Social Grouping and Troop Size in Yellow Baboons

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Introduction

Recent studies of primate morphology have shown the need to characterize complicated objects of study in a small number of dimensions and the utility of mathematical models in revealing simplicity underlying apparent variability [OXNARD, 1969]. The same need arises in the study of primate social behavior and a similar strategy appears useful.

Though varied mathematical models are available for human social behaviors, the inclusion of the nonhuman primates in the comparative application of such models is recent [COHEN, 1971]. As a result, the data on nonhuman primates which have been analyzed so far in relation to these models [COHEN, 1969] have been collected for other purposes in forms not ideally suited to the analysis.

The models offer predictions about what will be observed in field studies of nonhuman primates, under certain circumstances which satisfy the assumptions of the models. The purpose of this paper is to present and analyze field observations made specifically to test some predictions of a family of models in COHEN [1971] and to report, within the limits of error imposed by finite data and available statistical tools, a failure to reject those predictions.

Setting and Methods

I observed yellow baboons *(Papio cynocephalus)* in the Masai Amboseli Game Reserve, Kenya, during the summer of 1969, as part of a field study headed by STUART A. and JEANNE ALTMANN. The setting of the study, as of 1963–64, is described in detail by ALTMANN and ALTMANN [1970]. The recent status of the habitat will be more fully described in future publications of the ALTMANNS.

Observations of baboon social hours began only after the ALTMANNS and I had been in the study area for several weeks. By this time we were able to approach several troops in a motor vehicle to within good viewing distance without disturbing them, were able to identify troops by recognizable individuals in them, and knew approximate total sizes of troops from censuses made by the techniques of ALTMANN and ALTMANN [1970].

For the purposes of these observations, freely forming or casual social groups (often referred to by primatologists as subgroups) within a troop (often referred to as a group) were defined as 'those whose members are relatively free to maintain or break off contact with one another, that is, they are ones where informal controls on behavior are at work and spontaneity is at a maximum'. Included are only those 'groups in which the members were in face-to-face interaction as evidenced by the criteria of gesticulation, [and for nonhuman primates, the social equivalents of] laughter, smiles, talk, play or work. Individuals who merely occupied contiguous space were not counted as members of a group' [definition of JAMES; see COHEN, 1971 for references]. The limitations of this definition as an adequate characterization of any real human, and perhaps nonhuman primate, social gathering are explored in exquisite detail by GOFFMAN [1963].

When at least half of the individuals known to be in a troop were visible at one time, and when the troop appeared to be primarily socializing, I began to record the sizes (the numbers of individuals) of casual social groups. Each epoch of observation consisted of a sweep from one side of the field of vision to the other and a simultaneous recording on a bank of hand counters of the number of visible groups of size 1, 2, 3 etc. Depending on the size of the troop, each sweep lasted from a few sec to approximately 1 min. At the end of each sweep, the frequency distribution of size of groups was recorded from the counters into a notebook. After at least 1 min had elapsed from the beginning of the last epoch, a new epoch began.

Many series of such epochs of observation were interrupted after only a few epochs because of a change in the troop's activities or the disappearance of animals. The sets of observations presented here are exactly

Table I. Observed freely forming group sizes in yellow baboons

Troop	Size	Date 1969	Start	Epochs	Frequencies of groups of size				
					1	2	3	4	5
1	18	7/24	0911	12	147	10	7	2	0
	or	8/7	1321	24	237	65	6	0	0
	19	8/8	1112	44	321	118	26	0	0
		8/8	1338	20	307	20	2	1	0
		8/16	0923	31	465	35	14	3	0
2	19	8/7	1632	26	284	47	16	2	1
		8/8	1030	11	72	25	10	1	0
3	22	8/15	1732	14	182	2	0	0	0
		8/16	0755	10	105	14	1	0	0
4	27	8/12	1540	12	120	35	3	0	0
		8/12	1745	27	395	47	5	0	0
		8/15	0925	39	536	58	5	0	0
5	34	7/17	0812	14	136	45	7	2	1
		8/12	0855	11	183	22	6	0	0
		8/12	1035	14	220	12	0	0	0
		8/17	1636	10	223	8	2	0	0
6	37	8/13	1508	11	180	5	2	1	0
		8/16	1720	40	1095	89	20	5	1
7	80	7/19	1740	10	544	27	4	1	1
		8/13	0824	26	1380	45	6	1	0
		8/15	0825	18	726	109	14	1	1

those with 10 or more epochs each. Three sets of observations made by JEANNE ALTMANN appear in table III as an indication that another observer could get results not markedly different from mine; one of her three sets, as an exception, contains only 9 epochs of observation.

The difficulties of observation in the field, where individuals may be partly hidden by brush or by other individuals, and where it may be difficult to tell if two neighboring individuals are interacting just by scanning them quickly, make me less than certain that my observations are exact. In addition, although the troops' socializing and feeding usually accompanied each other to some extent, I tried to exclude periods when most individuals were intent upon feeding and were, perforce, in groups of size 1. By themselves these periods would have been in trivial agreement with the equilibrium predictions of the models to be tested.

Data and Statistical Analysis

Table I presents, for each set of observations, the troop observed and its size, the date, the time at which observation began, the number of epochs of observation, and the numbers of groups of each size observed after summing over the epochs in each set.

If a χ^2 test of homogeneity is performed on the sets for each troop, the assumption that the time and date of observation of the troop make no difference in the shape of the frequency distribution of group sizes is rejected at the 0.01 level, for each of the troops except troop 6, and is

Table II. Observed and fitted frequency distributions of group sizes in yellow baboons, by troop

Troop	a/d	b/d	Nominal df [d]	χ^2	Nominal P[d]	Frequencies of groups of size				
						1	2	3	4	5
1	0.19[a]	0.16[a]	1	4.19	0.02	1477	248	55	6	0
						(1475	259	44	9)[e]	
2	0.19[a]	0.26[a]	2	4.27	0.10	356	72	26	3	1
						(355	79	19	4	1)
3	0.12[b]	0	303	315.08	0.60	287	16	1	0	0
						(287	17)			
4	0.26[b]	0	1	0.01	0.90	1051	140	13	0	0
						(1052	139	13)		
5	0.01[c]	0.23[c]	1	0.23	0.50	762	87	15	2	1
						(759	91	14	3)	
6	10-6[c]	0.20[c]	1	15.16	f	1275	94	22	6	1
						(1250	128	17	3)	
7	0.01[c]	0.14[c]	1	5.81	0.01	2650	181	24	3	2
						(2641	198	19	2)	

a Brass estimates for the truncated negative binomial distribution.

b Maximum likelihood estimates for the truncated Poisson distribution; b = 0 by definition.

c Estimates found by numerical experimentation.

d df = degrees of freedom; P = probability that a worse fit would have occurred by chance, assuming the model true.

e Fitted values; rightmost value given is predicted number of groups of that size or larger. χ^2 computed before rounding.

f P < 0.001.

rejected at the 0.05 level for troop 6. Because the group sizes observed in successive epochs are far from independent, this test, which assumes the independence of observations, grossly exaggerates the differences from one set to another of a given troop's group size distribution. Similar differences appear in small samples of artificial data created by a simulation of group processes known to have constant parameters [COHEN, 1971]. Hence the sets of observations for each troop will be pooled before analyzing the form of the frequency distributions. No assumption that different troops have the same frequency distributions will be made.

In table II the summed frequency distributions of group size are stated for each troop. Beneath each observed distribution a fitted theoretical distribution is given. For troops 3 and 4, the fitted distribution is the truncated Poisson; for the remaining it is the truncated negative binomial. Except for troop 3, the value of χ^2 given is the Pearson measure of goodness of fit between observed and expected distributions. For troop 3, the value of χ^2 is the truncated Poisson variance test [COHEN, 1971] which tests whether the first two moments of the observed distribution are consistent with the data coming from a truncated Poisson distribution. This test is used here because there are too few cells in the fitted frequency distribution to assign a positive number of degrees of freedom to the Pearson χ^2.

The degrees of freedom assigned to each value of Pearson's χ^2 equals the number of cells, after pooling so that no cell is less than 1, minus 1, minus the number of parameters in the distribution. The Poisson distribution has 1 parameter and the negative binomial has 2. This assignment of degrees of freedom is strictly correct only when the parameter values are the maximum likelihood estimates. Otherwise this procedure assigns too few degrees of freedom. For example, the predicted distribution for troop 7 has 4 cells and the degrees of freedom are $4 - 1 - 2 = 1$. With nominal df $= 1$, $\chi^2 = 5.81$ has nominal P between 0.01 and 0.02. But in this case the parameter estimates were arrived at by numerical experimentation. With the correct degrees of freedom, or with maximum likelihood estimates, it may be that a worse fit would be more probable. Moreover, as does the χ^2 test of homogeneity, these χ^2 tests assume independent observations; hence deviations from expectations are exaggerated.

Even with these artificial increases in the power of the χ^2 test, the assumption that the observed frequency distributions are truncated Poisson or truncated negative binomial is rejected at the 1 % level only by my observations of troop 6. Table III presents three sets of frequency dis-

Table III. Observations by Jeanne Altmann of freely forming group sizes in yellow baboons[*]

Troop	Date 1969	Start	Epochs	a/d[a]	Nominal df [b]	χ^2	Nominal P>	Frequencies of groups of size			
								1	2	3	4
1	9/1	1706	9	0.80	121	107.07	0.35	78	34	9	1
6	8/24	0739	11	0.49	241	235.74	0.80	188	44	10	0
6	8/24	0806	11	0.48	237	234.46	0.90	184	48	4	2

[*] Unpublished data presented here by kind permission.
[a] Maximum likelihood estimates of the Poisson parameter; b = 0 by definition.
[b] Truncated Poisson variance test [COHEN, 1971].

tributions of group size observed by JEANNE ALTMANN, including 2 of troop 6. The value of χ^2 obtained from the truncated Poisson variance test is too small to reject the assumption of a truncated Poisson distribution in each case.

No striking relation between troop size and the parameters of grouping appears from inspection of the tables.

Interpretation and Conclusion

The conclusion from the analysis of the observed frequency distributions is that they probably could have been drawn from truncated Poisson or truncated negative binomial distributions.

A family of models for the formation and dissolution of casual social groups predicts that the equilibrium distribution of group sizes should be described by the truncated Poisson or negative binomial distributions [COHEN, 1971]. The equilibrium distributions are characterized by 2 ratios a/d and b/d of the 3 parameters a, b, d which have the following interpretation: a is the rate (per unit time) at which an isolate in a system of freely forming groups joins a group solely because of the attraction of group membership; b is the rate at which an isolate joins a group solely because of the attraction of an individual in the group; and d is the rate at which an individual in a group departs because of a spontaneous decision of his own which is independent of the size of group he is in.

The ratios a/d and b/d characterize concisely the equilibrium distributions of group sizes; their relations to the parameters of the truncated

Poisson and truncated negative binomial are given in Cohen [1971]. The dynamics assumed by the models remain untested in this case. The comparative interpretation of the parameter values obtained from these baboons and from other primates will be attempted in Cohen [in press].

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