

CONTEXTS AND PREDICTABILITY OF AGGRESSION IN CHIMPANZEES

By FRANS B. M. DE WAAL & JANNEKE A. HOEKSTRA

*Laboratory of Comparative Physiology of the University of Utrecht, Jan van Galenstraat 40,
3572 LA Utrecht, The Netherlands*

Abstract. Reasons for aggression may be deduced from the situations preceding aggressive behaviour. This we may call the *retrospective approach*. In addition to results from this conventional procedure the present paper investigates the predictability of aggressive behaviour. In this so-called *anticipatory approach*, particular non-agonistic events were used as predictors of aggression. These events had in common that they were intuitively judged to be unpleasant for one of the chimpanzees. This individual was observed during the next 10 min in order to establish if its inclination to exhibit aggression had increased shortly after that seemingly frustrating event. The studies reported here were carried out on a colony of 20 semi-free-living chimpanzees *Pan troglodytes* in Arnhem Zoo. The data show that: (1) half of all aggressive actions arose in agonistic contexts: thus aggression was contagious; (2) adult males performed apparent spontaneous aggression remarkably often: this result is suggested to reflect dominance-rivalry among males; (3) aggressive behaviour was predictable on the basis of intuition, but attempts to account for the observer's intuitive knowledge were not entirely successful.

Human intuition plays a cardinal, though tacit role, in the recognition and interpretation of animal behaviour (Hebb 1946; Lorenz 1959), and thus in the generation of verifiable hypotheses. Nowadays, while most ethologists may not deny this role, subjectivistic (Lorenzian) accounts are frowned upon. They may only be excused if announced as preliminary steps toward a more objectivistic (Tinbergian) approach.

Objections to such studies may be forestalled by working with a number of observers and demonstrating close agreement between their subjective judgments, as was done by Buirski et al. (1978). However, the great interobserver consistency they report still leaves some cause for doubt. For example, the possibility remains that the suggested human-like personality differences between male and female chimpanzees simply reflect Western gender-role prejudices shared by observers of humans and chimps (Shields 1978) and all observers may have biased each other. Nevertheless, the work by Buirski et al. suggests an acceptable way to take advantage of explicit empathy in the study of animal behaviour (see also Stevenson-Hinde & Zunz 1978).

Another way of assessing the reliability of human intuition is by basing predictions on it and then comparing these with the outcome. This method has been used in this investigation of the external sources of chimpanzee aggression. It consisted of observing individuals after their participation in particular non-agonistic inter-

actions which, according to the observer's intuition, might increase the chance of future aggression. The actual subsequent reactions were compared to the anticipated aggressive behaviour. Up to now this approach is untried in the field of intra-group antagonism, but it may appear a fruitful method provided, of course, observers are conscious of most premises, steps of deduction and components of Gestalt-perception underlying their intuition. It may be called the *anticipatory approach*.

Our second method was to look back in time at the situation just before an aggressive incident in order to detect, or remember, the 'context', i.e. events that might have instigated the aggression. This is the conventional method of investigation in the non-experimental field, and it may be called the *retrospective approach*.

Most authors studying the problem of aggression-causation in this way provide informative definitions of contexts, but we have not seen lists with mutually exclusive definitions allowing for unequivocal classification. Yet, concurrence of two or more context-types is not rare in the real world (Moyer 1976, page 135). For example, fighting induced by food provision to hamadryas baboons may fit many existing definitions of 'food competition', but could be classified as defence of harem integrity (Kummer 1971, page 103).

Concurring context-types leave subjectivity room to influence decisions and the observer's familiarity with the animals in the group may thus be of greater weight than usual in this type

of study. The observer must 'know where to look' and be able to distinguish between 'relevant' and 'irrelevant' aspects of the complex social situations preceding aggression in a group of animals. The retrospective approach is therefore best regarded as only semi-objective. One requirement of classifying context-types should be that they refer exclusively to situations observable on the spot. Thus Bygott (1974, page 73) warns against inclusion of contexts such as the presumed nature of particular inter-individual relationships. (Note that this does not alter the fact that the nature of a relationship may be a relevant causal factor.)

For results of the retrospective approach to primate aggression, see Hall (1965), Hamburg (1974), Nagel and Kummer (1974), Seyfarth (1976), and Ehrlich and Musicant (1977). However, in view of our subject, the accounts by van Lawick-Goodall (1968a) and Bygott (1974) on chimpanzees in the Gombe Stream National Park, Tanzania, are specially relevant. Bygott (1974) analysed the contexts of 83 attacks delivered by adult male chimpanzees outside the banana provision area and reports that 88% had arisen in three contexts only: (1) encounter after at least half an hour of separation (see also Bauer 1975); (2) excitement over food, e.g. meat; and (3) recent occurrence of other attacks. The last category will be called 'agonistic context' in this paper and is of outstanding importance in most primate groups. 'Aggression has a universal quality of contagion' observes Marler (1976, page 243), and macaques even have a special type of aggressive behaviour that demonstrably stimulates others to join in the fight (de Waal et al. 1976).

Van Lawick-Goodall (1968a) draws attention to the role of frustration. She describes how chimpanzees express apparent frustration in 'displacement activities', such as scratching, yawning, charging display and aggression. She also noticed a sort of catharsis effect: 'An individual often seemed to be more relaxed after performing one or more of these display patterns' (page 331).

The relation between frustration and aggression has been investigated intensively since the classic publication by Dollard et al. (1939). With a few exceptions (e.g. Harris 1974) this research has been carried out in laboratory settings, and non-experimental investigations are unknown to us. However, the present study, while only covering spontaneous behaviour, did

identify seemingly frustrating events as predictors of aggression.

Methods

The Chimpanzee Colony

The colony in Arnhem Zoo (The Netherlands) was established in 1971, and its composition during our study in summer 1976 was as follows: three adult males; one adolescent male; nine adult females; four juvenile females; and three infant males. Adults and adolescents will be taken together as 'seniors', and juveniles and infants as 'juniors'. During the winter these 20 chimpanzees live in a community hall (21 × 18 m) and they spend the summer in a 'forest' of approximately 1 ha. For further details on the colony see van Hooff (1973) and de Waal (1978). In connection with aggression-causation the following situations are important:

Feeding. As we know that feeding a group of chimpanzees may induce an intolerably high level of aggression (e.g. Wrangham 1974) our apes never receive food while all together. The keeper feeds them twice daily in their night-cages, in which they spend the night separated in groups of two to four animals. Zoo visitors are prevented from feeding the apes.

Reunion. When the chimpanzees leave their night cages and meet each other at about 0930 hours in the hall or outside enclosure, there is a lot of excitement and aggression for about 10 min, as reported for reunions between feral chimpanzees by Bygott (1974) and Bauer (1975). Two such meetings have been included in our data on the retrospective approach, constituting only about 0.5% of observation time.

Definitions

We employ a very strict definition of 'agonistic interaction', or 'conflict', based on van Hooff's (1974) work (de Waal 1978). Accordingly, at least one of the following nine behaviour patterns must have been observed: 'tug', 'brusque rush', 'bite', 'grunt-bark', 'shrill-bark', 'flight', 'crouch', 'bared-teeth scream' and 'shrink, flinch'. Definitions of these patterns, and of others mentioned in this paper, have been provided by van Hooff (1974). The first (and often only) performer of aggressive behaviour within an agonistic dyad (i.e. a two-animal interaction) will be called the aggressor, and this act itself an aggressive action. Not only attacks but also threats fit this definition of an aggressive action.

Interruptions (i.e. periods without any agonistic behaviour) shorter than 2 min are included within one agonistic interaction. Thus if A shows an aggressive action towards B during or within 2 min after a conflict between B and C this sequence is regarded as a single interaction with two agonistic dyadic components. The second dyad (AB) is said to have arisen in an agonistic context, and the first (BC) in a non-agonistic context. These two context types are mutually exclusive, and need further splitting up. This paper is only concerned with non-agonistic contexts, however.

The category 'non-agonistic context' includes all aggressive actions not preceded within 2 min by agonistic behaviour by any animals in the group. The first subdivision of this category is into 'unknown' and 'known' contexts. 'Unknown' refers to instances when the observer had been unable to relate the aggression to any particular aspect of the foregoing situation in spite of having observed that situation. Secondly, the following 'known' non-agonistic contexts are distinguished.

Play: a conflict starts during rough gnaw-wrestling with 'relaxed open-mouth face'.

Infant protection: an aggressive action preventing an infant from being touched by an approaching chimp, or stopping the awkward handling of an infant by another chimp.

Annoyance: a chimp evokes aggression in another after having thrown sand in its face, having jumped on its head, or other presumably discomforting actions.

Social competition: competition over access to a sexual partner (e.g. an oestrous female), an infant, or another contact partner (e.g. grooming partner).

Object competition: competition over objects, both edible (leaves, beechnuts, acorns) and non-edible (sticks, tyres).

Spatial competition: competition over a seat (e.g. shelter during rain).

Retrospective Approach

During the period 13 April to 7 October 1976 we used a method specially designed for descriptive analyses of complex agonistic interactions (cf. de Waal et al. 1976). Two observers, positioned at opposite sides of the large outside enclosure, simultaneously recorded their spoken reports on tape, while a third person recorded the behaviour and vocalizations of the chimps on a video-recorder. From these three sources, providing complementary rather than over-

lapping information, the course of events could be reconstructed. We gathered 90 h of observation.

The present analysis concerns 765 agonistic dyads (including dyadic components of triadic and polyadic interactions) of which both participants had been observed during the preceding 2 min. The classification of contexts is either based on the tape-recorded eye-witness accounts or on the video pictures; we continuously video-recorded the apes, except during extremely quiet periods.

Anticipatory Approach

The second author investigated the possibility of predicting aggressive behaviour on the basis of a diversity of social interactions. These had in common that she intuitively judged them as very unpleasant or frustrating for at least one of the participants: the 'target'. As we cannot know whether chimpanzees experience the same emotional state as we would under similar circumstances, we did not speak of frustrating events, but chose the neutral term of '*possible predictor*', abbreviated to PP. During the summer period selection of PP's was made entirely by intuition, but during the following winter period, defined PP's were included as well. These definitions, developed after the preliminary summer study, will be given in the Results section. The summer data were used purely to arrive at these definitions; the data to be discussed here come entirely from the winter period.

Once the start of a PP had been noticed, at t_0 , the observer noted down on her checklist the identities of the target individual and its partner(s), their behaviour, whether the PP fitted any definition or not, and her intuitive expectations regarding chances (i.e. whether increased or not) of future aggression. The only requirement to which PP's had to conform was that there should not have been any sign of agonistic behaviour at the onset of t_0 or just before (i.e. no vocalizing, chasing, hitting or hair-erection). Consequently, although losing a fight, for example, seems very unpleasant and almost certainly increases the chance of future aggression, it has not been included as a PP.

After t_0 the observer recorded the agonistic and bluff behaviour of the target for 10 min after the end of the PP. For analytical purposes this period was later divided into two sub-periods, p_1 and p_2 , lasting 5 min each. p_1 started at t_0 , and p_2 ended 10 min after the end

of the PP. This implies that if the PP had been of short duration these two sub-periods joined each other, but if the PP had taken some time, a corresponding time interval existed between the end of p_1 and beginning of p_2 . Therefore, all PP situations had definitely ended before the second period began.

Results

Contexts of Aggression

The retrospective study showed that just over half (51%) of the 765 aggressive actions arose in an agonistic context (Table I). In about 90% of these cases, one or both antagonists had exchanged agonistic behaviour with another opponent before the new aggressive act occurred, e.g. A attacks B during a fight between B and C. The remaining 10% were what might be called 'parallel conflicts', e.g. A attacks B during a fight between C and D.

Most other conflicts, arising in non-agonistic contexts, seemed to occur spontaneously, i.e. the context remained 'unknown'. Table I shows that it was especially difficult to detect the possible instigators of male aggression: senior males showed a significantly higher ratio between 'unknown' and 'known' contexts than

each of the other two classes of group members (χ^2 tests, $P < 0.001$). This does not imply that conflicts initiated by these males occurred unexpectedly. On the contrary, male aggression was preceded by bluff display significantly more often than was aggression by others (χ^2 test, $P < 0.001$). Bluff displays (e.g. hooting sounds, swaying, hair-erection) are very conspicuous and look like a warm-up and warning of aggressive intentions. In addition, it was clear to us that in many cases of male aggression a possible reason for it could not have been brought to light by more detailed observations. Males might approach their prospective opponent from a distance without any apparent relation to the latter's previous behaviour. Sometimes the opponent had been sitting out of the male's sight and the male quietly and menacingly prepared himself for the encounter by searching for a stick or heavy stone.

Table II gives the frequencies of the different 'known' non-agonistic contexts and reveals that senior males regularly showed aggressive sexual competition: e.g. one male sexually invited an oestrous female and another male attacked him or chased the female away. Sexual competition was by far the most fre-

Table I. Contexts of Agonistic Interactions

Context	Aggressor class			Total
	Senior males	Senior females	Juniors	
Non-agonistic 'known'	44 (9%)	80 (41%)	28 (43%)	152 (20%)
'unknown'	172 (34%)	42 (21%)	11 (17%)	225 (29%)
Agonistic	288 (57%)	74 (38%)	26 (40%)	388 (51%)
Total	504 (100%)	196 (100%)	65 (100%)	765 (100%)

Table II. Subdivision of 'Known' Non-Agonistic Contexts of Agonistic Interactions

Non-agonistic contexts	Aggressor class			Total
	Senior males	Senior females	Juniors	
Play	8	0	12	20
Infant protection	1	11	3	15
Annoyance	2	36	3	41
Social competition				
a. Sexual	23	0	0	23
b. About infant	2	11	3	16
c. Other types	1	5	1	7
Object competition	6	14	5	25
Spatial competition	1	3	1	5
Total	44	80	28	152

quently observed non-agonistic context of male aggression, but males showed so many aggressive actions in 'unknown' or agonistic contexts that sexual competition accounted for less than 5% of all their aggression. It was definitely not a main proximate cause of male aggression. Thus an analysis (similar to one by Hausfater 1975) of about 200 male-male conflicts observed in the course of the past three years demonstrated that neither the frequency nor the intensity of these conflicts depended on whether any of the adult females was in oestrus or not. Also the frequency of inter-male bluff displays did not vary with the sexual state of the females in the colony (de Waal, unpublished data).

Junior males showed no competition about sexual contacts during the period of study, but during later periods they sometimes harassed copulating pairs so persistently that conflicts arose. During the present study the main source of conflicts involving infant males or juvenile females was rough play between partners of a considerably different age, e.g. an infant and an adult male.

A favourite activity of all infants and juveniles was 'teasing': they approached quietly-sitting apes, threw sand or sticks towards them, stamped with their feet on the ground, and ran away if their object jumped to its feet, but shortly afterwards came back to throw sand again, and so on. Especially in senior females, this teasing provoked aggressive actions. These have been classified under 'annoyance', which was the most common 'known' non-agonistic context of female aggression (Table II).

Senior females started agonistic interactions over infants relatively often: they competed for access to infants, and protected infants against aggressors (this has been classified as an 'agonistic context') and also against rough handling of a non-agonistic kind. There were also many non-agonistic interventions by these females, however, as shown by observations made by A. Grotenhuis, in December 1977 and January 1978. During this time the colony was kept indoors, and she scored contacts of the five juniors born in the group, at that time ranging in age from one to four years. Of the 1512 non-agonistic interactions involving at least one of these youngsters and lasting longer than half a minute (e.g. play), 216 led to an intervention restricting the behaviour of one of the participants (mostly the elder partner) or resulting in the contact being broken off for a while. The proportion of interventions in interactions

between these youngsters themselves was much higher than that in interactions between one of these youngsters and an elder partner (i.e. 26% as compared to 8%; χ^2 test, $P < 0.001$). Adult females were responsible for about 80% of all interventions.

The strong inclination of females to interfere with interactions between youngsters regularly created tension among the senior females themselves. When two females together watched their children at play, a threatening conflict between the children almost automatically induced tension between the mothers as well, as they were both ready to interfere in favour of their own offspring. Van Lawick-Goodall (1968b, page 236) described similar situations for wild chimpanzees: 'When a small infant screamed or whimpered during a play session the mother, in addition to rushing to embrace the child, sometimes then attacked the mother of its playmate'.

A striking solution to such a problem has been observed in our colony: Jonas and Wouter (aged 2½ and 3 years, respectively) play-wrestled in front of their mothers, Jimmie and Tepel. They sat together with Mama, the much-respected alpha-female, who was sleeping. Suddenly the wrestling between the two infants turned into fighting and screaming. Both mothers alternately looked at each other and at the ongoing fight. Jimmie gave a soft grunt and Tepel restlessly shifted her position. Eventually, Tepel woke up Mama by poking several times in her side. She pointed in the direction of the infants with her hand. Mama got up slowly, seemed to take in the situation at a glance and stopped the fight by an upsway with her arm and a loud grunt-bark. The two infants separated for a while and Mama soon continued her siesta. Thus Tepel's behaviour seemed to be aimed at the regulation of a conflict involving her child without risking a conflict with Jimmie.

Predictability of Aggression

The first anticipatory study, during the summer, was purely intuitive and concerned only four adult individuals (one male and three females). After 23% of the 72 possibly predictive events (PP's), we observed an aggressive action within 5 min (p_1) and much less often during subsequent 5-min periods (p_2). Most PP's fitted one of the following definitions:

1. *Unsuccessful social invitation.* The target individual invites another for a contact but the

contact does not take place. Invitations may take many forms: an approach with play-face (invitation to play); 'vacuum thrust' with penis-erection towards an oestrous female (sexual invitation by male); presenting the shoulder or back towards another (invitation to groom), etc.

2. *Unsuccessful competition.* The target individual tries to acquire something possessed by another, but does not succeed. It grabs at an object or infant, while the other refuses to give it up and succeeds in keeping it.

3. *Lost competition.* A partner succeeds in taking away an object or infant from the target individual, stopping its ongoing social interaction (e.g. copulation; grooming; play with an infant), or taking over its seat.

These definitions were used in the second anticipatory study during the following winter period, when the colony was kept indoors. We distinguished three types of PP. Social interactions that were intuitively judged as non-predictive, but nevertheless fitted one of the definitions, were called 'defined PP'. Those which did not fit any definition, but had intuitively been thought to increase the likelihood of aggression in the near future, were called 'intuitive PP'. Social events fitting both definition and intuition, finally, were called 'complete PP'. To which type a PP belonged was decided at the moment of observation itself, i.e. before knowing the outcome of the prediction (see Methods section).

The purpose of the analysis was to test the predictive value of the PP's with respect to aggressive actions by the target individual. For each PP, we used the sign test to compare

the first half of the subsequent 10-min period (p_1) with its second half (p_2) with respect to the presence/absence of aggressive behaviour by the target individual. We called it a 'plus' case if aggression had occurred only during the first 5 min and a 'minus' case if it had occurred only during the last 5 min. Table III shows the results, and in addition, indicates the number of individual chimpanzees showing the general (+) or opposite (-) trend. Another study during this winter period showed that the random occurrence of aggressive actions in a 5-min block was on the average 2% per individual and 12% for the most aggressive individual.

A similar procedure was applied to pure bluff displays (i.e. hair-erection together with elements of the 'bluff system'; van Hooff 1974), but since these occurred at a lower rate and in fewer individuals, we took the three PP-types together (Table III).

Table III demonstrates that target individuals had an increased tendency to show aggressive behaviour and pure bluff displays shortly after the particular social interactions called PP's. Our definitions of such interactions are apparently still inadequate, however, as there is a significant difference between the predictive value (i.e. percent p_1 periods with aggression) of events fitting the definition only and those fitting both definition and intuition (i.e. comparison between 'defined' and 'complete' PP's; $\chi^2 = 23$, $P < 0.001$). This means that several aspects relevant for the prediction, while being known to the observer, were not incorporated in the definitions. Such aspects may have been the temperament of the target individual, its relationship with the partner (e.g. dominance

Table III. Tendency of Chimps Involved in a 'Possibly Predictive' Interaction (PP) to Initiate Aggression or Bluff Display during the Five Minutes Immediately Following this Event (Period p_1) or during a Subsequent Five-Minute Period (p_2)

Type of 'possible predictor'	N	Subsequent five-minute periods		Trends per:	
		p_1	p_2	Case	Individual
		<i>Aggressive actions:</i>			
Defined PP	125	5 (4%)	1 (1%)	5+, 1-	4+, 1-
Complete PP	81	23 (28%)	6 (7%)	18+, 1-*	11+, 0-*
Intuitive PP	43	12 (28%)	4 (9%)	8+, 0-*	5+, 0-
Total	249	40 (16%)	11 (4%)	31+, 2-*	15+, 1-*
		<i>Bluff displays:</i>			
All PP's	249	19 (8%)	7 (3%)	16+, 4-*	8+, 0-*

*Sign-test, $P < 0.05$.

relation), and the apparent 'gravity' of the situation. In addition, the initial reaction of the target individual may betray whether it regards the situation light-heartedly or otherwise (e.g. scratching and urinating seem to be signs of taking it seriously) and such signs may unconsciously have influenced the observer's expectation. It is evident that we are still a long way from exact operational definitions of PP's with optimal predictive value.

In most of the 40 instances of aggressive behaviour following a PP the aggression seemed ineffective as it did not change the situation at all, e.g. it neither served to retrieve a disputed object nor did it induce the invited partner to comply more willingly. In 21 instances the aggressive action was even (re-)directed at an uninvolved lower-ranking ape, and 17 times this occurred several minutes after the PP had ended.

Finally, we draw attention to the finding that eight individuals showed a tendency to bluff shortly after a PP (Table III). The individuals showing this inclination were two adult males, two male infants and four adult females. Such bluff displays seemed fully irrelevant to the PP situation: they consisted typically of a 'rising hoot' erupting in a loud crow, and noisy stamping and banging against one of the resounding metal doors or on a large set of hollow drums. According to van Hooff (1973) these drums were installed in the hall to serve as instruments for 'stamping' displays, and: 'There is reason to believe that this 'bluff' behaviour may act as an outlet for social tensions' (page 199).

Discussion

The results indicate that aggressive behaviour among chimpanzees is predictable on the basis of rather inconspicuous social interactions in which an ape fails to reach an apparent goal, has to relinquish a seemingly desired object or contact, or is confronted with other presumably unwanted changes in its situation. It should be possible to define such changes objectively, but our definitions apparently did not contain all the information necessary for optimal prediction. As yet, the observer's empathy is a superior guide to chimp behaviour as presently observed. Hebb (1946, page 88) concluded: 'The objective categorization therefore missed something in the behavior of the chimpanzee that the ill-defined categories of emotion and the like did not—some order, or

relationship between isolated acts that is essential to comprehension of the behavior'. Further studies may yield more predictive categories, however.

If frustration is defined as a condition existing when a goal-response suffers interference (cf. Dollard et al. 1939) the aggressive actions predicted in our study seem frustration-induced. It should be added immediately, however, that the elasticity of this definition is such that it will be hard to find aggression *not* resulting from frustration (Lawson 1965). Thus after rephrasing the definitions of context-types distinguished in the retrospective study, most of them seem to fit the frustration-aggression hypothesis as well (e.g. 'annoyance').

'Competition' may be a term with an equally wide applicability (with the advantage that its emotional connotation is much weaker). For example, the context-type 'annoyance' may be regarded as competition between one partner just wanting to sit quietly and another who is engaging in all kinds of activities, some of which are bothering to the first. This is in addition to straightforward competition over objects or sexual partners. Definitions may widen to the extent that frustration and competition almost become synonymous. Thus Moyer (1976, page 190) states: 'Aggressive behavior resulting from competitive interactions may be considered as resulting from frustration'.

Besides these semantic problems there is another point: no less than 80% of all aggressive actions did not seem to arise, or at least not directly, from these frustrating or competitive situations. Despite the size of the enclosure (with ample space for animals to be separate) the main source of aggression was aggression between others. Minor incidents could develop into highly complicated, multi-individual encounters, which were sometimes disproportionately extensive and severe in view of the original cause.

Another large category is aggression of 'unknown' sources. The proportion of such apparently spontaneous aggression was remarkably high for senior males. One may regard this aggression as the 'flowing away' of accumulated energy (e.g. Lorenz 1950). Another possibility is that the nature of certain relationships between the males instigated these aggressive actions. Thus we suggest rivalry as a possible causal mechanism, i.e. many of these actions may express male status competition and be means to rise in rank or to consolidate an ex-

isting rank. Verification of this hypothesis demands analysis on an entirely different time scale. These analyses are still in progress, but we can say that we witnessed two dominance changes among adult males in the course of the present study; each process took about two months to accomplish (see also de Waal 1978).

The role of aggressive behaviour in dominance processes among primates has been described by Riss & Goodall (1977), Chance et al. (1977), de Waal (1977), Walker Leonard (1979) and Lee & Oliver (1979). Deag (1977) discusses its adaptive significance. Apart from aggression between the rivals themselves, redirection against scapegoats may occur during periods of unstable dominance relationships. Thus Bygott (1974, page 77) mentions severe attacks by an adult male chimpanzee against an 'innocent bystander' just after arrival of a male with whom he had a strained relationship. De Waal (1975) describes 'joint-redirection' by two adult male macaques during a temporary rank-reversal.

In non-primates rivalry may also be an important source of aggression. Thus Roëll (1978) saw how jackdaws persistently sought aggressive interactions with those colony members with whom the outcome (winning/losing) of encounters had been highly inconsistent. He suggests that they did so in order to re-establish their dominance relationships. The situation described by Blanchard et al. (1978) for Japanese brown bears is similar to that in our chimpanzee colony: 'spontaneous' fights lasted longer than those over food and primarily involved the larger and higher-ranking male bears. The authors hypothesize that such fights facilitate the determination of rank.

The general view is that dominance hierarchies are effective in preventing social tensions and hostilities. But if aggressive behaviour plays a role in the acquisition and maintenance of dominance positions, hierarchies not only reduce but also produce aggression. The crucial question as to the net result (increased or decreased aggression?) remains unanswered.

Human violence may be dominance-related as well. Van Dijk (1977) extensively discusses this hypothesis in the light of criminological, psychological and ethological literature. Acts perceived as expressions of doubt about a man's status may be particularly likely to result in serious aggression. Thus frustration has often been seen as a blow to self-esteem (e.g. Berkowitz 1962), and Feshbach (1971, page 285) states:

'Violations to self-esteem through insult, humiliation or coercion are powerful elicitors of hostility, probably the most important source of anger and aggressive drive in humans'.

It may be possible to offer fairly plausible explanations of rivalry in terms of frustration or competition (e.g. frustration due to low rank; competition over priorities), but for the time being progress in the field of aggression-causation requires that we refrain from translating the three terms—frustration, competition and rivalry—into each other. They seem to form quite different levels of explanation.

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