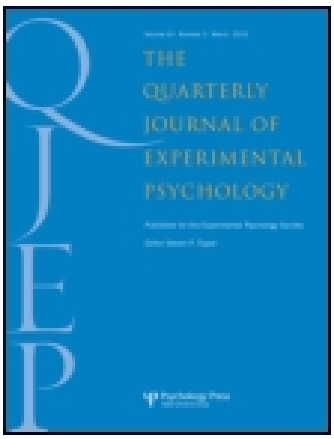

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PERSONALITY IN MONKEYS: FACTOR ANALYSES OF RHESUS SOCIAL BEHAVIOUR

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Three factor analyses were performed on social interaction data from 168 juvenile macaques. Animals were tested in stable quadrad peer groups; in newly-formed dyads with infant, juvenile, and adult stimulus monkeys; and in similar triads with the stimulus animal plus a familiar cage-mate. Factors emerged, most strongly in the most stable condition, which were interpreted as affiliative, hostile and fearful. These factors were almost entirely independent and resembled the extraversion, psychoticism, and emotionality factors frequently found in humans.

Introduction

Factor analyses of human social behaviour have been undertaken primarily in two areas. The first is upon humans in a solo setting, usually having the subject fill in a questionnaire. The subject is rating his own behaviour in another postulated setting, usually an interacting one. Reliably, factors of introversion–extraversion, emotionality or neuroticism, and psychoticism emerge (reviewed recently by Eysenck and Eysenck, 1968, 1969). Looked at from the point of view of the behaviour patterns on which these factors are based, extraversion is characterized by sociable behaviour, neuroticism by fearful behaviour, and psychoticism by hostile, aggressive behaviour. The second area is upon humans in an interactive setting, usually dyadic. Studies of mother and child (Becker and Krug, 1964; Hatfield, Ferguson and Alpert, 1967), adults (Borgatta, 1964; Schaefer, 1959), children (Borgatta and Sperling, 1963), and infants (Cobb, Grimm, Dawson and Amsterdam, 1967) report factors which can be termed affection or extraversion, emotionality or neuroticism, and assertive reponse to assertiveness. One might expect to find similar patterns of behaviour in the higher subhuman primates. Certainly when primatologists describe behaviour, they often do so using comparable terms.

In subhuman primates two studies have been published, both in the latter category. The first (Locke, Locke, Morgan and Zimmerman, 1964) recorded 10 behaviour categories in 12-year-old rhesus monkeys that had been reared in social isolation (probably not visual or auditory isolation) from soon after birth. The severely restricted repertoire of isolated monkeys, when tested in quadrads, enabled

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the experimenters to record only the following behaviours: pass, approach, contact, chase, aggression, passive awareness, avoidance, escape, submission, and apparent unawareness. Two factors emerged: dominance, and submission in response to dominance.

Van Hooff (1971) reported a component and cluster analysis of 53 behaviours recorded in a stable group of 25 chimpanzees. Sixty-nine per cent of the variance was accounted for by components termed affinitive or social positive, play, aggressive, and submissive. In addition, contributing a small but significant amount to the results, were factors termed groom, excitement, and "show" or display.

The following is a report of three factor analyses, of 10 behaviours, performed on data from a stable group situation and on data from less stable dyadic and triadic situations.

Method

Subjects

One hundred and sixty eight *Macaca mulatta*, about 85% males, were separated from their mothers at birth and reared in individual mesh cages. They were given daily peer experience starting at between 15 and 90 days of age. For about half the animals this consisted of daily 2-h pairings in the homecage and bi-weekly 1-h group sessions in a playroom or in a large cage. For the rest social experience entailed daily 40-min group sessions in a playroom. All subjects were assigned to a group composed of four age-mates, and all social experience, both pairings and group sessions, involved these group members. All group social interaction was experienced when all four members were present, so that after a few months the group had formed stable social relationships which were retained even when monkey subjects were paired.

Apparatus

The animals were group tested in that particular playroom or large cage to which they had become accustomed through daily group sessions throughout most of their lives. The playrooms used were Wisconsin Playroom II for 44 animals (see Chamove, Waisman and Harlow, 1970, for a description), Wisconsin Playroom III for 36 animals (described by Chamove, 1966), and a standard rectangular mesh cage measuring $3 \times 1{\cdot}5 \times 1{\cdot}5$ m for the remaining monkeys. Stimulus testing was carried out in a similar sized cage but fitted with a plexiglas front and a plexiglas partition which could divide the cage in half. It allowed the animals to observe one another in the adaptation interval before testing.

Behaviours were recorded using a bank of 10 Standard Electric Timers activated by 10 microswitches (as described by Chamove, Harlow and Mitchell, 1967). The timers recorded the duration of the following behaviours: *social explore*—any investigation, contact or not, of another animal, primarily looking at another monkey (reliability, $r = 0{\cdot}88$); *social play*—playing with another monkey, usually a relaxed, complex, and vigorous behaviour ($r = 0{\cdot}95$); *nonsocial play*—similar behaviour not directed toward another animal ($r = 0{\cdot}90$); *nonsocial fear*—withdrawal from the environment, scored when no social object could be credited with the instigation of the fear response ($r = 0{\cdot}96$); *appropriate withdrawal*—avoidance of an animal that is exhibiting hostile behaviour ($r = 0{\cdot}91$); *inappropriate withdrawal*—withdrawal from an animal exhibiting fear, exploratory, or play behaviour ($r = 0{\cdot}90$); *hostile contact*—biting or grabbing another animal ($r = 0{\cdot}96$); *nonhostile contact*—all other behaviours involving physical contact except clinging ($r = 0{\cdot}95$); *social cling*—clinging to another animal ($r = 0{\cdot}99$); *noncontact hostile*—($r = 0{\cdot}91$).

Reliability is given as product-moment inter-observer coefficients.

Procedure

Group Testing was done on all subjects between 9 and 12 months of age, and all monkeys were tested in their group of four a minimum of twice weekly. Testing consisted of at least thirty 60-min sessions during which each animal was observed for three 5-min periods. One experimenter did all the Group Testing. The data were converted to "per cent of total time tested" scores for purposes of analysis.

Stimulus Testing was performed on 63 of the above subjects soon after Group Testing. At 12 months of age the monkeys were housed in groups of four continuously. At approximately 13 months of age the first Stimulus Test was undertaken. The subject was housed in one half of the Stimulus Test cage, separated from the stimulus animal by the plexiglas partition, for a 23-h period. The transparent barrier was then removed and testing immediately begun; it was continued for 15 min unless one of the animals was seriously injured.

Testing involved placing the subject animal with a stimulus animal of relatively constant characteristics in the following 3 × 2 design. The stimulus monkey was either an infant of approximately 1 month, a juvenile male of approximately 6 months of age and chosen for its playfulness, or an adult male chosen for its docility. The subject was tested with each of these three in the above order in a dyadic social situation. The tests were separated by a period of about 10 days. After the "Alone" Stimulus Test, another three sessions followed. The subject monkey was first paired with an animal from his original four-membered test group. The two animals were quite familiar with one another, having lived together for over a month in a group of four and having interacted with one another from an early age. These two monkeys were then tested *together* with the stimulus animal. Here two experimenters were used. The procedure followed was the same as for the Alone testing except that two animals were adapted for 23 h in half of the test cage, and the test situation was triadic—two subjects and one stimulus monkey. This was called the "Partner" situation.

Analysis of the data was by means of principal components analysis rotated to oblique simple structure (Eysenck and Eysenck, 1969). Interfactor correlations of the promax factors were derived and all factors with eigenvalues less than unity were ignored. Computer limitations forced a division of the Stimulus Test data into two halves, the Alone and the Partner testing situations. As clinging was rarely observed in the Group Test situation, it was deleted from the analysis.

The rationale of the procedure is as follows. The Group Test situation involves a maximum of adaptation to the social test situation. Because of the formation of hierarchies and preferences during their year of social interaction, one would expect a maximum of within-group divergence, the most subordinate subject, e.g. being able to show almost no hostility. Tempered by this very stable structure, personality differences might be expected to emerge.

The Stimulus situation has been shown to demonstrate the effects of early environmental manipulations which the group situation has failed to detect (Mitchell, 1970; Chamove, 1966), but it may be less reflective of habitual modes of social response due to the variability of the various test situations. Dominance position, dyadic alliances, and social response are much more controlled in this stimulus situation. The stimulus infant at 1 month moves about very little and normally elicits very little aggression. The juvenile is very active but always subordinate to the experimental subject, and so aggression is more commonly elicited; play is quite common and fear uncalled for. The docile adult is a test for aggressive-fearful factors. Excessive fear should be rare and aggression rarer, brief submissive gestures being more appropriate with these males. Isolate monkeys, however, suicidally attack all animals (Mitchell, 1970) whereas certain brain damaged monkeys carefully discriminate the objects of their hyper-aggression (Chamove *et al.*, 1970).

The Partner situation is used because it was felt that having a familiar peer present might elicit certain behaviours not elicited in the Alone condition as has been previously found (Chamove, 1966).

Results

The results of the factor analysis of the *Group Test* data are striking. Three clear factors emerge having little intercorrelation: hostile, fearful, and affiliative or sociable (see Table I). These three all show positive intercorrelations. This may be a result of the constrained social situation, for an animal showing play or hostility may induce fear in other animals. Another possible cause of this correlation may be the existence of a kind of monkey which is relatively nonsocial and inactive; he will score low on all behaviours. The factor we have here termed hostility correlates 0·23 with the one we termed fear, 0·34 with affiliation while the affiliation factor correlates 0·21 with fear. These correlations account for only 10% of the variance at most, and we consider them unimportant.

TABLE I

Loading of nine behaviours on three factors resulting from analysis of the quadrad Group Test data and labelled play, fear, and aggression–hostility

	Factors		
Behaviours	I	II	III
Nonsocial play	0·10	0·78	0·02
Social play	−0·07	0·99	0·03
Positive contact	−0·04	0·96	−0·01
Social exploration	0·73	0·39	−0·15
Nonsocial fear	0·99	−0·16	0·04
Inappropriate fear	0·91	0·04	−0·03
Appropriate fear	0·95	0·00	0·14
Noncontact hostility	0·40	−0·10	−0·80
Contact hostility	−0·25	0·04	−0·98

One nonfear variable, noncontact hostility, shows a moderate correlation with the fear factor. This single aberrant score can be explained in terms of the behaviour pattern termed redirected-threats. These are hostile behaviours directed toward a more subordinate animal in an attempt to distract the hostile attentions of a more dominant monkey. The behavioural sequence is initiated by the dominant animal and the redirection is a response to that initiation.

The results of the *Stimulus Test* are less clear, as might be predicted from the unstable nature of the test situation (see Table II). When monkeys are tested in a dyad with the stimulus animal (upper half of Table II), four factors are found. The first loads negatively on infant fear, juvenile fear and hostility, and adult hostility; and positively on infant hostility. The second factor is one of juvenile play versus infant positive contact, probably of an exploratory nature. The third loads on nonsocial fear versus social explore. Both are fairly nonsocial behaviours as they involve little social contact and are seen in nonsocial animals such as long-term isolates. The final factor is social play versus adult hostility.

When monkeys are stimulus tested paired with familiar partners four factors again emerge (lower half of Table II). The first loads positively on play and on cling directed toward the juvenile and adult stimulus animal versus a negative

TABLE II

Loadings on the first four factors resulting from analysis two (upper) and analysis three (lower) of Stimulus Test data when subjects are tested with three types of stimulus monkey

		Factors											
		I			II			III			IV		
	Behaviours	infant	juvenile	adult	infant	juvenile	adult	infant	juvenile	adult	infant	juvenile	adult
"alone" or dyad condition	Nonsocial play	0·04	0·05	0·27	0·16	0·03	0·15	0·22	0·17	0·15	0·02	0·36	0·14
	Social play	0·18	0·23	0·16	−0·06	−0·51	−0·09	0·56	0·22	0·07	0·23	−0·27	0·26
	Positive contact	0·10	−0·24	0·01	0·75	−0·48	0·03	0·09	0·00	0·09	−0·13	−0·09	0·21
	Social cling	0·20	−0·36	−0·11	−0·03	−0·26	−0·29	−0·05	0·01	0·04	−0·09	0·05	−0·10
	Social exploration	−0·13	0·01	0·18	0·49	0·35	−0·20	−0·08	−0·21	−0·04	−0·33	0·09	−0·48
	Nonsocial fear	0·28	0·04	0·15	0·03	−0·05	0·12	−0·17	0·06	0·04	0·17	0·52	0·45
	Inappropriate fear	−0·55	−0·64	0·28	0·09	0·12	0·09	0·17	0·21	−0·86	0·15	−0·04	−0·11
	Appropriate fear	0·00	−0·68	−0·37	0·00	0·04	0·07	0·00	0·11	0·08	−0·00	−0·06	−0·34
	Noncontact hostility	−0·02	−0·48	−0·61	−0·01	0·06	−0·08	0·10	−0·23	−0·13	0·17	−0·09	−0·07
	Contact hostility	0·73	−0·33	−0·69	0·06	−0·13	−0·04	0·01	−0·33	−0·19	0·18	0·08	0·12
"partner" or triad condition	Nonsocial play	−0·40	−0·48	0·19	−0·05	0·02	0·31	0·07	0·15	0·48	0·05	0·11	−0·09
	Social play	0·05	0·52	0·24	−0·73	0·16	−0·08	0·37	−0·14	−0·06	0·18	0·44	−0·42
	Positive contact	0·04	0·68	−0·14	0·62	0·11	−0·03	0·04	0·01	−0·13	0·07	0·01	−0·41
	Social cling	0·10	0·50	0·33	−0·06	−0·02	−0·04	0·46	0·21	0·12	0·14	−0·27	−0·08
	Social exploration	0·04	0·44	−0·45	0·70	0·08	0·19	0·01	0·14	−0·01	0·09	−0·25	0·19
	Nonsocial fear	−0·05	−0·05	0·05	0·28	−0·00	−0·22	−0·09	0·15	0·03	−0·38	−0·03	0·12
	Appropriate fear	−0·36	0·05	−0·06	−0·16	−0·16	−0·13	−0·04	−0·42	−0·11	−0·20	0·32	0·15
	Noncontact hostility	−0·10	−0·24	−0·07	−0·65	−0·12	−0·21	−0·35	0·05	−0·65	0·07	0·07	−0·11
	Contact hostility	−0·14	−0·06	0·18	−0·42	−0·15	0·21	−0·08	−0·05	−0·82	0·02	0·06	−0·20

loading on nonsocial play and social fear. The second loads on infant hostile and play versus infant explore and nonsocial fear. The third factor loads on adult and infant hostile, juvenile fear versus infant play and cling and adult nonsocial play. The last factor loads positively on juvenile play and inappropriate withdrawal as contrasted with negative loading on adult play, juvenile explore and cling, and infant nonsocial fear. Table III lists the intercorrelations between each of the four factors from both of the Stimulus Test factor analyses. Except for factors I and II, the correlations between pairs of factors is remarkably low suggesting a high degree of independence.

TABLE III

Interfactor correlations of promax factors from Stimulus Testing

Analysis two; dyads			
Factors	II	III	IV
I	0·33	−0·27	0·07
II		−0·18	−0·09
III			0·06
Analysis three; triads			
Factors	II	III	IV
I	0·61	−0·12	−0·08
II		−0·17	−0·04
III			−0·03

The complexity of the Stimulus Test data is what one might expect if for no other reason than that different behaviours are elicited in the six situations. For example, in the Partner or triad situation the subjects exhibit less juvenile-directed hostility, less inappropriate fear toward the adult, more adult hostility, and less nonsocial fear, substituting partner-directed clinging in many cases for nonsocial fear. Factors III and IV, found in the Alone condition, are represented in factor I of the Partnered situation; factors II and III of the Partner test are found in IV and I respectively of the Alone condition.

The first factor of the Alone condition and second factor of the Partner test are clearly a social fear and hostile category. The second factor of the dyadic test appears comparable to an affectional category, showing play toward the juvenile and restrained positive and exploratory behaviour toward the infant, the first infant these monkeys had ever seen. The first factor of the triad or Partner test, like factors III and IV on the dyad test, seem also to reflect an affectional character, perhaps more comparable to the meaning of extraversion. We see here an animal exhibiting play toward the juvenile and other monkeys, showing some avoidance of other animals, considerable nonsocial play, and some hostility toward the playful juvenile stimulus monkey. The last triad factor dichotomizes between adult play and juvenile play.

Discussion

The factor analysis of the Group Test has resulted in three clear behaviour factors: fearful, hostile, and affectionate. These patterns of behaviour are not dissimilar to those which gave rise to the three major factors in research on human personality; neuroticism-stability, extraversion–introversion, and psychoticism. It would be premature to seek to prove the identity of the factors in these different species; no acceptable method exists at the moment for any such proof. What would be required to make the identification reasonable would be the incorporation of these factors in a nomological network, rather in the fashion adopted by Eysenck and Broadhurst (1964) with reference to emotionality in rats. Thus it should not prove impossible to test whether affectionate (extraverted) monkeys have lower cortical arousal patterns than do non-affectionate ones; similarly, it should be possible to test for differences in conditioning between the two groups. A programme for testing the suitability of the "neuroticism" tag for the fearful animals could with advantage follow that adopted for emotionality in rats. Psychoticism might be the most difficult factor to investigate, for the simple reason that least is known about it in the human population. However, even here such behaviours as lack of co-operation or inappropriate aggression should be susceptible to observation and quantification.

It might at first seem surprising that similar factors emerge from two different species, but there are good reasons for expecting such agreement. The first reason is linked with the simple fact that monkeys and men (and rats also) have similar anatomico-physiological structures to subserve emotional/fearful behaviour, i.e. an autonomic system and a visceral brain, and arousal behaviour, i.e. a cortex linked with an ascending reticular formation; one would expect individual differences in behaviour to be linked with differences in the functioning of both these systems, and these behavioural differences would be expected to be the more similar to those observed in humans, the closer the species under investigation was to *Homo sapiens*. As regards psychoticism, it is much more difficult at this moment to suggest a biological locus for this trait, but a close relation has been observed with masculinity. The possibility of a link with some hormonal secretion related to the sex glands would be supported by recent investigations of rhesus monkeys (Rose, Holady and Bernstein, 1971).

The second reason is that we are here concerned with social behaviour, i.e. how one animal behaves towards another, and the major possibilities of such behaviour seem to be limited to the three patterns we noted; an animal can be friendly-sociable-affectionate, it can be hostile-aggressive-cruel, or it can be fearful-emotional-withdrawing. Most if not all social behaviour can be grouped under these three main headings, and it is perhaps not too surprising that these patterns should emerge as factors in our investigation. Nor is it surprising that the picture is somewhat more complex (and confused) when we turn from the Group Test data to those collected in the Stimulus Test. This would be expected if for no other reason than that different behaviours are inevitably elicited in the six situations by the different "stimulus" patterns.

This observational study demonstrates marked individual differences between monkeys in their social behaviour. These differences are apparently highly

reliable, and characteristic of the animals concerned, and may thus be regarded as aspects of the "personality". Yet experimental work with monkeys, and other animals as well, seldom pays attention to their "personality". We would argue that this omission is a serious one, just as experimentation in human subjects can be very misleading if it leaves out of account personality factors like extraversion–introversion (Eysenck, 1967). In rats a whole host of experimental studies can be shown to be influenced profoundly by differences in emotionality, and quite different theoretical conclusions can be drawn from identical experiments depending on the strain of animals used (Eysenck and Broadhurst, 1964; Eysenck, 1967). The usual process of "averaging" serves simply to relegate such "personality" factors to the error term, which thus becomes unduly swollen and often far exceeds in importance the main effects looked for. Personality factors usually emerge as "interaction" factors, and may serve materially to reduce the size of the error term. It is in this function that we see the main importance of our findings; work with monkeys too should bear in mind the importance of individual differences and use scores on these factors to keep the error term as small as possible. In addition there is of course the possibility that continued work along these lines will increase our knowledge about "personality" factors in animals, and humans as well. In view of the lack of knowledge in this field, such increases would be more than welcome.

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