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SOCIALIZING FUNCTIONS OF PRIMATE PLAY

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SYNOPSIS. The socializing functions of nonhuman primate play behavior are discussed. An evolutionary perspective of play behavior is presented to provide a concise view of its importance in primate phylogeny. Some of the major variables influencing play behavior's socializing functions, i.e., gender, age, group structure and population dynamics, and the eoniche, are reviewed. It is concluded that the major socializing functions of play behavior include proper social development, setting the basis for the adult dominance hierarchy, social integration of individuals into the group structure, and learning the social communicatory matrix.

INTRODUCTION

We lack a full appreciation of the processes involved in primate socialization, even though the need for an adequate understanding of primate socialization is pivotal to understanding the ontogeny of adult behavior (e.g., Mason, 1963; Kaufman, 1966; Dolhinow and Bishop, 1970; Poirier, 1971, 1972*a,b*, 1973*a,b*). This paper deals with one dimension of the socialization process, namely, the development and elaboration of play behavior as an integral unity of the social development of nonhuman primates. Washburn (1973) notes that if the field observer were to list the kinds of daily behaviors witnessed according to the amount of time they consume, the usual order would be: sleeping, obtaining food, eating, playing, resting, and social contacts. Play is a major behavioral trait which was adaptive during primate phylogenetic histories.

For most types of social behavior there are multiple variables which can effect its expression. Play is no exception. There exists a great deal of intra-specific and inter-specific variation, both qualitatively and quantitatively in the expression of play. For instance, object play assumes a greater role among chimpanzees than it does in the

play behavior of Old World cercopithecines (Bernstein, 1962; DeVore, 1963). Differences noted in play behavior between north and south Indian langurs (Poirier, 1969*a*, 1970) point out the variability in play behavior within one species. Play may have a more important socializing function in some species than in others. Species-specific action patterns are important in the development of play behavior in a wide variety of mammals (Bekoff, 1972) and in the development of play in nonhuman primates.

Play is most frequently observed when the more immediate physiological needs of the animal are met (Bekoff, 1972). Therefore, play may be classified as a second order, or non-primary activity (Meyer-Holzappel, 1956*a,b*). This is borne out by Loy's (1970) observations of rhesus macaques on Cayo Santiago and by the work of Baldwin and Baldwin (1972) for squirrel monkeys in western Panama. In both situations food deprivation reduced the incidence of play and, for that matter, all social interactions.

AN EVOLUTIONARY PERSPECTIVE OF PLAY BEHAVIOR

To fully appreciate the role of play behavior, one must take an evolutionary per-

spective. Play seems to be a major mammalian behavior pattern. Within the class Mammalia we witness variability in type and complexity of play, as well as variability in the capacity for learning. The nature and adaptive value of play becomes clear only when its magnitude and distribution are considered. The most highly developed "learning animals" play in the true sense of the word. These are curious animals who experiment with new behavioral patterns, learning in the process. The distribution of play behavior indicates that play is related to learning.

Mammals depend heavily upon trial and error learning (Poirier, 1972*b*, 1973*a*). In most animals activity and learning results from the need to satisfy the primary drives of hunger, sex, and self-preservation. Among mammals a new behavioral determinant has evolved which does not satisfy these immediate needs. This new element, the drive to investigate and explore the environment without the immediate objective of satisfying a prime biological need, is termed effectance motivation (White, 1959; Campbell, 1966).

Effectance motivation typifies the playful and exploratory activity of young mammals with those parts of the (animate and inanimate) environment that provide changing feedback. Play and exploration lead individuals to discover how the environment can be changed and manipulated. The adaptive value of play and exploratory activity is not immediately apparent. Effectance motivation is correlated with increasing complexity and gross size changes in the mammalian brain. With this increase, information input becomes the limiting factor in optimum learning. It is not mere chance that there is an increase in the size and complexity of the cerebral hemispheres among mammals concomitantly with the onset of play behavior. Input is maintained through the highly developed sense organs and effectance motivation, thus bringing the animal to heightened awareness with its surroundings. Based upon experiences provided by play and exploratory behavior, the brain can predict the likely course of external events and can fit occurrences into

the total life experience. Effectance motivation is a behavioral development based on the evolution of a larger and more complex neuronal structure. This process, by increasing one's knowledge about the environment, also increases one's chances of survival (Campbell, 1966).

The trend toward prolonged immaturity is associated with the increasing importance of learned behavior. The elongation of the juvenile developmental period appeared early in primate evolution (perhaps during the Eocene or Oligocene geological epoch). There is a recognizable extension of adolescence as one ascends the primate phylogenetic ladder (Schultz, 1956, 1969). For example, the juvenile period in lemurs is approximately 2 years, in macaques it is 4 years, in chimpanzees 8 years, and among *Homo sapiens sapiens* the juvenile period is extended to 16 years. Many have noted that retardation of growth and longer periods of infant dependency are biological bases for socialization. The longer the growth period the more time available for learning. The extended growth period "... provides the species with the capacity to learn the behavioral requirements for adapting to a wide variety of environmental conditions" (Washburn and Hamburg, 1965, p. 620).

There appears to have been selection for delayed maturation, especially among apes and man. Since higher primates are more vulnerable to death, for example, by predation and disease during the early years there must have been strong compensatory selective pressures for delayed maturation which may have come in the form of learned behavior. With retardation of growth and a longer period of infant dependency, there is a clear tendency for individual experiences to assume a more subtle role in shaping effective behavioral patterns. The extended dependency period enhances the amount and complexity of learning possible and increases opportunities to shape behavior to meet local conditions. Flexibility of behavioral patterns may be one of the principal benefits of the long period of infant dependency (Poirier, 1969*b*, 1972*a*, 1973*b*).

The basis for the flexibility of nonhuman primate behavior, their remarkable ability to adjust to new situations, seems to be related to their play behavior. Play behavior may have assumed a major role in the evolution of "non biologically programmed" responses to environmental stresses. Washburn and Hamburg (1965) suggest that play brings about a diversified sampling of the environment, important in adaptation to the ecotope. Frequent variation and modified repetition of behavior as well as the possibility for innovative behaviors are essential to the plasticity of primate behavior. Fedigan (1972, p. 363) suggests that "... play is a type of social and solitary behavior which provides these qualities during the period in which the immature individual is developing species behavior, group specific behavior, and social perception."

If the traditional view that much of early primate learning occurs during play sessions is correct, then any mechanism (e.g., prolongation of youth) providing more time for learning also provides more time for play. There appears to be a definite relationship between prolonged postnatal dependence and the increasing complexities of adult behavior and social relationships. Prolonged adolescence allows for learning in infant and juvenile play groups and provides (in species where it occurs) more time for regular contact with adults, promoting the socialization process and integrating youngsters into the social group. Nonhuman primates learn, by observation and repetition, behaviors for which they are adapted (Poirier, 1972*b*, 1973*b*). Because of the possibility for learning during play sessions, young primates may practice adult behaviors years before such behaviors must be undertaken under serious conditions. Play behavior appears to be crucial for the learning process of slowly maturing primates.

Playfulness is often characteristic of immature and hence of neotonized organisms, particularly higher animals. Playfulness is interrelated with so-called intelligent behavior in many ways. For example, playfulness facilitates the easy connectability of behavior patterns and the easy elicitation

of a great variety of behaviors (Breland and Breland, 1966). Loizos (1967) suggests that the period of maximal nonhuman primate social play may correspond to the brief period of avian imprinting, or to the critical socialization period noted in canids (Pfaffenberger and Scott, 1959). The very quality of play, exaggeration of movement, ensures maximal energy expenditure. This, in turn, reinforces the learning process.

Viewing play from an evolutionary perspective, it is clear that play is a major category of adaptive behavior that must be investigated before a complete understanding of primate socialization is possible (Dolhinow and Bishop, 1970). That play is adaptive behavior is readily demonstrated by noting the amount of time animals spend playing, the amount of energy expended, and the complexity of the behaviors involved.

ONTOGENY OF PLAY BEHAVIOR

Harlow (1963) has demonstrated five stages in the development of play behavior among laboratory rhesus macaques. Although we have little specific evidence, play behavior apparently functions differently in the individual's development at each of these various stages. Harlow's first stage is presocial play during which infants explore and manipulate all the objects in the test area, including other infants. However, contact with other infants does not lead to play interactions. The second developmental stage is labelled rough-and-tumble play. During this stage infants romp, wrestle, and roll about vigorously. The third stage, approach-withdrawal play, is characterized by pairs of monkeys chasing one another without necessarily engaging in physical contact. The fourth stage of integrated play combines rough-and-tumble and approach-withdrawal play. The fifth stage, aggressive play, appears at the end of the first year. Aggressive play is characterized by biting and pulling, which seldom results in actual injury, however it eventually graduates into true aggression. As each of these play patterns intergrades into the next successive one during the various phases of the primate

life cycle, it undoubtedly assumes varying degrees of importance at any particular point in developmental time. Not only do differing play patterns appear at definite times, it is also possible that they change function during the developmental sequence.

Poirier (1968, 1970) applied Harlow's developmental scheme in a feral study of Nilgiri langurs. While differences exist, the Nilgiri langur study suggested that certain developmental phases in play behavior are more important for socialization than others. During the presocial stage, Nilgiri langur infants occasionally explored and manipulated objects in the environment, while in the mother's presence, and usually while maintaining tactile contact. The first infant-infant contact occurred on day 25; however, there was no apparent play behavior. Playful social contacts were rather frequently established during the seventh week. At this time the first instances of play chasing were recorded; this characterized stage II play. Until now, play seemingly functions more as locomotor practice than as a means of establishing social relationships. The third developmental stage of Nilgiri langur play behavior, wrestling, appeared at approximately 9 to 10 weeks of age. Initially, the bouts were usually short as the infants tired rapidly and returned often to the mother to rest. Wrestling involved rolling and tumbling about on branches. The third stage seems an appropriate time during which social relationships and, perhaps, later dominance roles are formed. By the tenth week, playful social contacts were consistently and actively sought whenever two or more animals were in proximity. Integrated play was more complicated than earlier manifestations. Most likely this is related to a maturation of the nervous system. There is a noticeable prolongation of play sequences during stage IV, integrated play.

The amount of time a Nilgiri langur youngster engaged in play behavior increased until the juvenile or subadult developmental stage. Play behavior markedly decreased beyond the subadult stage. Adult play behavior was rarely witnessed.

In addition to physiological changes associated with the onset of sexual behavior, play-fighting seems to reduce the amount of social play and general activity. Perhaps the motivation eliciting play becomes inadequate for submerging agonistic behavior. As the intensity of play-fighting increases with consequent pain and frustration, involvement in other types of play decrease

VARIABLES INFLUENCING PLAY BEHAVIOR

Gender

There are rather clear-cut differences in play behavior which are related to gender. These often appear before the first year in the more rapidly maturing monkeys, and somewhat later in the slower maturing forms. Gender differences arise not so much in the time of onset of play (Hinde and Spencer-Booth, 1967) as in its expression. There are qualitative and quantitative differences between the play of the young male and the young female primate (i.e., Goodall, 1965; Hall and DeVore, 1966; Hall, 1968; Sorenson, 1970; Poirier, 1971, 1972*a,b*, 1973*b*; Lindburg, 1971; Burton, 1972; Smith, 1972).

Harlow and Harlow (1966) have distinguished the play of male from female laboratory rhesus at about 2 months of age. The dichotomy between male and female play also appears in the field situation. In 2 years of age, male and female baboons engage in differential play behavior. Juvenile male baboons play more roughly and frequently than juvenile females. Female baboons groom more frequently and spend more time with the newborn infants in the group (DeVore, 1965).

Dolhinow and Bishop (1970) have suggested that there is a powerful effect of endocrines in influencing sexual differentiation in play behavior. Goy and his associates (i.e., Goy, 1968) have studied hormonal influences upon the development of sexual differences in rhesus macaques. Hormonal changes may act to produce behavioral patterns in various ways (Lancaster, 1972).

The gender differences witnessed in play behavior are ultimately related to the socialization process which is, in turn, related

to respective adult roles (Poirier, 1973b). A mother's earlier rejection of a male infant forces it into early contact with other male infants. Contact usually occurs in the form of play group interactions. Among most nonhuman primates, young males show a definite preference for rough-and-tumble play and are often found in age-graded play groups which range far from the mother. At the same life stage that older juvenile and young subadult males are playing, young females are often found associated with adult females, manifesting an intense interest in newborn infants.

Fedigan (1972) has discussed gender differences in play behavior within a colony of vervets. Peer groups are a very important element of vervet play behavior. Fedigan suggests that it is probably with peer group individuals that one has the closest and most stable relationships. Adult female vervets tend to remain in close proximity for grooming and nursery groups. Adult males will also be in proximity to one another. It may be important for subordinate males to have a stable relationship with more dominant males than with dominant females or juveniles who are easily avoided. Juvenile females seem to develop their social relationships during long grooming sessions with other females and while holding or exchanging infants. "For males, peer group play provides an opportunity for many diversified interactions with the very monkeys one will 'have to live with'" (Fedigan, 1972, p. 360-361). Play should not be considered an insignificant aspect of female vervet socialization, however. Lancaster (1972) has shown that among east African vervets subadult females "play-mother" infants, thus practicing maternal roles.

Kummer (1968) notes that the earliest observed differences between the social relations of cynocephalus and hamadryas baboon females is in the amount of juvenile participation in play groups. The hamadryas play group is composed primarily of males. Cynocephalus females engage in group play up to 3 years old; however, hamadryas females older than 1 year rarely join a play group. It would be premature

to state that there is a causal relationship between the hamadryas female's limited social experience in play groups and their failure to develop into independent and freely moving group members, but the possibility exists.

Ransom and Rowell's (1972) study of feral baboons shows that differences in peer interactions appear as early as 2 or 3 months. By the transitional period to the juvenile stage, there are clear sexual differences in play behavior, which increase with age. By the birth of the next infant, young males have joined relatively permanent peer play groups where they spend considerable time. Young females, however, avoid rough and prolonged peer-group interactions and spend most of their time in the mother sub-group.

Sociographic analyses among nonhuman primates show that male juveniles interact in larger groups than females, who mainly associate with only one partner. A similar pattern has been found to be true with human children (Knudson, 1971, 1973).

Age

The incidence of play decreases with age. Adult play is an infrequent activity, especially among males. Adults do not engage in playful activities because (i) There is potential danger to the would-be player. A misinterpreted signal could result in considerably greater damage than in juvenile play bouts. (ii) Adults generally enforce a certain modicum of social space not conducive to the initiation of play. (iii) Activity or action without observable reason is much less frequent among post-adolescent primates than among younger ones (Dolhinow and Bishop, 1970).

There is another possibility why younger animals are more playful. Recent studies of Japanese macaques (Itani, 1958; Tsumori, 1967; Frisch, 1968) and Nilgiri langurs (Poirier, 1968, 1969b, 1970, 1972b, 1973b) indicate that immature animals are the most explorative, flexible in behavioral patterns, and innovative. These animals often introduce new behavioral patterns to the group. Immature animals seem to test

the environment more than the adults, and therefore tend to be more open to change and more innovative. The data on Japanese macaques suggest that beyond 3 years of age individuals tend to stagnate in their adaptability to new situations (Itani, 1958; Kawai, 1965; Tsumori, Kawai, and Motoyoshi, 1965). Data on Nilgiri langurs (Poirier, 1969b, 1970) suggest that it is not only the infants, but more specifically infant males, who are the most innovative.

Kummer (1971) attempts to explain why infants are more innovative by suggesting a selective advantage for behavioral conservatism. The less flexible adults form a safety reservoir of previous behavior variants. In the learning and spreading of new behavioral patterns, adult rigidity functions as low mutation rates in evolution. Juveniles (and in many cases excess males) are the most obvious candidates for acquiring new behavioral patterns since they are the most easily replaced investment in terms of food and experience.

The logical extension of this argument is that play is not only an important integrating mechanism on the individual level, it is also important for group survival. A species may ultimately ensure its survival by allowing its younger members playful experimentation and manipulation of the environment. New behavioral patterns acquired during play, new foods tasted, new travel routes discovered, may become crucial in the younger animal's assumption of adult roles. Perhaps one reason males tend to play more than females is because males will eventually assume a leader role. Elsewhere it has been argued that females are behaviorally more conservative than males (Poirier 1969b, 1970, 1972a,b, 1973b). This is reflected in their various play behaviors, males being more playful (more prone to exploration) than the females.

Group structure and population dynamics

There is obviously some relationship between the amount of play behavior and the number of infants available for play activity. The availability of peers is influ-

enced by population dynamics and group structure. The demographic composition of primate social groups undoubtedly has some effect on play behavior, especially in the formation of infant peer play groups. The age/sex compositions of many primate groups lend themselves to the formation of large play groups more readily than others.

It has been suggested that the time of birth may affect play behavior. Baldwin (1969) reports that among squirrel monkeys infants born early in the birth season have few play partners other than stronger and more behaviorally sophisticated juveniles. However, individuals born late in the birth season interact with a preponderance of infants and consequently may be the more helpless of their age class (Hinde, 1971).

Poirier (1969a, 1970, 1972a) mentions that the limited number of available playmates in many Nilgiri langur groups influences the socialization process. A maturing youngster in an average Nilgiri langur group has limited opportunities for peer social interaction. While the consequences of this are yet to be fully understood, it has been suggested that the dearth of play (and grooming) behavior, both of which tend to establish and reinforce social bonds, may have militated against the formation of strong group ties (Poirier, 1969a, 1970). One of the explanations offered for the loose Nilgiri langur group structure, and the consequent fragmentation of some groups, is that youngsters have minimal social interaction with one another. Nilgiri langurs seem to lack one of the most important troop cohesive behaviors, play, found among many other species.

Ellefson (1967, 1968) has also suggested a possible relationship between play, or lack thereof, and social organization. Based on his gibbon study, Ellefson has suggested that the lack of play among gibbons is due to the absence of possible playmates and to disparities in size, strength, and coordination. In turn, these conditions are due to age differences between nonadults in the gibbon group, the ultimate result of their "family" social structure.

Econiche

The primate literature suggests that terrestrial species generally spend more time in play activity than arboreal species. The ecological setting affects play behavior both qualitatively and quantitatively. Since play behavior is often cited as a group-integrating mechanism, it may be that the more cohesive terrestrial macaques, baboons, and langurs require play to maintain troop cohesion and adult cooperation. Jolly (1972) suggests there are differences in the play of predominantly terrestrial and arboreal species. The quality of play reported for savanna-dwelling baboons (Washburn and DeVore, 1961) compared with that of forest-living baboons (Rowell, 1966) suggests differences. Furthermore, the environmental setting has been demonstrated to affect play in pigtail macaques in the laboratory situation (Jensen et al., 1968).

FUNCTIONS OF PLAY BEHAVIOR

Social Development

Play is one of the first non-mother-directed activities appearing in ontogenetic development. It is generally accepted that involvement in play behavior is fundamental to the development of future skills requisite for survival. The hopping, chasing, and wrestling bouts characteristic of play behavior help increase a youngster's muscular coordination. Key elements of social life, the development of social bonds, grooming, components of sexual behavior, and aggression, are to some degree learned and rehearsed in the play group. Mason (1965, p. 530) notes that "playfulness . . . is rightly regarded as a useful index of the physical and psychological well-being of the young primate. Its prolonged absence raised the suspicion of retardation, illness, or distress."

Laboratory studies have fully documented the need for social interaction in order for full social and physical development. Much of what is considered "normal" development does not occur unless an animal has had the opportunity for peer play group interaction. The importance of the peer group has been documented by Harlow's

(1969) studies on the relative importance of the mother and the peer group in the social development of young rhesus. Harlow's studies provide evidence for the field workers' impressions that play within the peer group is important for the full development of social behaviors. Deprivation studies have shown that peer play interaction is more important for the development of normal social behaviors than maternal interaction (Harlow, 1969). Even brief daily play-sessions between infants raised with surrogate mothers fully compensated for their lack of real mothering. At similar chronological ages, these infants developed a repertoire of infant-infant play relations and, later on, adult sexual behaviors, as varied as that of infants raised with mothers in the playpen. Surrogate-raised infants which were allowed 20 min of play per day with their peer group were considerably better adjusted adults than infants raised with their mothers alone.

As Bekoff (1972) noted, play with peers is important enough that peer interaction can override the effects of maternal separation making it a less traumatic experience, as demonstrated by Harlow (1969) and Tisza et al., (1970) studying infant rhesus monkeys and hospitalized children respectively. Harlow et al. (1971) studying the social recovery of isolated monkeys, stated that the most critical and valid measures of social recovery were those of social contact and play.

Mason's work (e.g., 1961, 1963) clearly shows that animals with restricted social experiences, those raised in isolation, show strikingly abnormal sexual, grooming, and aggressive social patterns. Laboratory studies suggest that the full development of an animal's biological potentialities requires the stimulus and direction of social forces normally encountered in the peer play group as well as in the larger social group (Harlow, 1963, 1966; Mason, 1963, 1965).

Establishment of the dominance hierarchy

The basis of the adult dominance hierarchy may be formed in the play group. Play behavior may help youngsters find

their place in the existent social order (Carpenter, 1934). In the course of play youngsters may compete for food, sleeping positions, the most convenient pathways, as well as for other "valued" items. Through trial and error, through the constant repetition of behaviors characteristic of play, an infant learns the limits of its self-assertive capabilities. Early dominance patterns may appear in rough-and-tumble play. Wrestling bouts characteristic of play give a growing primate practice in behavior that, at least in part, influences its social position. Although dominance among juveniles is mostly a function of relative size, during play juveniles gain social experience and become familiar with both dominant and subordinate situations (Dolhinow and Bishop, 1970). The play group provides an environment in which mistakes and experimentation can go without punishment or threat of danger from other monkeys. Adjustments appear during play (i.e., animals learn each other's aggressive and defensive capabilities) enabling a young primate to function properly as an adult of the species and to occupy a place within the group's social organization. The play group is the center for experimental learning because its members, mostly peers, are young and their teeth are neither sharp nor long enough to inflict damage.

Social integration

Social play is one of the most interesting modes whereby animals appear to maintain familiarity with other group members. Play must help establish and maintain social affinities. It is noteworthy that play is rare among adults where social relations are already well established. Play may be considered one of the means of reiterated stimulus exchange whereby social animals maintain their familiarity with one another as individuals (Etkin, 1967). In play, young social mammals learn their place in the group and develop appropriate in-group feelings. Play maintains pair relations in social mammals, replacing the kumpan relation commonly serving this function in lower vertebrates.

Play facilitates the individual's integration into its troop and eventual reproductive success. During play animals learn patterns of social cooperation, without exceeding certain limits of aggression. Diamond (1970) notes that cooperation of this kind brings its own rewards. Aggressive, non-cooperative animals may be socially rejected, and perhaps physically excluded from the group. A most obvious example of cooperative interaction in adult social behavior is sexual behavior, in which a complicated interactional chain occurs. Play behavior relates to learning in early infancy and to the behavioral dialogue between mother and offspring, as well as between peers.

Harlow and Harlow (1966) state that the successful initiation of social or interactive play is crucial to the development of an age-mate affectional system. If youngsters lack the opportunity to play, they are faced with the options either of being maladjusted or of being excluded from the social group (Carpenter, 1965). The integration of an individual into a peer play group allows juveniles to establish relationships that will later help maintain group unity. The play group is perhaps the major context for learning social and physical skills, and as such it is an important factor in social integration. On the basis of his patas study, Hall (1968) suggested that play behavior among patas males may contribute towards the decision of whether or not a male stays in the group or is temporarily eliminated from it. Jay (1963) has also noted that through their play male juvenile langurs establish the close bonds that will later help maintain group unity.

A "test" of the integrative function of play behavior occurred during the process whereby three "bachelor" males joined a bisexual Nilgiri langur troop (Poirier, 1969a, 1970). Play behavior between an infant-2 and members of the bachelor group assumed a major role facilitating the integration of the males into the bisexual group. Play behavior accounted for 31% of the observed interactions during the first 2 weeks of merging. Play behavior was particularly striking in view of the fact that the domi-

nant male of the bachelor trio played with the infant during this period. Once the trio merged with the group, the dominant male ignored the infant.

Social communication

One feature of mammalian play behavior seems to be universal: most play behavior is performed by immature animals. Although the equation of youth with play is usually a valid generalization, adults do play in some species (e.g., among bonnet macaques) (Simonds, 1965). Nevertheless play behavior is often suggested as one means whereby young animals practice their adult roles. Loizos (1967) has questioned the all-or-none assumption that play as practice or rehearsal of behavior improves one's efficiency in adult life. However, Loizos admits that play is an important part of the normal maturation of the young primate.

Play behavior serves to fully acquaint an animal with its species-specific, and perhaps group-specific, communication matrix. Isolation studies have clearly documented that socially deprived animals have problems with response integration and communication. Although the socially deprived animals exhibited most components of normal social behavior, these components were not combined into an integrated pattern and effectively applied in social interaction. Mason (1963) believes this to be a deficiency in sensory-motor learning or "shaping." Although all basic postures, gestures, and vocalizations are probably unlearned, their effectiveness in social interaction is dependent upon experiences. This applies to the reception as well as the sending of messages. Messages within the communication matrix can only be effective if individuals know their meanings. Animals raised in isolation, without benefit of social experiences (such as provided in play) are both poor senders and poor receivers. These animals are incapable of response integration in an appropriate context.

Perhaps one of the most useful approaches to understanding the role of play in the socialization process is to consider

play as a kind of "grammatical structure" (Chomsky, 1965). During their development, the players learn the behavioral syntax of particular interactions. If play is a developing, dynamic behavior, then it is useful to consider the learning of this behavioral syntax as a mathematical game, as suggested by Kalmus (1969). Consideration of play as a mathematical game allows us to look at the two components of such a game: (i) a finite number of rules or positions and (ii) the rules specifying the outcome. In play behavior, there are undeniably precise rules that the infant must learn. Certainly, the acquisition of an adequate performance and competence in the rules of play (following Kalmus) is a developmental process spread over the juvenile period. The rules that a young primate must learn are not without some sort of logical connection of structure. Nonsense grammatical structures are unintelligible, so also are behavioral patterns improperly strung together. Altmann's (1965) stochastic approach to rhesus communication clearly shows that there is considerable predictability within the communication system of properly socialized animals.

As a primate develops more elaborate and intense play behavior, it orders the rules of the game into the correct sequence for proper functioning in a social unit. The key to the acquisition of these rules is in the sequencing of the playful interactions and the association of relatively disjunctive units of behavior into larger functional categories. The behavioral syntax for certain adult behaviors is learned through repetition in the playful situation.

An aspect vital to learning the rules of appropriate play behavior is the development of communicative ability. Bateson (1955) notes that play can only occur when primates are capable of some degree of metacommunication to carry the message, "This is play." Altmann (1965) points out that it is the development of a system of metacommunication, communication about communication, that allows the animal's full participation in adult behaviors. Sade (1973) notes that the first stage in the development of this metacommunicatory abil-

ity necessary for play behavior is anatomical and neurological sophistication to the point of adequate performance of rotary bodily movements in the transverse plane. He notes that this posture is characteristic of the initiation of playful behavior in rhesus. The key to understanding primate play behavior may rest with discerning discrete elements of the metacommunicatory system. Fedigan (1972) suggests that the ability to predict other individuals' behavior and to react accordingly, might be termed "social perception." This, she suggests, is a fundamental social skill of most primates. Perhaps play behavior is a very important context for the development of social perception.

If it is possible to view social play as a kind of communication system, then it might be of some utility to consider the application of certain models developed in communication theory to enhance our understanding of the basis of social play. Recently, Goyer (1970) proposed a structural pattern for approaching the study of communicative behavior in which any communicative event may be seen as a dynamic system in which information is transferred between a message generator and a message perceiver. If such a situation is intrinsic to communicative behavior, then it is relatively easy to see the application of such a notion to social play behavior.

If the play bout is perceived as a communicative event, then we may view the behaviors involved as transmitting messages, correspondingly affecting the interactants' behavior. It is useful to consider this type of exchange of messages in analogy to a DNA helical strand, with the roles of generator and perceiver of the messages overlapping, and reversing through time (Goyer, 1970). If the overlapping strands of the helical model are considered as interactions, one can see how roles in the play encounter are easily reversed with animals readily changing from the role of generator to perceiver (Smith, 1973).

Social play can be seen, in this context, as one aspect of development, with time as an important factor in its manifestation. As the young animal matures then, these com-

municative events, play bouts, may become longer and more meaningful. Only through perceiving play as this type of ongoing process can we come to fully understand its real basis.

It is our opinion that one of the most important socializing functions of play behavior is the learning of proper social communication (but see Baldwin and Baldwin, 1974; Symons, 1974; Bekoff, 1974). During play infants learn that there are restraints upon the recombination of communicative acts. They learn that certain sequences (communication chains) are far more useful to them as individuals than are others. The sequences in which communicative units are strung together is learned, and the mode of recombination for each animal depends upon previous social experiences. Perhaps within the play group animals learn to predict one another's behaviors. (It is this predictability, in the final analysis, which allows our description of social behavioral patterns.) The value of such predictability is quite obvious if one considers the fate of an animal continually issuing inappropriate responses.

The relative success or failure of any social animal relates to its ability to associate properly with its role, to communicate with the appropriate signals at the appropriate time. Each animal assumes various roles during the daily cycle; each role entails a set (perhaps an opposing set) of communicative actions. Animals must learn, by the juvenile stage, to alternate between what may be termed "primary" and "secondary" responses. They must be able to switch from one role to another, called code switching, without interference (Haugen, 1953). For example, a beta animal's "primary" responses are those associated with its subordinate position in relation to the alpha animal. The appropriate use of these responses can be learned and practiced, with minimal risk, during the formative stages in play behavior.

CONCLUSION

Most researchers agree on the fundamental importance of play behavior in the "nor-

mal" development of the young primate. Through experience gained in play the young primate equips itself for adult patterns of social interaction. By its nature, primate play affords the maximum opportunity for learning the intricacies of adult life. However, play behavior is quite variable and is dependent on the influence of a number of factors.

An understanding of the complex repertoire of signals employed in playful interaction is another area of fruitful research. Only through an ethological study of play itself will we come to appreciate its full significance in the socialization process. Conceptualization of play as having a behavioral syntax may allow us to appreciate more fully the interrelationship of the various behavioral patterns comprising play.

REFERENCES

- Altmann, S. A. 1965. Sociobiology of rhesus monkeys. II. Stochastics of social communication. *J. Theoret. Biol.* 8:490-522.
- Baldwin, J. D. 1969. The ontogeny of social behavior of squirrel monkeys (*Saimiri sciureus*) in a semi-natural environment. *Folia primatol.* 11:35-79.
- Baldwin, J. D., and J. I. Baldwin. 1972. The ecology and behavior of squirrel monkeys (*Saimiri oerstedii*) in a natural forest in Western Panama. *Folia Primatol.* 18:161-184.
- Baldwin, J. D., and J. I. Baldwin. 1974. Exploration and social play in squirrel monkeys (*Saimiri*). *Amer. Zool.* 14:303-315.
- Bateson, G. 1955. A theory of play and fantasy. *Psychiat. Res. Rep.* 2:39-51.
- Bekoff, M. 1972. The development of social interaction, play and metacommunication in mammals: an ethological perspective. *Quart. Rev. Biol.* 47:412-433.
- Bekoff, M. 1974. Social play and play soliciting by infant canids. *Amer. Zool.* 14:323-340.
- Bernstein, I. S. 1962. Response to nesting materials of wild born and captive chimpanzees. *Anim. Behav.* 10:1.
- Breland, K., and M. Breland. 1966. *Animal behavior*. Macmillan, New York.
- Buton, F. D. 1972. The integration of biology and behavior in the socialization of *Macaca sylvana* of Gibraltar, p. 29-62. In F. Poirier [ed.], *Primate socialization*. Random House, New York.
- Campbell, B. 1966. *Human evolution*. Aldine Publ. Co., Chicago.
- Carpenter, C. R. 1974. A field study of the behavior and social relations of howling monkeys. *Comp. Psychol. Monogr.* 10:1-168.
- Carpenter, C. R. 1965. Naturalistic behavior of non-human primates. Pennsylvania State Univ. Press, University Park.
- Chomsky, N. 1965. *Aspects of the theory of language*. Mass. Inst. Tech. Press, Boston.
- DeVore, I. 1963. Mother-infant relations in free-ranging baboons, p. 305-335. In H. L. Rheingold [ed.], *Maternal behavior in mammals*. Wiley, New York.
- DeVore, I. 1965. Mother-infant relations in free-ranging baboons, p. 541-558. In T. McGill [ed.], *Readings in animal behavior*. Holt, Rinehart and Winston, New York.
- Diamond, S. 1970. *The social behavior of animals*. Harper, New York.
- Dolhinow, P. C., and N. Bishop. 1970. The development of motor skills and social relationships among primates through play. *Minn. Symp. Child Psychol.* 4:141-198.
- Ellefsen, J. O. 1967. A natural history of the gibbon of the Malay Peninsula. Ph.D. Diss. Univ. California, Berkeley.
- Ellefsen, J. O. 1968. Territorial behavior in the common white-handed gibbon. *Hylobates lar*, p. 180-199. In P. C. Jay [ed.], *Primates: studies in adaptation and variability*. Holt, Rinehart, and Winston, New York.
- Etkin, W. 1967. *Social behavior from fish to man*. Univ. Chicago Press, Chicago.
- Fedigan, L. 1972. Social and solitary play in a colony of vervet monkeys (*Cercopithecus aethiops*). *Primates* 13:347-364.
- Frisch, J. 1968. Individual behavior and intergroup variability in Japanese macaques, p. 243-253. In P. Jay [ed.], *Primates: studies in adaptation and variability*. Holt, Rinehart & Winston, New York.
- Goodall, J. 1965. Chimpanzees of the Gombe Stream, p. 425-473. In I. DeVore [ed.], *Primate behavior: field studies of monkeys and apes*. Holt, Rinehart, and Winston, New York.
- Goy, R. 1968. Organizing effects of androgen on the behavior of rhesus monkeys, p. 12-31. In R. Michael [ed.], *Endocrinology and human behavior*. Oxford Univ. Press, London.
- Goyer, R. S. 1970. Communication process, meaning: toward a unified theory. *J. Comm.* 20:4-16.
- Hall, K. R. L. 1968. The behaviour and ecology of the wild patas monkey, *Erythrocebus patas*, in Uganda, p. 32-119. In P. C. Jay [ed.], *Primates: studies in adaptation and variability*. Holt, Rinehart and Winston, New York.
- Hall, K. R. L., and I. DeVore. 1961. Baboon social behavior, p. 53-110. In I. DeVore [ed.], *Primate behavior: field studies of monkeys and apes*. Holt, Rinehart, and Winston, New York.
- Harlow, H. 1963. Basic social capacity of primates, p. 153-161. In C. H. Southwick [ed.], *Primate social behavior*. D. Van Nostrand Company, Inc., Princeton.
- Harlow H. F. The primate socialization motives. *Trans. Stud. Coll. Physicians Philadelphia.* 33: 224-237.
- Harlow H. F. 1969. Age-mate or peer affectional systems. *Advan. Stud. Behav.* 2:333-383.
- Harlow, H. F., and M. K. Harlow. 1966. Learning to love. *Amer. Sci.* 54:244-272.
- Harlow, H. F., M. Harlow, and S. Suomi. 1971. From thought to therapy: lessons from a primate laboratory. *Amer. Sci.* 59:538-550.
- Haugen, I. 1953. *The Norwegian language in America*. Univ. Pennsylvania Press, Philadelphia.
- Hinde, R. A. 1971. Development of social behavior, p. 1-68. In A. M. Schrier and F. Stollnitz [ed.], *Behavior of non-human primates*, Vol. 3. Academic Press, New York.
- Hinde, R. A., and Y. Spencer-Booth. 1967. The behaviour of socially living rhesus monkeys in their first two and a half years. *Anim. Behav.* 15:169-196.
- Itani, J. 1958. On the acquisition and propagation of a new food habit in the natural group of the wild Japanese monkey at Takasakiyama. *Primates* 1:2:84-98.
- Jay, P. C. 1963. Mother-infant relations in langurs, p. 282-304. In H. L. Rheingold [ed.], *Maternal behavior in mammals*. John Wiley, New York.
- Jensen, G. D., R. A. Bobbitt, and B. N. Gordon. Sex differences in the development of independence of infant monkeys. *Behaviour* 30:1-14.
- Jolly, A. 1972. *The evolution of primate behavior*. MacMillan, New York.
- Kalmus, H. 1969. Animal behavior and theories of games and of language. *Anim. Behav.* 17:607-617.
- Kaufman, J. H. 1966. Behavior of infant rhesus monkeys and their mothers in a free-ranging band. *Zoologica* 51:17-28.
- Kawai, M. 1965. Newly acquired precultural behavior of the natural troop of Japanese monkeys on Koshima Islet. *Primates* 6:1-30.
- Knudson, M. 1971. Sex differences in dominance behavior of young human primates. Paper presented at 70th Annual Meeting, American Anthropological Association, New York City.
- Knudson, M. 1973. Sex differences in dominance behavior of young human primates. Ph.D. Diss., Univ. Oregon, Eugene.
- Kummer, H. 1968. Two variations in the social organization of baboons, p. 293-312. In P. C. Jay [ed.], *Primates: studies in adaptation and variability*. Holt, Rinehart, and Winston, New York.
- Kummer, H. 1971. *Primate societies*. Aldine-Atherton, Chicago.
- Lancaster, J. 1972. Play-mothering: the relations between juvenile females and young infants among free-ranging vervet monkeys, p. 83-104. In F. Poirier [ed.], *Primate socialization*. Random House, New York.
- Lindburg, D. G. 1971. The rhesus monkey in North India, p. 1-106. In L. A. Rosenblum [ed.], *Primate behavior: developments in field and laboratory research*. Vol. 2. Academic Press, New York.
- Loizos, C. 1967. Play behavior in higher primates, p. 226-282. In D. Morris [ed.], *Primate ethology*. Aldine, Chicago.
- Loy, J. 1970. Behavioral responses of free-ranging rhesus monkeys to food shortage. *Amer. J. Phys. Anthropol.* 33:263-272.
- Mason, W. 1961. The effects of social restriction on the behavior of rhesus monkeys: I. Free social behavior. *J. Comp. Physiol. Psychol.* 54:287-290.
- Mason, W. 1963. The effects of environmental restriction on the social development of rhesus monkeys, p. 161-174. In C. H. Southwick [ed.], *Primate social behavior*. D. Van Nostrand, Princeton.
- Mason, W. 1965. The social development of monkeys and apes, p. 514-544. In I. DeVore [ed.], *Primate behavior: field studies of monkeys and apes*. Holt, Rinehart, and Winston, New York.
- Meyer-Holzappel, M. 1956a. Über die Bereitschaft zu Spiel- und Instinkthandlungen. *Z. Tierpsychol.* 13:442-462.
- Meyer-Holzappel, M. 1956b. Das Spiel bei Säugetieren. *Hanb. Zool.*, Berlin 8(10), 5:1-36.
- Pfaffenberger, C. J., and J. P. Scott. 1959. The relationship between delayed socialization and trainability in guide dogs. *J. Gen. Psychol.* 95:145-155.
- Poirier, F. 1968. The ecology and social behavior of the Nilgiri langur (*Presbytis johnii*) of South India. Ph.D. Diss., Univ. Oregon, Eugene.
- Poirier, F. 1969a. The Nilgiri langur troop: its composition, structure, function, and change. *Folia Primatol.* 19:20-47.
- Poirier, F. 1969b. Behavioral flexibility and intergroup variability among Nilgiri langur of South India. *Folia Primatol.* 19:119-133.
- Poirier, F. 1970. Nilgiri langur ecology and social behavior, p. 251-383. In L. A. Rosenblum [ed.], *Primate behavior: developments in field and laboratory research*. Academic Press, New York.
- Poirier, F. 1971. Socialization variables. Paper presented at 70th Annual American Anthropological Association Meetings, New York City.
- Poirier, F. 1972a. Introduction, p. 3-29. In F. Poirier [ed.], *Primate socialization*. Random House, New York.
- Poirier, F. 1972b. Primate socialization and learning. Paper presented at American Ethnological Society Meetings, Montreal.
- Poirier, F. 1973a. Primate socialization—where do we go from here? Paper presented at American Association of Physical Anthropologists Meeting, Dallas.
- Poirier, F. 1973b. Primate socialization and learning, p. 3-41. In S. Kimball, J. Burnett [ed.], *Learning and culture*. Univ. Washington Press, Seattle.
- Ransom, T., and Rowell, T. 1972. Early social development of feral baboons, p. 105-144. In F. Poirier [ed.], *Primate socialization*. Random House, New York.
- Rowell, T. E. 1966. Forest-living baboons in Uganda. *J. Zool. Soc. London* 149:344-363.
- Sade, D. S. 1973. An ethogram for rhesus monkeys. I. Antithetical contrasts in posture and movement. *Amer. J. Phys. Anthropol.* 38:537-542.
- Schultz, A., 1956. Postembryonic age changes, p. 887-964. In H. Hofer, H. Schultz, and D. Starck [ed.], *Primateologia*, S. Karger, Basel.
- Schultz, A. 1969. *The life of primates*. Weidenfeld and Nicolson, London.
- Simonds, P. 1965. The bonnet macaque in South

- India, p. 175-197. In I. DeVore [ed.], Primate behavior: field studies of monkeys and apes. Holt, Rinehart and Winston, New York.
- Smith, E. O. 1972. The interrelationship of age and status, and selected behavioral categories in male pigtail macaques (*Macaca nemestrina*). Master's thesis. Univ. Georgia, Athens.
- Smith, E. O. 1973. A model for the study of social play in non-human primates. Paper presented at the Midwestern Regional Meeting of the Animal Behavior Society, Oxford, Ohio.
- Sorenson, M. W. 1970. Behavior of tree shrews, p. 141-194. In L. A. Rosenblum [ed.], Primate behavior: developments in field and laboratory research. Academic Press, New York.
- Symons, D. 1974. Aggressive play and communication in rhesus monkeys (*Macaca mulatta*). Amer. Zool. 14:317-322.
- Tisza, V., I. Hurwitz, and K. Angoff, 1970. The use of a play program by hospitalized children. J. Amer. Acad. Child. Psychiat. 9:515-531.
- Tsumori, A. 1967. Newly acquired behavior and social interaction of Japanese monkeys, p. 207-221. In S. A. Altmann [ed.], Social communication among primates. Univ. Chicago Press, Chicago.
- Tsumori, A., M. Kawai, and R. Motoyoshi. 1965. Delayed response of wild Japanese monkeys by the sand-digging test (1)—case of the Koshima troop. Primates 6:195-212.
- Washburn, S. 1973. Primate field studies and social science, p. 128-135. In L. Nader and T. Maretzi [ed.], in Cultural illness and health. American Anthropological Association, Washington.
- Washburn, S. L., and I. DeVore. 1961. The social life of baboons. Sci. Amer. 204:62-71.
- Washburn, S., and D. Hamburg. 1965. The implications of primate research, p. 607-623. In I. DeVore [ed.], Primate behavior: field studies of monkeys and apes. Holt, Rinehart, and Winston, New York.
- White, R. 1959. Motivation reconsidered: the concept of competence. Psych. Rev. 66:297-333.