A Component Analysis of the Structure of the Social Behaviour of a Semi-Captive Chimpanzee Group[1]

Our knowledge of the natural behaviour of the chimpanzee, *Pan troglodytes*, has been considerably increased by a number of recent studies[2–5]. With respect to the social behaviour, these studies were mainly of a descriptive nature. This preliminary report is concerned with the first part of a quantitative analysis of the social behaviour of the chimpanzee.

Materials and methods. After extensive and mostly qualitative observations in zoos, the main study was carried out at the Holloman Aeromedical Research Laboratory, New Mexico (USA) in 1966. About 200 h of observation were devoted to a group of 25 individuals (11 ♂♂ and 14 ♀♀), living in a compound of about 10 ha (for a description see [6]). The age composition of the group was quite representative.

A great number of different elements of social behaviour could be distinguished. Of these the facial expressions have been described before[7]; the others will be described extensively elsewhere. Here, only the descriptive names will be given (Table I). Before a detailed study of the motivational and functional aspects of these behaviour elements could be made, it was found necessary to obtain a general picture of the motivational structure of the social behaviour.

To this end a method was used similar to that introduced into ethology by WIEPKEMA[8]. As usual the temporal proximity of the elements of an animal's behaviour sequence was taken as a measure for their motivational relationship. For the 53 most common elements the mutual transition frequencies were determined (the data for all animals were taken together). As there was appreciable variation in the total number of times each element occurred, the observed transition frequencies are not comparable straightaway. Therefore, the 'importance' of each transition was expressed in the degree to which its observed frequency (o) deviated from the frequency (e) to be expected on the basis of a random distribution of transitions, given the total number of occurrences of each element. By taking the excentricity, $(o-e)/\sqrt{e}$, as a parameter, the effect of random variations is minimized. For each pair of behaviour elements the similarity of their patterns of excentricities was expressed in the correlation coefficient (product-moment correlation of the rank numbers).

By means of a multivariate technique, known as component analysis, followed by a varimax rotation[9], the multidimensional structure of relations which is represented by the matrix of correlations can be simplified. The total variance of the 53 behaviour elements is described in terms of a number of new motivational components. The less complex the structure, the smaller is usually the number of components that is required to explain a relatively large part (say 70 or 80%) of the total variance. The degree to which each component explains the variance of a behaviour element is, moreover, expressed in a coefficient, the component loading (values

Table I. Component loadings (multiplied by 100). Positive significant values in bold print, negative ones in italics (further explanation in text)

Component	I	II	III	IV	V	VI	VII
Touch	**90**	8	—9	—12	13	6	—3
Cling	**87**	6	0	—7	4	—11	—2
Hold out hand	**86**	—20	—19	6	1	10	—15
Smooth approach	**86**	—3	—23	—16	12	15	2
Silent pout	**83**	0	7	10	3	18	—12
Groom	**83**	19	—9	—16	—9	—11	**36**
Embrace	**82**	0	*—28*	—1	8	*—16*	3
Groom-present	**78**	17	—14	—8	9	—10	**45**
Pant	**78**	—15	—18	—16	34	—3	19
Vocalized pout	**76**	—23	—2	26	8	—8	*—36*
Mount-present	**75**	—6	—10	2	0	10	2
Mount-walk	**75**	26	—16	2	5	—11	—11
Male mating	**73**	20	9	—15	—13	**37**	—11
Mouth-mouth	**72**	—13	—30	—25	**35**	—4	31
Genital investigation	**70**	30	—9	—25	—4	24	1
Autogroom	**66**	17	—1	—5	—6	—3	**44**
Silent bared-teeth	**65**	—19	—13	27	25	—1	—13
Stretched pout	**65**	—25	—4	**43**	4	—30	*—38*
Crouch-present	**63**	—27	—29	28	25	18	—4
Watch	**45**	—29	—14	6	33	6	5
Relaxed open-mouth	—12	**95**	4	—6	—8	10	—1
Grasp, poke	3	**94**	14	—12	—2	10	—4
Gnaw-wrestle	—10	**93**	2	—2	—14	—4	10
Gnaw	23	**87**	—3	—15	—13	—8	15
Pull limb	16	**85**	8	—19	—26	11	—6
Gymnastics	—9	**81**	14	—16	—10	2	—11
Hand-wrestle	34	**68**	—16	—11	—24	—6	30
Gallop	—23	**62**	13	—3	12	**35**	14
Mount	34	**46**	1	—32	22	3	—26
Trample	2	27	**91**	—1	—1	11	9
Tug	—24	—5	**89**	17	4	—11	—4
Brusque rush	—27	—9	**88**	15	5	—3	—1
Bite	—8	6	**84**	30	—10	—19	10
Grunt-bark	—8	—26	**80**	—2	12	5	—24
Sway-walk	—2	**46**	**67**	—17	0	27	—3
Stamp-walk	—20	27	**65**	—16	—7	**52**	8
Hit	*—49*	**55**	**55**	—6	—14	16	—5
Stamp	*—39*	**41**	**54**	—7	10	**39**	—5
Bared-teeth bark	—30	—29	**52**	**49**	26	—20	—11
Arm sway	*—62*	30	**50**	—13	15	**36**	3
Flee	—23	—13	32	**80**	—8	0	21
Crouch	12	—30	7	**76**	15	—18	6
Avoid	—20	—4	—12	**75**	20	28	—2
Bared-teeth scream	7	*—38*	25	**73**	—8	—28	—20
Bared-teeth yelp	**37**	*—36*	—11	**65**	15	—28	—29
Parry	—33	**42**	—3	**62**	—12	—26	—16
Shrink, flinch	—11	*—64*	7	**59**	28	6	2
Hesitating approach	32	*—58*	—10	**43**	29	13	—16
Squat-bobbing	22	—12	5	18	**86**	—3	—2
Rapid 'oh oh'	22	—30	—1	8	**82**	12	4
(Rising) hoot	17	—22	**40**	—19	**62**	24	—12
Upsway	0	*—40*	8	32	**48**	29	—7
Vertical nod	**38**	0	4	—17	28	**74**	—4
Portion of variance explained	26%	20%	13%	10%	6%	5%	3%

[1] The observations at Holloman were carried out under Grant No. AF 61(052)799 of the Holloman Aeromedical Research Lab.

[2] J. GOODALL, in *Primate Behavior* (Ed. I. DEVORE; Holt, Rinehard and Winston, New York 1965), p. 425.

[3] V. REYNOLDS and J. REYNOLDS, in *Primate Behavior* (Ed. I. DEVORE; Holt, Rinehart and Winston, New York 1965), p. 368.

[4] A. KORTLANDT, in *Handgebrauch und Verständigung bei Affen und Frühmenschen* (Ed. B. RENSCH; H. Huber, Bern 1967), p. 59.

[5] J. VAN LAWICK-GOODALL, Anim. Behav. Monogr. *3*, 161 (1968).

[6] J. A. R. A. M. VAN HOOFF, ARL-TR-67-15, 6571st Aeromedical Research Lab., New Mexico (1967).

[7] J. A. R. A. M. VAN HOOFF, in *Primate Ethology* (Ed. D. MORRIS; Weidenfeld and Nicolson, London 1967), p. 7.

[8] P. R. WIEPKEMA, Arch. néerl. Zool. *14*, 103 (1961).

[9] H. H. HARMAN, *Modern Factor Analysis* (Chicago University Press 1967).

Table II. Components explaining more than 4% of the total variance (for explanation see text)

Total							
P 1	Affinitive	Play	Aggressive	Submissive	Show	Excitement	Infantile
78%	23.7%	13.8%	11.5%	9.1%	8.2%	6.2%	5.6%
P 2	Affinitive	Play	Aggressive	Submissive	Excitement	♂ sex	♀ sex
75%	19.8%	15.3%	13.4%	11.8%	6.2%	4.5%	4.4%
P 3	Aggressive	Affinitive	Play	Submissive	Excitement	Groom	♂ sex
69%	13.7%	13.5%	13.4%	8.2%	8.1%	7.6%	4.8%
T	Affinitive	Play	Aggressive	Submissive	Excitement	Show	
79%	25.8%	20.0%	12.7%	9.9%	6.3%	4.6%	

> 0.35 regarded as significant). A component can be identified by considering the behaviour elements that have high loadings on it.

Results and discussion. The results, of which the general nature rather than the details interests us here, are presented in Table I. The loadings of the behaviour elements on the 7 most 'important' components (i.e. together explaining more than 80% of the total variance) are given. The first 4 components can easily be characterized as the 'affinitive' (= social positive) system, the 'play' system, the 'aggressive' system and the 'submissive' system respectively. Component V combines a number of elements with a rather agitated appearance and has, therefore, been called the 'excitement' system. Number VI, combining a few 'conspicuous' patterns, is termed the 'show' system, though most of the loadings on which the identification is based hardly surpass the significance level. The latter is also true for component VII which is termed the 'groom' system. The other components remain insignificant, do not permit a meaningful interpretation and have therefore not been presented here.

Inspection of Table I shows that all behaviour elements have loadings > 0.35 on 1 of the first 5 components; all but 1 have their greatest loadings (in all cases > 0.40) on 1 of the first 5. Apparently the repertoire of social behaviour patterns of this group of chimpanzees is satisfactorily categorized in terms of these 5 components. This is confirmed by the following.

In order to get an insight into the stability of the material, the total amount of observations (T) was split up in 3 parts (P1, P2, P3), for each of which the same analysis was done. As Table II shows, T's first 4 components also appear as the first in P1, P2 and P3. The 'excitement' component occupies the fifth place in 3 cases and the sixth in 1 case. Besides, practically all behaviour elements have significant loadings on these 5 components. There are considerable differences only with respect to the following components, that may occasionally manifest themselves, depending on the relative frequency of occurrence of their 'typical' elements.

Thus the picture emerges of an hierarchical motivational structure with 5 (or at least 4) main motivational systems and a certain number of more specific motivational (sub)systems whose influence does not manifest itself consistently. A similar structure of the social behaviour has also been revealed by a different method, namely hierarchical cluster analysis[10].

The categorization thus obtained is not based on any a priori postulated reference classes but is determined by the material itself. It can serve as an objective starting point for further, more detailed research. It would be valuable to perform this type of study on other groups of chimpanzees in order to find out whether the motivational categories found are indeed representative.

Zusammenfassung. Mittels Komponentenanalyse wurde die Struktur des sozialen Verhaltens einer in Halb-Gefangenschaft lebenden Gruppe von Schimpansen untersucht. Das Repertoire der 53 allgemeinsten sozialen Verhaltensmuster konnte als Funktion von 5 unabhängigen motivationellen Komponenten beschrieben werden.

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[10] L. L. MCQUITTY, Educ. psychol. Measur. *26*, 825 (1966).

A New Broad-Spectrum Anthelmintic: 2-(4-Thiazolyl)-5-*iso*propoxycarbonylamino-benzimidazole

Discovery of the anthelmintic effectiveness of thiabendazole [2-(4-thiazolyl)benzimidazole, I] was reported by H. D. BROWN et al.[1] in 1961. It was subsequently found safe and effective against a wide spectrum of parasitic nematodes in ruminants, horses, swine, poultry, and other animals, as well as man[2–5]. An extensive program of structural modification was continued in this laboratory, with the aim of finding new thiabendazole relatives with unique properties.

We now wish to report the finding that a number of derivatives (e.g., III–VI) of 5-aminothiabendazole (II) demonstrated the same breadth of anthelmintic activity as thiabendazole, and with an enhanced degree of potency. Of some 300 such compounds synthesized for anthelmintic