan's study. Hence, this study was similar to the one done earlier by Hodan (1970) with the differences in group composition noted above and one other significant factor to be discussed shortly. The specific hypotheses for the first portion of the experiment 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 second portion of the experiment was designed to investigate the theories of coalition formation proposed by Caplow (1959), Simmel (1955), and Vinacke and Arkoff (1957). Of particular interest was the possible effects of coalitions, if any, on the dominance hierarchy established in the first part of the experiment. As in the Hodan study, this was accomplished by increasing the number of animals together in the same food-getting situation from two to three. In an earlier study, Maslow (1936) determined that whenever more than two macaques were placed together in a food-getting situation, a dominance hierarchy emerged which was "distinctively different" than the hierarchy obtained when the animals were placed in the food-getting situation in pairs. In fact, the struggle for dominance which emerged with the increased number of animals became so intense and there was so

much aggression that one of the previously dominant animals had to be removed from the experimental situation to prevent its destruction at the hands of the other previously subordinate animals. Henshel (1963) concluded that these struggles for dominance were the result of coalition formation between subordinate animals in the colony. The hypotheses for the second portion of the experiment were as follows.

Hypothesis IV. In a triadic situation where $A > B > C$, two chimpanzees will unite or form a coalition against the third.

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

Hypothesis VII. In a triadic situation consisting of two chimpanzees with nearly equal high status and one with low status, the reward received by the low status chimpanzee will increase as the amount of resources he contributes to the coalition increases.

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.

The eleven hypotheses making up the first two parts of the present experiment were formulated by Hodan (1970) in his earlier study with younger chimpanzees. The first two parts of the present experiment were similar to Hodan's study but involved an older and more homogenous group of animals. The final portion of the experiment represented an attempt to extend coalition theory to the tetradic situation. Although this has been attempted on a very limited scale with humans (Willis, 1962), it has not been done with any of the other members of the primate family and there is not yet any substantial theory for

tetradic systems of interaction. Thus, the hypotheses for the tetradic portion of the experiment serve the dual function of attempting to extend and make use of already existing triadic coalition theory (Caplow, 1959; Gamson, 1961; Vinacke and Arkoff, 1957) and, at the same time, hopefully generate other hypotheses about tetradic systems of interaction. The specific hypotheses for this part of the experiment were as follow.

Hypothesis XII. In a tetradic situation where $A > B > C > D$ two or more subordinate chimpanzees will form a coalition.

Hypothesis XIII. When the dominant chimpanzee in the tetrad has more initial power than that of the other three chimpanzees combined, i.e. $A > (B + C + D)$, the coalition will be ineffective. Conversely, when the dominant chimpanzee in the tetrad has less initial power than that of the other three chimpanzees, i.e. $A < (B + C + D)$, the coalition will be effective.

Hypothesis XIV. The dominance hierarchy which emerges in the tetradic situation is not as apparent when the amount of space in which the chimpanzees are confined is increased.

Hypothesis XV. The dominance hierarchy which emerges in the tetradic situation is temporarily disrupted when a female manifests maximum perineal swelling.

CHAPTER III

METHOD

Subjects. The subjects used in this study were a group of four adult chimpanzees (Pan troglodytes) consisting of one male Mutzie (Mu) and three females, Carolyn (C), Ella (E), and Maude (Ma). These four animals were acquired from a large midwestern zoo in October 1966. Prior to moving to their present circumstances, these animals had been housed and displayed together for a total of at least 11 years. The male Mu was born in captivity, was human reared, and wore diapers until he was approximately six years of age. Though a specimen of remarkable physical proportions, Mu had never been observed to copulate or masturbate since coming to his "new home" in 1966. Penile erections were observed on numerous occasions however, but most of these occurred in conjunction with feeding.

The three females (C, E and Ma) were wild caught as juveniles and placed on display at the midwestern zoo in May of 1955. Since their procurement from the zoo in 1966, two of these females C and Ma have given birth to infants sired by a mature male (Pan) who was housed in an adjoining cage. The delivery of each of the infants was accomplished without assistance, the only complication being Ma's retention of the placenta. Thirty-six hours after birth of her infant a dilatation and curettage was performed and there were no further complications. Three days after birth Ma's infant was taken from her because of her inability to care adequately for him. She carried him in an upside down position, failed to groom him and carried him too low to permit nursing. C cared for her infant for a period of three months at which time the infant was removed for experimental purposes.

Experimental Design

Apparatus. The apparatus used consisted of three major units; a Coin Receiver-Ejector Unit (CREU); the Feeder; and a Switching Unit-Remote (SUR). The CREU was mounted in an upright plywood enclosure measuring 48" x 40" x 20" and contained a nickel coin

ejector, Gerbrands Model B; a 28 volt, direct current, 4 amp power supply; an automatic switching unit; an annunciator; and a coin receiver modified to accomodate wet nickels.

The Feeder portion of the apparatus was a Davis Universal Feeder, Model 320. The SUR was composed of four non-locking push-button switches and a ready light which indicated to the operator the readiness of the system 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 the event of malfunction in the coin receiver which would result in failure of the automatic Feeder; and the fourth switch served the function of clearing the coin receiver in the event a coin happened to lodge at some point in the coin receiver while in transit (Hodan, 1970). Schematics for the entire apparatus are included in Appendices I, II, and III.

The experimental procedure required two cages (C1 and C2) located adjacent to each other. The experiment was conducted in the normal living area of these animals and the only transportation required for the experiment was movement from one cage to another. The two cages were identical in size with dimensions of 8'9" x 10'4" x 7'. Grapes were used as rewards and the feeding of the animals was arranged so that they were fed at least four hours prior to the beginning of each series of trials. This feeding schedule eliminated the possibility of satiated animals being used in the experiment.

The CREU was affixed permanently to the side of C1 and the Feeder was mounted on a plywood platform and was suspended from the ceiling. Provisions were made so that the Feeder could be moved from atop C1 to C2 whenever necessary for experimental purposes. A metal plate with a coin slot was welded to the inside of C1 where the CREU was affixed to receive the coins.

Procedure. The first step in the experimental procedure involved "shaping" the subjects to operate the apparatus. Initially, each animal witnessed the experimenter enter the cage containing the apparatus and demonstrate removal of a coin from the lead cup and insert it in the coin receiving slot to obtain the reward (a grape) automatically dispensed from the Feeder portion of the apparatus located atop the cage. This sequence was repeated for each of the animals a total of five times. Then each animal was placed individually in the cage with the apparatus and was prompted and "exhorted" to complete the sequence outlined

above. The older animals used in the present study did not learn this procedure as readily as the younger animals in Hodan's study.

The procedure was modified and a "shaping" procedure was instituted and each animal was given a reward for execution of even small parts of the procedure. That is, the animals received rewards for touching the lead cup containing the coins, for taking coins from the cup, for exchanging coins with the experimenter for grapes, and, finally, for inserting the coins in the proper slot.

The animals were not at all "cooperative" in this process and it proved to be extremely time consuming. Whereas several of the younger animals in Hodan's study learned the procedure in a matter of a few minutes, the older animals required considerably more time before they would consistently operate the apparatus. In fact, the training sessions for these animals required a period of 45 days to complete. Ma operated the apparatus approximately three weeks earlier than any of the other animals and Mu was the last to learn the procedure.

The first step in the experimental procedure involved a determination of the presence or absence of a linear dominance hierarchy. This was accomplished by pairing all possible combinations of animals in a food-getting situation. Each pair was given a series of 12 trials in the food-getting situation and the variables of estrus and space were controlled by limiting all trials to the one cage situation and using the females only while they were in anestrus. Before a series of trials was begun, a short period lasting anywhere from 30 seconds to 2 minutes was allowed so that the animals could become acclimatized to the experimental situation. A trial was considered to have ended when one of the pair ate the grape. The animal obtaining a significant proportion of the 12 grapes (using the chi-square statistic) was considered to be the dominant member of the pair. This procedure was repeated for each dyadic combination.

To determine if coalitions would form and upset the previously established linear dominance hierarchy, the animals were divided into all possible combinations of 3 and each triad was given a series of 12 trials in exactly the same manner as had been done in the dyadic situation. In a similar fashion, the effects of coalitions upon the dominance hierarchy were explored in the tetradic situation by placing the 4 animals together and repeating the series of 12 trials just as was done previously in the dyadic and triadic situations. Again, the

variables of estrus and space were controlled for by running the series of trials in both the triadic and tetradic conditions in one cage and when the females were in a condition of anestrus.

To determine the effects of increased physical space upon the linear dominance hierarchy, the Feeder was moved from atop C1 to C2 and each animal was given a brief training period in which they were taught to receive the reward in C2. After this training period, all possible combinations of dyads, triads, and the tetrad were given another series of 12 trials each under these new conditions. The variable of estrus in the females was again controlled for by using the females when they were in the anestrus condition.

It was not possible to obtain estrus data on all of the females in the study inasmuch as C did not manifest maximum perineal swelling during the course of the experiment. After thirty days, the reason for C's failure to develop maximum perineal swelling became apparent-she gave birth to an infant. Nevertheless, the effects of estrus upon the dominance hierarchy were explored in the remaining two females Ma and E in the following manner. During the period when Ma and E manifested maximum perineal swelling each female was given a series of 12 trials in each experimental condition. That is, each female was run in the dyadic, triadic, and tetradic situations in both the one and two cage conditions with every possible combination of animals.

CHAPTER IV

RESULTS

Throughout the experiment the number of grapes obtained by an animal was the dependent variable. Chi-square statistics were calculated to determine if the number of grapes obtained by each animal in each dyadic condition differed significantly from what would be expected on the basis of chance alone. In the triadic situation the number of grapes obtained by the previously dominant member (dominant in the dyadic situation) and the combined number of grapes obtained by the two previously subordinate animals were compared with what would be expected on the basis of chance alone. Effective coalitions were operationally defined as existing whenever "(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 two subdominant members did not differ significantly from that which could be expected purely on the basis of chance" (Hodan, 1970, p. 44). The alpha level for statistical analysis was arbitrarily chosen to be $p < .10$ with $n=1$ degrees of freedom (one tailed tests).

The first hypothesis posited that the social structure of captive chimpanzees is organized around a linear dominance hierarchy. Application of the chi-square statistic reveals significance levels in the dyadic one cage condition ranging from non-significance to $p < .001$. There were significant differences between animals in five of the six pairings. The only dyad in which the differences between animals was non-significant was the dyad containing Ma and C--the two most dominant animals. The exact chi-square values for each dyad are presented in Table 2.

The hierarchy which emerged from the dyadic one cage condition was determined by ranking each of the four animals. This was accomplished by assigning the animal receiving the largest proportion of grapes the status of alpha animal. A similar

procedure was followed for the remaining animals until the relative rank of each was established. The rank of the animals and the total number of grapes obtained by each in the dyadic one cage condition were: Ma 30, C 26, E 16, and Mu 0. Were it not for the nearly equal status of the top two animals (Ma and C), the dominance hierarchy which emerged would have been both linear and completely transitive. Since the hierarchy which emerged was linear however, hypothesis I was accepted.

Table 2
Chi-square Values for Dyadic
One Cage Condition

Critical Values				
$\chi^2=12.00, p<.001; \chi^2=8.32, p<.005; \chi^2=3.00, p<.10$				
	Ma	C	E	Mu
Ma		.33	8.33	12.00
C			3.00	12.00
E				12.00
Mu				

The second hypothesis posited that the linear dominance hierarchy would not be as apparent if the amount of space in which the two chimpanzees were confined was enlarged. In Table 3 the chi-square values for all possible dyads in the two cage condition are presented. The rank of the animals and the total number of grapes obtained by each in the dyadic two cage condition were: Mu 27, E 21, C 13, and Ma 11. Thus, the data strongly supports the hypothesis regarding the effects of increased space upon the dominance hierarchy. The chi-square values of four of the six dyads in the two cage condition have significance levels of $p<.10$ or better. These values, it should be emphasized occurred in conjunction with a complete reversal in the dominance hierarchy obtained in the one cage condition. The alpha animal in the one cage condition dropped to the gamma position in the two cage condition, the beta animal in the one cage condition dropped to the omega

position in the two cage condition, the gamma animal in the one cage condition moved up to the beta position in the two cage condition, and the omega animal in the one cage condition achieved the status of alpha animal in the two cage condition. Thus, it was concluded that the dominance hierarchy is clearly affected by increased space and hypothesis II was accepted.

Table 3

Chi-square Values for Dyadic

Two Cage Condition

Critical Values			
$\chi^2=12.00, p<.001; \chi^2=3.00, p<.10$			
Mu	E	C	Ma
Mu	12.00	.00	3.00
E		12.00	3.00
C			.33
Ma			

Hypothesis III states that the linear dominance hierarchy is temporarily disrupted when a female in estrus manifests maximum perineal swelling. Because of C's failure to develop maximum perineal swelling, the data for this portion of the experiment was limited to the two remaining females Ma and E. Yerkes (1943) indicated that temporary changes in dominance relations between males and females occur when the females are sexually receptive if the mates are "physically normal, mature, experienced, congenial, and at least moderately self-assertive and self confident" (p. 75).

Mu, as noted previously, hardly fits the criteria set forth by Yerkes and, because of this, it was not possible to meaningfully evaluate hypothesis III. Theoretically, Mu should have been dominant over both Ma and E because of his large size and sex. However, when Mu was paired with Ma and E in the one cage anestrus condition, both females were dominant over him and the pairings resulted in chi-square values of 12.00 in both dyads

($p < .001$). When Mu was paired with Ma and E in the one cage estrus condition both females again were significantly dominant over him and the chi-square values were identical to those obtained in the one cage anestrus condition ($\chi^2 = 12.00$, $p < .001$). Because the two females were already significantly dominant over Mu in the anestrus one cage condition however, the estrus data is meaningless with respect to Yerkes (1943) theory of temporary shifts in dominance associated with estrus and, hence, hypothesis III can neither be accepted nor rejected on the basis of this data.

Hypotheses IV, V, and VI were derived from coalition theory and research done with humans. Hypothesis IV states that in a triadic situation where $A > B > C$, two chimpanzees will unite against the third. Hypothesis V states that in the triadic situation where $A > B > C$, the two subordinate chimpanzees will form a coalition. In an earlier study Hodan (1970) indicated it was somewhat difficult to adequately test hypotheses IV and V. He pointed out that coalitions may be either "openly aggressive or covertly manipulative". Because of this, a decision was made to include only those overt coalitions in which two animals were actually observed to unite against the third. In the present study testing of hypotheses IV and V yielded results which failed to support any of the existing theories of coalition formation. In the triadic one cage condition there was one triad (Ma with C and E) which involved overt aggression directed against the dominant animal and which was statistically effective. There was one other overt coalition which formed (Mu and E against Ma) however, it was not successful, i.e. neither of the subordinate animals obtained the grape. A one sample proportion test was calculated to determine the significance of overt coalition formation (2 out of 48 trials) and resulted in a z score of -6.31 and the null form of both hypotheses IV and V were supported.

Hypothesis VI states that in a triadic situation when the dominant chimpanzee has more initial power than that of the other two chimpanzees combined ($A > B > C$); $A > (B + C)$, the coalition will be ineffective. Conversely, when the dominant chimpanzee in the triad has less initial power than that of the other two chimpanzees combined ($A > B > C$); $A < (B + C)$, the coalition will be effective. This hypothesis was an extension of hypotheses IV and V and represented an attempt to predict the validity of the linear dominance hierarchy established in the initial dyadic situation. The predictions were based upon the "power" of the dominant chimpanzee determined by the number of grapes obtained by each animal in

the one cage pairings. The total number of grapes obtained by each animal in the one cage pairings were: Ma 30, C 26, E 16, and Mu 0. The animals were divided into all possible combinations of triads and scores were combined for the two subordinate animals in each triadic situation and predictions were made as to the probable outcome of each triad. For example, in one triadic situation the dominant animal Ma was pitted against C and E. Ma obtained 30 grapes in the dyadic pairings and C and E had a combined total of 42 grapes. Since C and E together obtained more grapes than Ma, it was predicted that a coalition between C and E would be effective. The chi-square values for the triadic one cage condition are presented in Table 4. A phi coefficient was calculated and the correlation was .237 ($\chi^2=2.94$, $p<.10$) and the null form of hypothesis VI was rejected.

Table 4
Chi-square Values for the Triadic
One Cage Condition

Critical Values				
$\chi^2=12.00$, $p<.001$; $\chi^2=8.32$, $p<.005$; $\chi^2=3.00$, $p<.10$				
	C/E	C/Mu	E/Mu	E/Mu
Ma	.00	8.33	1.33	
C				3.00
E				
Mu				

Hypothesis VII was designed to test Gamson's (1961) thesis that in a triadic situation with two nearly equal high status individuals and one low status individual the reward received by the low status member will increase as the amount of resources he contributes to the coalition increases. The low status animal (Mu) failed to obtain any grapes in the triadic one cage condition. In addition, there were only two overt coalitions which formed out of a total of 48 trials. Because of the small number of coalitions which formed and the failure of the low status animal to acquire any grapes, there was insufficient data upon which to evaluate hypothesis VII.

Hypothesis VIII posited that there would be a qualitative difference in the behavior of the male and that of the females in the triadic situation. There were obvious qualitative differences in the behavior of the male Mu and that of the females Ma, C, and E. Although he was not successful in his efforts, Mu behaved in ways much like that described for normal chimpanzees. He threatened the females by stamping his feet loudly on the cement floor and nearby metallic objects and clubbed at the females with his forearms and open palms. These aggressive episodes appeared not to have their intended effect however, in that the females did not permit him to obtain any of the grapes even after such outbursts. Mu would then become very meek and submissive, sit beside the female operating the apparatus, and pat the floor with his knuckles and emit food grunts thereby indicating his desire for grapes.

The females, particularly Ma and E, relied on more cunning means to obtain grapes in both the one and two cage triadic conditions. In the one cage condition it was possible for the animal operating the apparatus to obtain the reward by moving only slightly away from the coin slot. Because of this, the dominant animal Ma consistently was able to both operate the apparatus and obtain the grapes with little effort. The subordinate females C and E relied on more "subtle" means to obtain grapes in the one cage condition. Both C and E watched intently as Ma operated the apparatus and quickly retrieved any grapes that happened to fall on the floor and bounce out of Ma's immediate reach. Ma's status was not sufficiently great to intimidate the other females and one of the subordinate females would simply get to the grape before Ma could reach it.

In the two cage condition the craftiness of the females was even more apparent. The dominant animal (Ma) was not able to operate the apparatus and obtain the grapes as she had done in the one cage condition. She soon ceased inserting coins in the slot as rapidly as she had in the one cage condition and she would wait until the other animals moved away from the feeder in the adjacent cage before inserting the coin in the slot. In addition, Ma "hoarded" coins, sometimes having as many as three or four in her possession at one time, and would not put the coins in the slot while other animals were near the feeder. Finally, Ma placed the coins on the cement floor of the cage and slid them under the wire towards the experimenter as if to "trade" the coin for a grape rather than operate the apparatus for one of the other animals to obtain the grapes.

Hypothesis IX stated that the dominance hierarchy which emerges in the triadic situation is distinct from the hierarchy which emerges in a dyadic situation. The chi-square values resulting from the dyadic and triadic one cage conditions and the dominance hierarchies emerging from these two conditions are presented in Table 5. Inspection of the chi-square values and hierarchies for the dyadic and triadic one cage conditions reveals no changes whatever as a result of the increased number of animals. Therefore, the null form of hypothesis IX was accepted.

Table 5
Chi-square Values and the Resulting Dominance
Hierarchies in the Dyadic and Triadic
One Cage Conditions

Critical Values						
$\chi^2_{12.00}, p < .001$; $\chi^2_{8.32}, p < .005$; $\chi^2_{3.00}, p < .10$						
<u>Dyads</u>						
	Ma	C	E	Mu	Rank	No. grapes obtained
Ma		1.33	8.33	12.00	Ma	30
C			3.00	12.00	C	26
E				12.00	E	16
Mu					Mu	0
<u>Triads</u>						
	C/E	C/Mu	E/Mu	E/Mu	Rank	No. grapes obtained
Ma	.00	8.33	1.33		Ma	25
C				3.00	C	14
E					E	9
Mu					Mu	0

Hypothesis X states that the dominance hierarchy which emerges in the triadic situation is not as apparent if the amount of space in which the chimpanzees are confined is increased. In Table 6 the chi-square values and resulting dominance hierarchies for both the one and two cage triadic conditions are presented. Inspection discloses marked changes in the status of the individual animals when moving from the one to the two cage condition. In fact, all four animals changed positions in the dominance hierarchy with the change from the one to two cage condition. The alpha animal (Ma) in the one cage condition slipped to the gamma position in the two cage condition, the beta animal (C) in the one cage condition slipped to the omega position in the two cage condition, the gamma animal (E) in the one cage condition moved up to the beta position in the two cage condition, and the omega animal (Mu) in the one cage condition attained alpha status in the two cage condition. In view of these findings, hypothesis X was confirmed.

Hypothesis XI stated that the dominance hierarchy which emerges in the triadic situation is temporarily disrupted when a female in estrus manifests maximum perineal swelling. As was previously indicated with respect to hypothesis III, the male (Mu) used in the present study cannot be considered "normal" sexually and in several other respects and, for that reason, the data concerning this hypothesis is meaningless. Because C did not manifest maximum perineal swelling during the course of the experiment, the estrus data obtained was limited to Ma and E. According to the theory, both Ma and E should have become temporarily dominant over Mu during their periods of sexual receptivity. However, since both of the females were already significantly dominant over Mu, it was not possible to meaningfully test this hypothesis.

Hypothesis XII posits that in a tetradic situation where $A > B > C > D$ two or more of the subordinate chimpanzees will form a coalition against the dominant animal. As was done in the triadic situation, data regarding coalition formation was accepted only in those instances in which overt coalitions were actually observed. This is, instances in which two or more animals actually united in an attempt to "overpower" the dominant animal. There was only one instance in the tetrad in which two animals banded together in an attempt to overthrow the dominant animal. C. and Mu formed a coalition, vocalized and slapped at Ma but, nevertheless, neither C nor Mu were able to obtain the grape in the following trial or in any of the succeeding trials. Thus, out of a total of 12 trials there was

Table 6
Chi-square Values and the Resulting Dominance
Hierarchies for the Triadic One
and Two Cage Conditions

Critical Values						
$\chi^2=8.33; p<.005; \chi^2= 3.00, p<.10$						
<u>One Cage</u>						
	C/E	C/Mu	E/Mu	E/Mu	Rank	No. grapes obtained
Ma	.00	8.33	1.33		Ma	25
C				3.00	C	14
E					E	9
Mu					Mu	0
<u>Two Cage</u>						
	E/C	E/Ma	C/Ma	C/Ma	Rank	No. grapes obtained
Mu	8.33	8.33	.00		Mu	26
E				3.00	E	10
Ma					Ma	9
C					C	3

one overt coalition involving two animals and this coalition was not effective. A one sample proportion test was calculated and resulted in a z of -2.8 ($p > .10$) and the null form of the hypothesis was accepted.

Hypothesis XIII posits that the dominance hierarchy which emerges in the tetradic situation is not as apparent when the amount of space in which the chimpanzees are confined is enlarged. The distribution of grapes in the one cage tetradic condition was as follows: Ma 10, C 1, Mu 1, and E 0 ($\chi^2=5.33$, $p < .025$). The change from the one cage to the two cage tetradic condition resulted in a markedly different distribution of rewards (Ma 4, Mu 3, E 3, and C 2). None of the animals obtained significantly more grapes than any of the other animals. Instead, there was a relatively uniform distribution of rewards in the two cage tetradic condition. Because of this, hypothesis XIII was accepted.

Hypothesis XIV posits that the dominance hierarchy which emerges in the tetradic situation is temporarily disrupted when a female manifests maximum perineal swelling. As was previously indicated for the triadic situation, it was not possible to obtain estrus data on all three females because C did not manifest maximum perineal swelling at any time during the course of the experiment. In addition, maximum perineal swelling theoretically affects dominance relations in that the male defers to the female in estrus in return for the "favor" of sexual accomodation (Yerkes, 1943). Mu did not meet the criteria of "normality" as defined by Yerkes in that prior to the experiment he had never been observed to copulate with any of the females at any time. In the experimental situation, Ma and E were both significantly dominant over Mu in both the anestrus and estrus conditions and for that reason it was not possible to meaningfully evaluate hypothesis XIV.

CHAPTER V

DISCUSSION

The results of the present investigation are consistent with the earlier observations of Yerkes (1943) and Wilson and Wilson (1968) regarding the existence of dominance hierarchies in the social structure of captive chimpanzees. The hierarchy which emerged in the experimental situation was relatively stable in that the status of each animal remained virtually unchanged in the dyadic, triadic and tetradic one cage conditions. As might be inferred from the preceding statement, there was very little support in the present study for any of the existing theories of coalition formation, i.e. Gamson (1961), Simmel (1955) and Caplow (1959). In fact, in both the one and the two cage conditions there were only a total of two overt coalitions during the course of the study. The only support in the present research for coalition theory was for Caplow's (1959) thesis that coalitions could be predicted if the "power" of the individual animals was known. Given the "power" of the individual animals, it was possible to reliably predict the outcomes when three animals were placed together in the one cage food-getting situation.

Yerkes (1943) indicated that status seeking is one of the basic processes out of which the social structure emerges in captive chimpanzees. Wilson and Wilson (1968) reported that the status of "middle sized" animals was more ambiguous than that of either large or small sized animals and that there was greater competition among the middle sized animals to achieve higher status. As was anticipated at the outset, there was a conspicuous lack of overt aggression in this group of chimpanzees. This seems primarily attributable to the large size and relatively advanced age of these animals and the fact that they had been housed together almost continuously for approximately 14 years. Because of these factors, the status of each animal probably was well defined long before the present experiment took place. Thus, the relative absence of overt aggression and comparatively small number of overt coalitions seem attributable to the unique characteristics of this particular chimpanzee group.

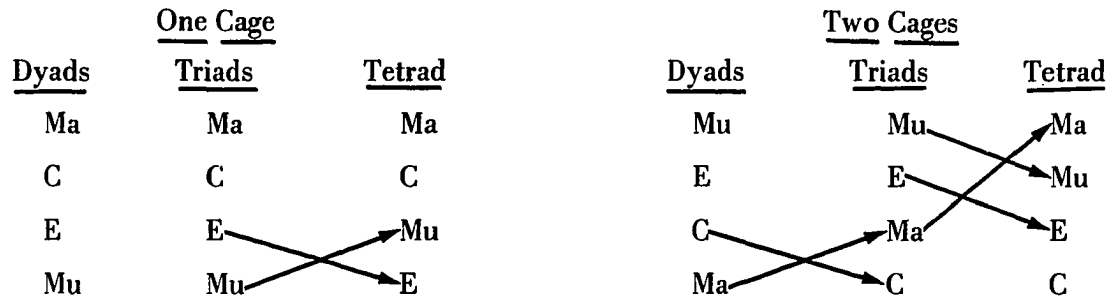
It seems probable that the factors referred to in the preceding paragraph helps explain the stability of the dominance hierarchy in the one cage condition. Maslow (1936) indicated that when three rhesus monkeys were placed together in a food-getting situation, a dominance hierarchy emerged which was "distinctively different" from the one obtained in the dyadic situation. There was no difference whatever in the relative rank of the chimpanzees in the present study when they were placed together in the dyadic, triadic and tetradic situations in the one cage condition. The hierarchies which emerged from each of these experimental conditions were identical.

The results of this study strongly support Sommer's (1969) thesis regarding the effects of physical space upon social organization. The dominance hierarchy which emerged from the dyadic one cage condition remained intact and virtually unchanged in both the triadic and tetradic one cage conditions. However, in the two cage condition the dominance hierarchy which emerged was completely different from that obtained in the one cage condition. In Figure 3 the effects of increased numbers of animals and the effects of added space upon the dominance hierarchy are contrasted.

It is significant that both coalition formation and aggressive behavior, to the limited extent they were observed, were limited to the one cage condition. This finding is consistent with Calhoun's (1962) observation that increased population density in rats brings about increased aggression. In addition, the exclusive occurrence of aggressive behavior in the one cage condition and its absence in the two cage condition is analogous to the conflicting descriptions of the behavior of free ranging and captive chimpanzees. That is, free ranging chimpanzees (Goodall, 1965) reportedly show little aggression and the social structure of such animals is described as "loose" and relatively free of "dominance behavior". The social structure of captive chimpanzees (Yerkes, 1943) however, is reportedly organized around a rigid dominance hierarchy. In addition, status seeking and aggressive and submissive interactions are said to be commonplace.

In recent years the literature on animal research has frequently called attention to conflicting reports on the behavior of animals. In many instances the conflicting descriptions are the result of laboratory and naturalistic field studies of the same species. In an attempt to reconcile the discrepancies between laboratory and naturalistic research findings, the laboratory experimentalist frequently criticizes naturalistic research and often

Space Fixed, Number of Animals Varied



Number of Animals Fixed, Space Varied

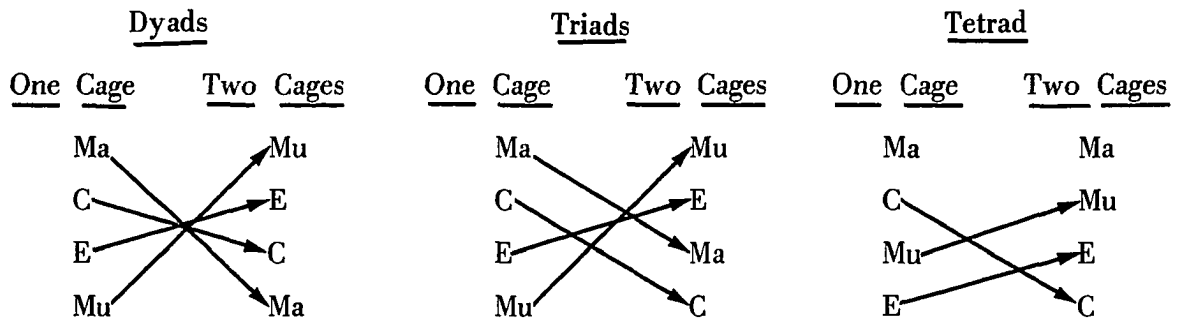


Fig. 1. Changes in the dominance hierarchy as a function of space and the number of animals.

times asserts that such research is not "scientific", that it is too "subjective", and that adequate quantification of the behavior it purports to describe is lacking. The protagonist of the naturalistic field study approach might respond to such criticism by asserting that the differences are attributable to the influence of the laboratory environment. Kavanau (1964) sought to account for difference in research findings by directing attention to the environment of the animal. He advanced the thesis that the behavior of animals reared under laboratory conditions is drastically altered by the confining living conditions of the laboratory. For example, Kavanau has indicated that the behavior of the laboratory rat is "atypical" in that it is not characteristic of the species.

As Hodan (1970) has indicated, the adaptability of animals is a factor which seems to have seldom been taken into account in the controversies surrounding the behavior of the animal in both laboratory and naturalistic environments. It appears more likely that the differences in research findings can be attributed to the capacities of animals to adapt to a variety of environmental conditions rather than one group exhibiting behavior "atypical" of the species.

In the present study there was a stable dominance hierarchy in the one cage condition but this hierarchy changed appreciably with increased space and there was a more even distribution of rewards. This finding is consistent with Scott's (1958) description of dominance behavior in the deer. He indicated that under natural conditions deer feed over relatively large areas and that dominance behavior is seldom observed. However, if the food of the deer is restricted to small areas a dominance hierarchy quickly emerges and the most dominant animals have first access to the food.

Because of the "inadequacy" of Mu, the data obtained from the estrus portion of the experiment was meaningless insofar as Yerkes (1943) theory of temporary changes in dominance relations between males and females is concerned. It was assumed that Mu would be the dominant animal in the group because of his sex and large physical size. However, he was not dominant over any of the females in the dyadic one cage condition. Instead, all of the females were significantly dominant over him. Since Yerkes (1943) theory assumed male dominance, it was impossible to meaningfully test his theory.

Since there were only four chimpanzees in the group, the data regarding the tetrad was necessarily quite limited. That is, there was only one tetrad and consequently a

limited number of trials (12) under each of the experimental conditions. As was true with the triad, there was very little evidence in the tetrad to support any of the existing theories of coalition formation. Because of the small number of chimpanzees available and the advanced age of these animals however, tetradic systems of interaction could probably be more profitably explored with a larger and much younger group of animals.

There were a number of unexpected findings growing out of this research relative to the status of the individual members in this chimpanzee group. Prior to the experiment it was assumed that Mu was the dominant animal in the colony. Though it was known that he had been human reared for the first six years of life and was regarded as somewhat "neurotic", no one involved in the study anticipated that Mu would be relegated to the status of omega animal during the course of the experiment. Another major finding was the unexpectedly high status of Ma in the group. Those who were most familiar with Ma felt that she was the animal with the lowest status in the group. These two findings were initially somewhat surprising but, in retrospect, are not too difficult to rationalize. It appears that no one fully appreciated the extent to which Mu's behavior was adversely affected by the human care he received during the first six years of life. It is apparent that, in addition to being sexually inadequate, Mu is equally inadequate in a number of other important respects. It is clear that he is a chimpanzee who in no way fits the stereotype of primate masculinity.

Ma's unexpectedly high status in the group was equally surprising but, upon closer analysis, understandable. As was previously indicated, the four animals comprising this experimental group had been housed together almost continuously for approximately eleven years. Accordingly, there were strong friendship bonds between most of the animals in the group. Mu and E spend large amounts of time together and E has repeatedly been observed to come to Mu's defense and to groom him regularly. C vocally "protests" whenever separated from the rest of the group even for short periods. In contrast, Ma has always been regarded as an isolate. She eats apart from the rest of the group and her interaction with the other animals is minimal. Because of her tendency to be an isolate, it was erroneously assumed that her status in the group was low.

It is apparent from the results of the study that the behavior of the individual animals was such as to render it impossible to meaningfully evaluate some of the

hypotheses. In addition, the behavior of the male Mu in the experimental situation was markedly different than what was anticipated. Because of these factors, it seems appropriate to include a description of the behavior of the individual animals during the course of the study.

Mu

Both prior to and during the experiment Mu displayed a “reluctance” to operate the apparatus. In fact, he inserted coins into the coin slot only two times during the course of the study and both of those occasions were instances in which he picked up a coin that one of the other animals had dropped. In no instance did he remove a coin from the coin cup and insert it into the coin slot. In the one cage condition he alternately sought to obtain grapes as they were dispensed from the feeder or appeared to become “enraged” and would turn his back on the apparatus and the other animals. His efforts to obtain grapes consisted of attempts to gain the “favored” position under the feeder. None of the females would relinquish their positions however, and Mu was not able to obtain any of the grapes. On two occasions in the one cage condition Mu aggressively challenged Ma for the position under the feeder. Ma relinquished her position temporarily by moving to a corner of the cage. Mu failed to take advantage of this opportunity however, and instead, moved to another corner of the cage. Ma waited a few seconds then moved back and regained her position under the feeder and resumed the process of obtaining grapes. Mu fared much better in the two cage condition in terms of number of grapes obtained. It was not possible for an animal to both operate the apparatus and position itself under the feeder located in the adjoining cage. Because of this, Mu stayed near the feeder in the two cage condition and was able to obtain a significant number of grapes.

Ma

Ma was one of the two smallest animals in the group. She was the first to learn to operate the apparatus and appeared eager to do so as long as she was able to obtain grapes. In the one cage condition Ma operated the apparatus rapidly with only brief intervals between trials. On occasions when the automatic coin ejection system failed, Ma would strike the apparatus as if to hasten the descent of the coin down the ejection slot.

In the two cage condition Ma could not obtain the grapes as readily as she had in the one cage condition and this gave rise to a unique set of behaviors. She initially was the

first animal to operate the apparatus in the two cage condition. She inserted coins in the coin slot and watched while one of the other animals obtained the grapes dispensed by the feeder in the adjoining cage. After a few such instances however, Ma ceased putting coins in the slot. Instead, she removed the coins from the coin cup and watched the other animals and waited until the area around the feeder was clear before inserting the coins in the slot to activate the feeder. If the other animal or animals with her did not move away from the feeder, after a wait of some minutes Ma would attempt to “trade” the coin with the experimenter for a grape by sliding the coin under the wire of the cage.

Ma did not assume the role of the aggressor with any of the other chimpanzees. She responded in kind however, whenever any of the other animals behaved aggressively towards her. It was clear that Ma depended more upon her “slyness” rather than brute strength to obtain the grapes. For example, in the tetradic two cage condition she obtained grapes in four instances because she climbed atop a tire she had leaned against the side of the cage directly beneath the feeder. Because of her position atop the tire, she was approximately two feet higher and nearer to the feeder than any of the other animals. This position enabled her to have first chance at obtaining the grapes as they were dispensed from the feeder above her.

C

C was the largest of the three females and second in size only to Mu in the group. She had the reputation of not being “cooperative” with humans in any respect. She was an aggressive chimpanzee who was anything but meek in her interaction with humans. For example, the pre-experimental shaping procedure with C required an exceedingly large amount of time and in part this was because C expended more energy in efforts to “get” the experimenter through the wires of the cage than in learning to operate the apparatus.

While C was the larger and more aggressive of the three females, this did not appear to be of particular value when paired with Ma in the one cage condition. C was keenly interested in obtaining grapes and made this known by attempting to gain the “favored” position beneath the feeder and in emitting low food grunts. The dominant animal Ma did not relinquish her position beneath the feeder but, instead, continued to operate the apparatus and obtain the grapes. C was very alert however, and would quickly capture any grape that happened to fall through Ma’s outstretched hand. It was only

through such alertness on C's part that she was able to obtain any grapes when paired with Ma.

C's behavior in the two cage condition was similar to that in the one cage condition. She was aggressive and was the first to capture grapes that were not caught in mid-air by one of the other chimpanzees. While alert and aggressive, C did not appear nearly as "sly" as the dominant animal Ma. In the two cage condition C continued to operate the apparatus even though the other animals obtained the majority of the grapes.

E

E was the last of the females to learn to operate the apparatus. She was one of the two smallest chimpanzees in the group. At the beginning of the training sessions E appeared indifferent to the whole procedure. She displayed little fear of the apparatus but, rather, seemed oblivious to its existence. For approximately two weeks she could not be induced to come to the edge of the cage to receive a grape from the experimenter. After mastering this task, it was an additional two weeks before she could be induced to "trade" coins for grapes. Upon learning this feat however, E suddenly became very cooperative and learned the remaining components of the shaping procedure in a matter of two days and thereafter seemed eager to operate the apparatus.

E was not especially aggressive in her interaction with the other chimpanzees. Neither was she particularly "sly" or adroit in obtaining grapes. Rather, she was passive and submissive in her interaction with the other chimpanzees. She obtained most of her grapes in the one cage condition when paired with Mu who permitted her to operate the apparatus and obtain grapes unmolested. When paired with one of the other females E typically watched the other female operate the apparatus and made no effort to contest the other animals for either the right to operate the apparatus only when the other female would temporarily relinquish her position. These instances were few in number and E would quickly retreat to the corner of the cage when either of the other females moved in to reclaim their position beneath the feeder.

In the two cage condition E obtained grapes by behaving in the same passive manner as she had in the one cage condition. She remained in the cage containing the feeder and whenever possible positioned herself beneath the feeder. She relinquished this position when one of the other females entered the cage but would remain in the immediate vicinity

of the feeder. She would not however, operate the apparatus for the other females but would instead merely wait until the other females resumed operating the apparatus. Thus, E's "dominance" over the other two females in the two cage condition was achieved entirely through passive means.

The similarities in behavioral processes between man and the lower order animals have repeatedly been emphasized. Because of these similarities, the study of such processes is fruitful both in man and the other animals. In view of the stability of the dominance hierarchy and the very limited amount of overt aggression in the group of chimpanzees used in this study, it seems appropriate here to discuss briefly some of the important differences between man and the other animals.

While each species must adapt to environmental conditions in order to survive, it is clear that man alone has the capacity to drastically modify or alter his environment. The technological improvements resulting from the industrial revolution is an indication of the extent to which man can modify his environment. Perhaps even more impressive however, is the highly developed science of nuclear physics which has placed in the hands of a few the power to destroy all of the human race.

Although not as dramatic but perhaps even more insidious are the indirect consequences of the industrial revolution. The rise in the standard of living and advances in medicine have increased man's life expectancy appreciably and have contributed significantly to the mushrooming increase in world population. The population of most species is held in check by the limited food supply, the killing off by predators, and a variety of other natural forces. Wynne-Edwards (1962) has indicated that dominance hierarchies also function to regulate population density in many species. In addition, such hierarchies inhibit overt aggression and facilitate social organization (Sommer, 1969).

The highly advanced state of technology has enabled man to minimize the influence of environmental factors, increased his longevity, and in effect "freed" him from many of the natural forces. In view of the open hostilities, overcrowding, and constant threat of nuclear destruction which characterizes modern man's existence however, it is clear that his comparative "freedom" carries with it responsibilities and limitations on behavior not found in any of the other species.

CHAPTER VI

SUMMARY

Social organization is a process which has been studied with a large variety of animals. Within the past twenty years however, particular attention has been directed to the social structure of the non-human primates. Dominance behavior seems to play a prominent role in the social organization of many primate societies. In addition, there is reason to believe that dominance relations between male and female chimpanzees are affected by the condition of the female. Sexually receptive females reportedly become temporarily dominant over males during their period of receptivity. When pairs of rhesus monkeys have been placed together in the same food-getting situation, a dominance hierarchy emerges which is "distinctively different" than that obtained when three or more monkeys are placed together in the same food-getting situation. There are discrepancies in the descriptions of the social structure of feral and captive animals. It has been suggested that many of the differences reported for feral and captive animals are attributable to the variables of population density and the amount of physical space.

The goal of the present study was to explore the social structure of a group of four captive chimpanzees. Specifically, the variables of physical space, estrus, and coalitions were investigated to determine their effects upon the social structure. All possible pairs of these animals were placed together in a food-getting situation to determine if the social structure of the animals was organized around a dominance hierarchy. The pairings resulted in a dominance hierarchy which was linear but not completely transitive. The two most dominant animals were found to be of nearly equal status when paired together.

Increasing the amount of space in which the animals were housed resulted in a markedly different dominance hierarchy than that obtained under the original spatially confining condition. It was concluded that the social structure of these chimpanzees was

clearly affected by the amount of space available. The dominance hierarchy was not disrupted when the females were in estrus and this finding differs significantly from what has been reported in other primate studies. The male chimpanzee in the group was sexually inadequate however, and the data appeared to be more of an index of his sexual inadequacy rather than a test of the theory of temporary shifts in dominance associated with sexual receptivity in the female.

There was very little support for any of the existing theories of coalition formation. Triads and tetrads of animals placed together in the same food-getting situation resulted in identical dominance hierarchies.

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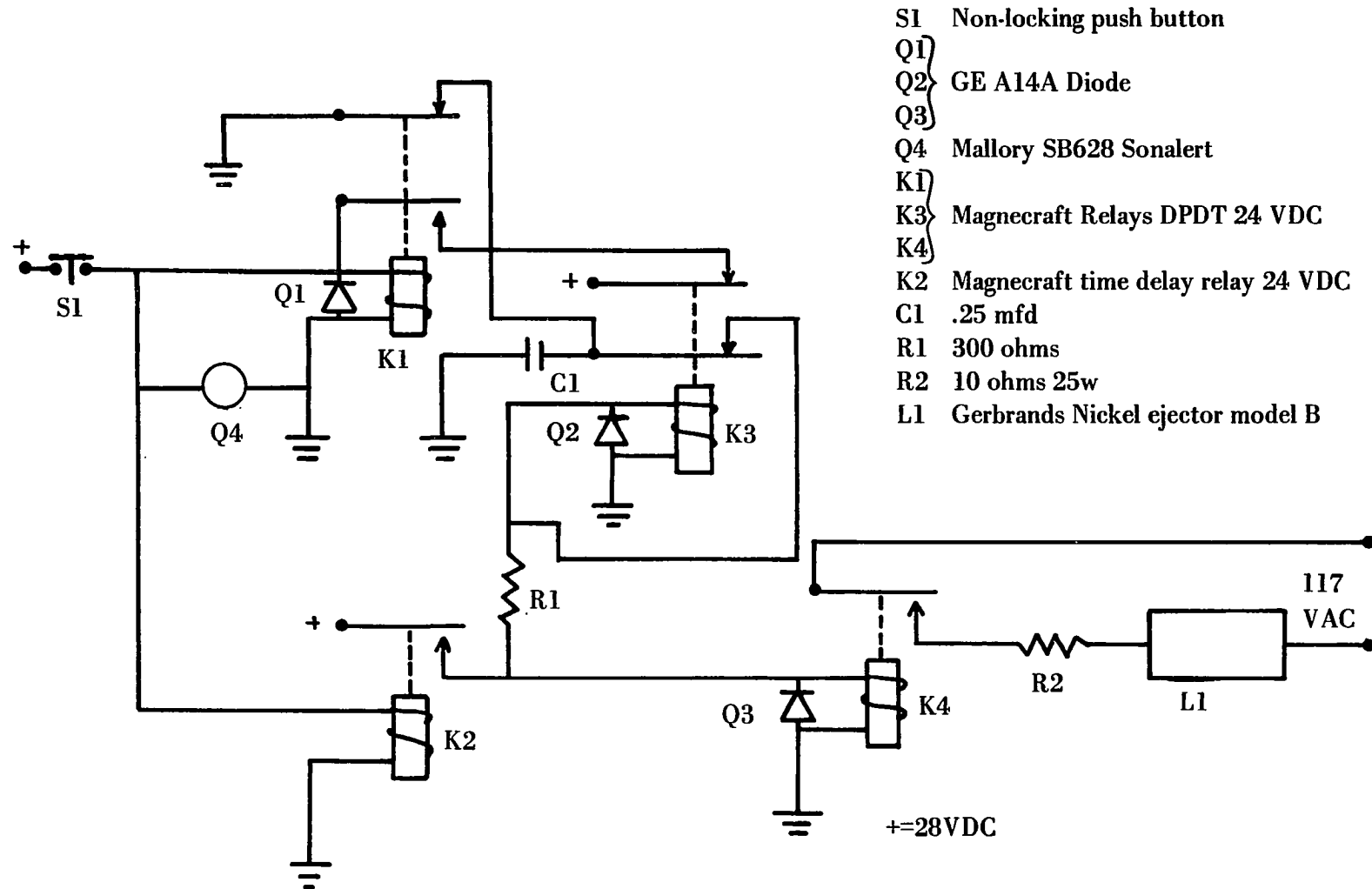
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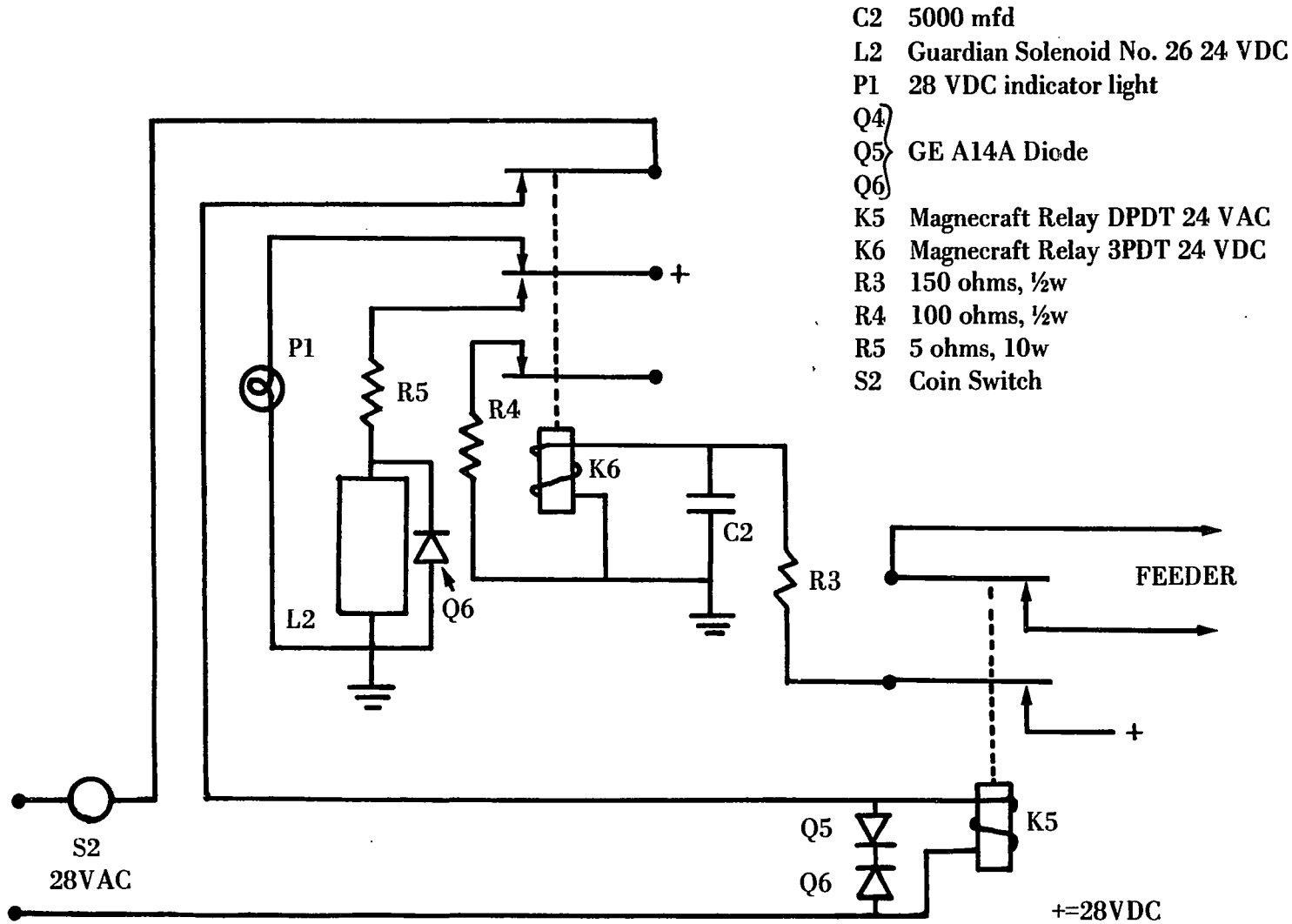
Appendix I

Delay - Alert - Coin Eject Circuit



Appendix II

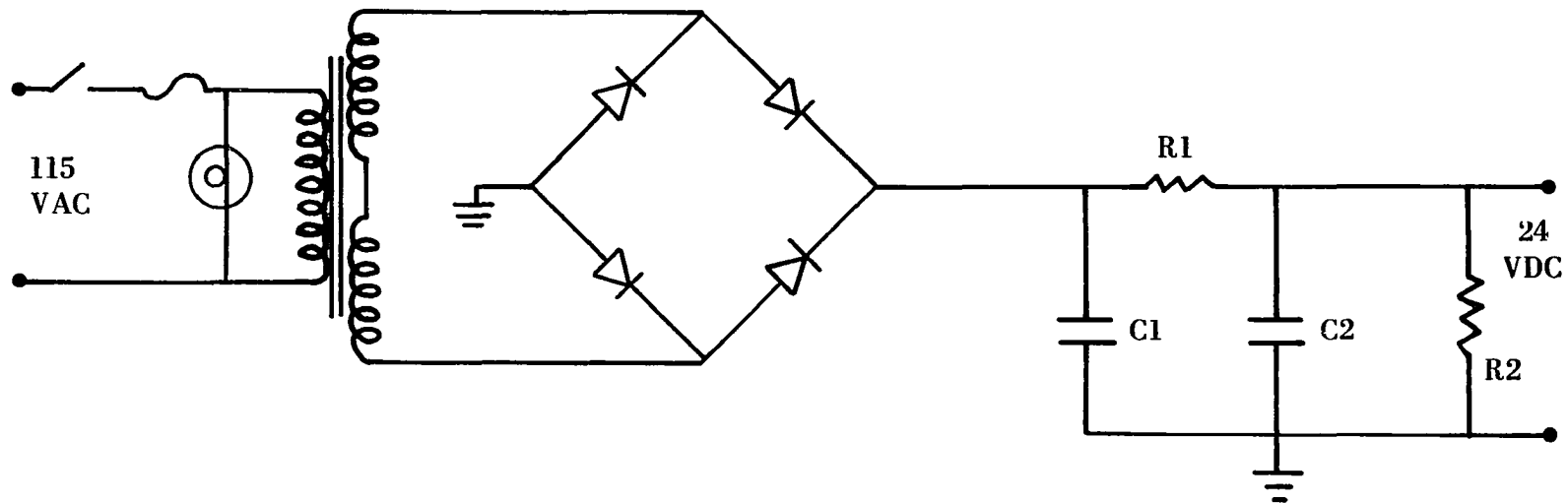
Feed - Coin Release Circuit



Appendix III

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 IV

Distribution of Grapes in Dyadic One Cage Condition

	Ma	C	E	Mu
		5	1	0
Ma		7	11 3	12 0
C			9	12 0
E				12
Mu				

Distribution of Grapes in Dyadic Two Cage Condition

	Mu	E	C	Ma
		0	6	3
Mu		12	6	9
			0	3
E			12	9
				5
C				7
Ma				

Appendix V

Distribution of Grapes in Triadic One Cage Condition

	C/E	C/Mu	E/Mu	E/Mu
	6	1	4	
Ma	6	11	8	
				3
E				9

Distribution of Grapes in Triadic Two Cage Condition

	C/E	C/Ma	E/Ma	C/Ma
	1	8	1	
Mu	11	4	11	
				3
E				9