Subjective Assessment of Reactivity Level and Personality Traits of Rhesus Monkeys

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The purposes of this study are to determine whether subjective assessment of reactivity level in rhesus macaques, between 1 and 14 years old, is related to assessment of personality traits and whether a configuration of personality traits most salient for assessment of reactivity can be defined. Results indicate that subjective assessment of reactivity is complementary to that of personality traits. Interrater reliability and convergent validity are established. Principal-component and discriminant analyses of the present data show that 10 personality traits can assign all subjects to reactivity level, but as few as 3 traits may be sufficient.

KEY WORDS: *Macaca mulatta*; subjective; assessment; reactivity; personality.

INTRODUCTION

Individual variation in emotionality and in personality traits of nonhuman primates has been investigated increasingly (Chamove *et al.*, 1972; Nash and Chamove, 1981; Reite and Short, 1980). Data from these studies have related emotions and traits across several primate species, thereby reinforcing the validity of nonhuman primate models for human comparisons. Personality traits have been studied as predictors of other behaviors, as the result of early experiences, or recently as manifestations of physiological

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response systems (Raleigh et al., 1989). Experiments utilizing manipulations, such as cross-fostering, have furthered the understanding of modifiability of certain traits and the relative contributions of heredity and learning (Suomi, 1987).

In several studies, subjective assessments of emotionality or personality traits have been employed. Subjective assessment is an active process, with the observer cumulating and integrating information about individual subjects (Stevenson–Hinde et al., 1980). Bias is inherent in subjective assessments; therefore, instruments to measure traits have been developed.

Systematic subjective assessments of nonhuman primates have generally been conducted in two ways: paired adjectives in which the adjective most descriptive of the subject is chosen (Buirski et al., 1973, 1978) and rating individuals with a 3-point (Caine et al., 1983) or a 7-point scale on behaviorally defined adjectives (Stevenson–Hinde and Zunz, 1978; Stevenson–Hinde et al., 1980). Stevenson–Hinde and Zunz (1978) initially developed their category system through descriptions of monkey traits from observers; subsequent behaviorally defined adjectives were used as ratings and have been reduced to 22 items from the original 33. Buirski et al. (1973, 1978) derived their adjectives from personality theory. Correlation and principal-component analyses have been used to determine clusters of traits and the relationship between traits and behaviors. These measures of personality traits appear to have reasonable interrater reliability as well as predictive stability over time (Stevenson–Hinde, 1980).

In previous studies, experienced observers rated personality traits of a small number of similar-aged animals (Caine et al., 1983), larger groups of animals excluding all individuals less than 1 year of age in laboratory situations (Stevenson–Hinde and Zunz, 1978), and varying numbers of animals, but often without subadults in feral situations (Buirski et al., 1973, 1978). In most instances, raters in these studies had more than 200 hr of observation before personality assessment, an important point since Martau et al. (1985) found familiarity essential to reliable assessment. Low interrater reliability has been found for monkey subjects whose social status was undergoing change at time of assessment, for adolescent males, subadults and infants, and for monkeys which died shortly after assessment (Martau et al., 1985).

Correlations of subjectively rated personality traits with social rank (Buirski et al., 1973, 1978; Caine et al., 1983), early separation experiences (Caine et al., 1983), age (Stevenson–Hinde et al., 1978, 1980), gender (Buirski et al., 1978; Stevenson–Hinde et al., 1978, 1980), and social behaviors (Buirski et al., 1973) also have yielded significant findings. For

example, animals experiencing early separations have been characterized as less social but not less dominant (Caine et al., 1983).

Recently, reactivity has begun to be utilized in the nonhuman primate literature to describe and to predict responses to demands and challenges (Suomi, 1987). Analogous to the concept of behavioral inhibition in humans (Kagen et al., 1986), behavioral reactivity level has been associated with specific physiological responses to environmental challenges. Reactivity level has been defined as the characteristic manner or affective and behavioral predisposition to respond to new or challenging stimuli (Higley and Suomi, 1989). Given this temperamental conceptualization of reactivity, it seems likely that experienced observers would also be capable of making valid and reliable assessments of animals as high, moderate, or low reactors.

Accordingly, the purpose of this study is to assess the interrater reliability and convergent validity of subjective assessment of reactivity among members of a small troop of captive rhesus monkeys (Macaca mulatta). The specific objectives are (1) to identify (subjective) personality traits that are correlated with (estimated) reactivity level, dominance rank, age, and gender; (2) to compare results to previous studies of personality assessment; (3) to identify clusters of related traits to be used as descriptors of personality dimensions; (4) to assess relationships between personality dimensions and reactivity, social rank, age, and gender; and (5) to determine whether a simple reactivity rating system can capture the essence of a larger collection of tempo-related traits.

METHODS

The subjects in this study were 12 male and 10 female rhesus monkeys (Macaca mulatta), between 1 and 14 years of age. The four oldest animals had been born in a laboratory and were surrogate-raised with limited peer experience. They were put together in a social group and were the originating members of the study troop, which had grown to include 25 animals at the time of analyses. Subsequent progeny/offspring animals were raised by their natal mothers, with the exception of two males which were fostered into the group at several days and at 6 months, respectively. The evolving troop has lived together in three different semi-free-ranging sites (O'Neill, 1989). During the period of 3 years, in which the animals were observed for the present study, they were living in a 5-acre outdoor area with two corncrib enclosures. Over the past 3 yrs, quantified observations of 36 behaviors were made between two and five times per week by the observers. Two of the raters in our study observed

from 8 to 10 weeks each summer, and one rater observed throughout the 3-year period. The number of hours during which raters had contact with the subject animals ranged from 188 hr of specific observation time plus 160 hr of animal care/general maintenance to 700 hr of observation with 1600 hr of animal care/general maintenance.

The reactivity and personality assessments were separately completed during late Autumn 1989 and early Winter 1990. Observers first ranked animals as high (3), moderate (2), or low (1) on reactivity. High reactivity was defined as least likely to approach new stimuli, most anxious, most socially inhibited, and least likely to attempt challenging situations; low reactivity as most likely to approach new stimuli, least anxious, least socially inhibited, and most likely to attempt challenging situations; and moderate reactivity in the intermediate positions (Suomi, 1987). After a period of several weeks, the observers independently assessed the 22 animals on the 25-item Stevenson–Hinde et al. (1980) inventory. Observers used a 7-point scale; no mutual discussion of the traits occurred. A list of the items and the instructions given to observers is shown in the Appendix. Animals also were ranked objectively as high (3), moderate, (2), or low (1) in social dominance according to their social status associated with the three matrilinies established in the troop. These matrilinies were established at the time of troop formation (1973–1974) and have remained stable through three changes in location, fostering of male infants, and deaths of troop members (Novak et al., 1991).

Interrater agreement among observers for each personality trait was determined by correlations between each pair of the three observers on each personality trait across all animals. The personality trait was considered reliable if the correlation between each pair of observers reached $P < 0.5$ (one-tailed, Spearman rho) level of significance (Stevenson–Hinde and Zunz, 1978; Stevenson–Hinde et al., 1980). Items that were not found to be reliable were not included in subsequent analyses. Scores on reliable items were averaged across the three observers. For the reactivity assessment, two of the three observers had to agree in order that an animal be categorized as a high, moderate, or low reactor.

Caine et al. (1983) utilized the Stevenson–Hinde and Zunz (1978) principal-components to investigate a relationship between dominance rank and personality. In order to facilitate comparison of our results with their studies, the same components were used. In addition, we conducted principal components analysis on our data to construct new components, and we tested differences of scores on personality dimensions between reactivity, rank, age, and gender groups. Discriminant analysis was used to determine if animals could be assigned to reactivity level on the basis of their ratings on personality traits.

RESULTS

Interrater Reliability of Personality and Reactivity Assessments

Twenty of the 25 personality traits (80%) were at the acceptable level of agreement. That five traits were not reliably rated across animals may imply that they were not appropriate descriptors of monkeys, that they are difficult to discern, or that the observers did not understand the terms. At least two of the three observers agreed on categorization of reactivity level as high, moderate, or low for 20 of the 22 animals. There was complete agreement on seven animals (32%). By chance alone, 78% of the subjects would have been classified into one of the three levels of reactivity with two-thirds agreement, and on 11% of them there would have been complete agreement. Of the two animals that were not categorized, one was not rated by all three observers and one received three different scores. The results of these analyses are summarized in Table I.

Relationship of Personality Traits to Reactivity Level, Maternal Social Rank, Age, and Gender

Individual personality traits that had a relationship with level of reactivity are listed in Table II. Animals ranked as highly reactive were also rated as least confident, curious, equable, and understanding, and the most excitable, fearful, insecure, irritable, and tense.

Correlational analyses were also used to determine relationships with maternal social rank, because social rank has often been cited as a contributor to differences in personality, as well as reactivity level. Personality traits that were significantly correlated with matrilinear rank are also shown in Table II. Low-ranking animals were the most fearful and subordinate and the least confident and effective. The personality traits that were significantly related to both reactivity level and maternal dominance rank were confident and fearful. High-reactive and low-dominance animals were rated as the least confident and the most fearful.

Traits that were found to have a relationship with gender were excitable and solitary. Females were assessed as more excitable, and males as more solitary. Active, playful, eccentric, motherly, and protective were related to age. With increasing age, animals were assessed as being less active and playful and more protective, eccentric, and motherly.

A significant relationship ($rPb = .47$, $P < .05$) was found between gender and reactivity level, with females as a group being assessed as more

Table I. Subject Characteristics, Temperamental Reactivity Ratings, and Maternal Dominance Rank[a]

Subject	Observer 1	Observer 2	Observer 3	Agree (%)	Reactivity level	Maternal rank	Sex	Birthdate
Eric	2	1	1	67	1	3 XX	M	9/5/73
Sleepy	3	3	2	67	3	1 XX	M	9/24/73
Sunflower	2	2	1	67	2	3 Sunf.	F	10/1/73
Molly	2	3	2	67	2	2 Molly	F	9/19/73
Cocoabean	2	1	2	67	2	3 Sunf.	F	2/21/80
Emma	3	3	3	100	3	1 Mona	F	11/20/80
Pierre	2	2	2	100	2	3 Sunf.	M	4/27/82
ET	1	3	1	67	1	1 XX	M	6/4/82
Evan	2	1	2	67	2	1 Mona	M	5/1/84
Hershey	2	3	3	0	—	3 Sunf.	F	3/28/84
Linda	3	3	3	100	3	1 Mona	M	3/9/84
Taurus	2	3	2	67	2	1 Mona	M	5/3/85
Tanker	3	3	2	67	3	3 Sunf.	M	5/21/85
Billy	2	3	2	67	2	1 Mona	M	3/8/86
Pearl	3	2	3	67	3	3 Sunf.	F	4/5/86
Muffin	2	2	2	100	2	2 Molly	F	5/22/86
Trout	1	1	1	100	1	3 Sunf.	M	5/12/87
Kiwi	3	3	3	100	3	3 Sunf.	F	6/26/87
Bardot	2	2	3	67	2	1 Mona	F	4/12/88
Lily	2	3	3	67	3	1 Mona	F	4/3/88
Schlim	1	2	—	—	—	2 Molly	M	3/23/88
Orbit	1	1	1	100	1	3 Sunf.	M	5/2/88

[a]Reactivity: 1, low; 2, moderate; 3, high. Maternal dominance rank: 1, low; 2, middle; 3, high.

Table II. Significant Correlations between Personality Traits and Reactivity, Social Rank, Gender, and Age[a]

Trait	Reactivity		Social Rank		Gender		Age	
	rho	P	rho	P	rho	P	rho	P
Apprehensive	0.81	< 0.002						
Confident	-0.74	< 0.002	0.45	< 0.05				
Curious	-0.56	< 0.05						
Equable	-0.86	< 0.002						
Excitable	0.81	< 0.002						
Fearful	0.57	< 0.01	0.54	< 0.05	0.46	< 0.05		
Insecure	0.74	< 0.002						
Irritable	0.72	< 0.002						
Tense	0.69	< 0.002						
Understanding	-0.53	< 0.05						
Effective			0.70	< 0.002				
Subordinate			-0.65	< 0.002				
Solitary					-0.79	< 0.02		
Active							-0.82	< 0.002
Eccentric							0.53	< 0.05
Motherly							0.69	< 0.002
Playful							-0.82	< 0.002
Protective							0.44	< 0.05

[a] P values are two-tailed.

highly reactive than were males. However, there was no significant relationship between age and reactivity (rho = -0.3, P > 0.10) or between age and gender (rho = 0.01, P > 0.10). Correlational analysis also did not reveal a significant relationship (rho = -0.18, P > 0.10) between social rank and reactivity level for the animals included in this present study. Thus, reactivity appeared to be largely independent of social rank, but related to gender.

Comparison to Previous Data

In order to compare these data with those of other studies, we, like Caine *et al.* (1983), used Stevenson-Hinde and Zunz's (1978) components of personality. Including only traits that were reliable from data in both our study and in that of Stevenson-Hinde and Zunz's (1978) principal-component analysis, components were comprised of the following: Components Ia (confident, effective, popular, aggressive) and Ib (apprehensive, fearful, insecure, subordinate, and tense); Components IIa (active, curious, eccentric, excitable) and IIb (equable); and Components IIIa (playful) and IIIb (solitary). Additional traits, which were reliable in these data but not used in this initial comparison, are irritable, motherly, protective, and understanding. Traits used by Stevenson-Hinde and Zunz (1978) but not found to be reliable in this study are opportunistic, permissive, sociable, strong, and slow.

Mean scores of traits comprising each dimension of each component were compared for high, moderate, and low reactors (Table III), for maternal social rank (Table IV), and for age and gender (Table V). We employed Mann-Whitney U tests to determine significance of between-group differences. The means of the above comparisons indicate that the first component had the greatest between-group differences for both reactivity and maternal social rank. This was the only component that is significantly different for both reactivity level and maternal dominance rank, though the dimension, equable, of Component II was significant for reactivity level. For example, low reactors were the most confident and equable and the least tense, while low-ranking animals are the least confident and equable and the most tense.

There also are significant differences in the Component I due to age/gender class. Adolescent and juvenile females are rated the highest on the tense/fearful dimension and lowest on the confident/aggressive dimension. Juveniles were between 1 and 3 years old, adolescents were 4-5 years old, and adults were ≥ 6 years old. There are also significant

Table III. Mean Scores for High-, Moderate-, and Low-Reacting Animals: Stevenson-Hinde And Zunz Personality Components

	High reactors ($n = 7$)		Moderate reactors ($n = 9$)		Low reactors ($n = 4$)	
Component I						
Confident-aggressive	3.08	$(1.31)^a$	3.80	(1.42)	4.44	$(1.84)^b$
Tense-fearful	5.39	(0.92)	4.04	(1.32)	2.52	$(1.54)^c$
Component II						
Active-eccentric	4.42	(1.32)	4.02	(1.22)	4.02	(2.02)
Equable	2.05	(0.52)	3.59	(0.92)	5.00	$(0.94)^c$
Component III						
Playful	3.95	(1.37)	3.29	(1.71)	5.08	(2.44)
Solitary	2.90	(1.40)	3.26	(1.57)	4.25	(1.87)

^{a} Standard deviation shown in parentheses.
^{b} 0.05 level of significance.
^{c} 0.01 level of significance.

differences between age/gender classes in Component III. Adolescent males and juveniles are rated the highest on the playful dimension and adolescent males and adult males highest on the solitary dimension.

Table IV. Mean Scores for High-, Middle-, and Low-Ranking Animals: Stevenson-Hinde and Zunz Personality Components

	High-ranking ($n = 10$)		Middle-ranking ($n = 3$)		Low-ranking ($n = 9$)	
Component I						
Confident-aggressive	4.54	$(1.49)^a$	3.53	(0.98)	3.15	$(1.51)^b$
Tense-fearful	3.14	(1.62)	4.24	(0.75)	4.84	$(1.39)^b$
Component II						
Active-eccentric	4.03	(1.60)	4.44	(1.29)	4.20	(1.39)
Equable	4.11	(1.61)	3.78	(0.77)	2.83	(1.03)
Component III						
Playful	4.63	(1.94)	4.33	(2.33)	4.17	(1.65)
Solitary	3.22	(1.22)	2.44	(0.38)	3.57	(1.89)

^{a} Standard deviation shown in parentheses.
^{b} 0.01 level of significance.

Table V. Mean Scores for Males and Females by Age: Stevenson-Hinde and Zunz Personality Components

	Adults		Adolescents		Juveniles	
	M	F	M	F	M	F
	(n=4)	(n=4)	(n=4)	(n=1)	(n=4)	(n=5)
Component I						
Confident-aggressive	3.23	4.75	3.71	2.83	4.02	3.05[b]
	(1.99)[a]	(1.56)	(1.54)	(1.23)	(1.39)	(0.98)
Tense-fearful	3.70	3.43	4.25	6.13	3.10	5.07[c]
	(1.92)	(1.54)	(1.52)	(0.51)	(1.29)	(0.89)
Component II						
Active-eccentric	3.96	4.04	4.08	4.08	4.19	4.48
	(1.53)	(1.31)	(1.36)	(1.71)	(1.88)	(1.28)
Equable	3.58	3.93	3.33	1.33	4.67	2.67
	(1.10)	(1.55)	(1.41)	—	(1.41)	(0.78)
Component III						
Playful	3.17	2.25	5.17	2.33	6.58	5.07[c]
	(1.37)	(0.17)	(1.29)	—	(0.42)	(0.83)
Solitary	5.58	2.08	4.08	2.00	2.92	2.27[c]
	(0.57)	(0.32)	(1.57)	—	(0.50)	(0.55)

[a] Standard deviation shown in parentheses.
[b] 0.05 level of significance
[c] 0.01 level of significance.

Mautau et al. (1985) noted that animals for which the correlation among observers was low had changing social statuses. In our study, there are seven animals for which interobserver corrections across traits are poor (P > 0.05) for at least one pair of observers. Four of them were male adolescents/young adults, three of which were undergoing perpherilization; and two were juvenile females which were undergoing social change as well as physiological change due to the birth of their first offspring. No known major social or physical change could account for the lack of agreement on the other adolescent male and the mature female (14 years old). One explanation for the lack of consistent ratings for the mature female was the almost equal estimation by the raters in the degree of both her confidence and her tense/fearful behaviors—she was rated as highly confident but highly fearful/tense. Among humans, such personality incongruities are often evidence of disorder.

Table VI. Principal-Components Analysis

	Component			
	1	2	3	4
Tense	0.91	0.12	-0.06	0.15
Apprehensive	0.90	0.23	-0.11	0.11
Excitable	0.88	0.17	0.22	0.13
Fearful	0.86	0.14	-0.20	0.19
Subordinate	0.84	-0.02	-0.39	0.10
Insecure	0.82	0.01	0.11	0.17
Popular	-0.75	0.11	0.01	0.31
Understanding	-0.82	0.11	-0.35	0.22
Effective	-0.83	0.26	0.27	-0.02
Equable	-0.86	-0.23	-0.20	0.02
Confident	-0.95	-0.09	0.14	-0.10
Motherly	-0.33	0.64	-0.06	0.39
Protective	-0.52	0.62	0.21	0.32
Eccentric	0.07	0.60	-0.45	-0.18
Active	0.31	-0.74	0.30	0.13
Curious	-0.31	-0.76	0.06	0.07
Playful	0.08	-0.90	-0.06	0.07
Aggressive	0.05	0.41	0.67	-0.42
Irritable	0.61	0.19	0.65	0.17
Solitary	0.09	0.11	-0.52	-0.72

Variance explained by each component				
Eigenvalue	9.10	3.43	2.03	1.33
Variance (%):	45.5	17.1	10.2	6.7
Cumulative variance (%):	45.5	62.7	72.8	79.5

Principal-Component Analysis

In order to determine variation in personality traits *within* the group, principal-component analysis, without rotation, was utilized with the 20 personality traits for which there was acceptable agreement (Kleinbaum *et al.*, 1988). Four major components, explaining from 7 to 46% of the variance were found. These components are listed in Table VII.

As with Stevenson-Hinde and Zunz (1978) and Stevenson-Hinde and co-workers' (1980) principal-component analyses, the first component consisted of the largest number of traits. Unlike their findings, in our data there are traits included or excluded in the first component which appeared to comprise less of an aggressive/dominance dimension and, instead, indicate a greater responsiveness or reactivity orientation, including that of tempo or change. For example, excitable, but not aggressive, was included. The second component was comprised of traits that appeared to cluster

Table VII. Mean Scores for High-, Moderate-, and Low-Reacting Animals: Current
Personality Components

	High reactors (n = 7)		Moderate reactors (n = 9)		Low reactors (n = 4)	
Component I						
Confident-popular	2.74	$(1.02)^a$	3.84	(1.33)	4.92	$(1.43)^b$
Tense-insecure	5.44	(0.88)	4.07	(1.28)	2.50	$(1.45)^b$
Component II						
Motherly-eccentric	3.35	(1.31)	3.58	(1.68)	3.25	(1.30)
Playful-active	4.11	(1.20)	4.31	(1.20)	5.14	(1.99)
Component III						
Aggressive-irritable	4.50	(1.82)	3.42	(0.99)	2.46	$(0.89)^b$
Component IV						
Solitary	2.90	(1.40)	3.26	(1.57)	4.25	(1.87)

^{a} Standard deviation shown in parentheses.
^{b} 0.01 level of significance.

around concepts of exuberance and nurturance (e.g., "party animal" vs. "homebody"). The third component included the traits aggressive and irritable; the last component is comprised of only one trait, solitary.

Relationship of Personality Components to Reactivity Level, Social Status, Age, and Gender

Here we examine the relationship between personality components, constructed from our data and reactivity level, maternal dominance rank, and age and gender. Findings in these analyses are compared to those in which Stevenson–Hinde and Zunz (1978) components were utilized.

We examine differences in components due to reactivity level, maternal social rank, age, and gender in the same way that we explored the Stevenson–Hinde and Zunz (1978) components (Tables III–V) but utilizing our components (Tables VIII–IX). Component I in both the Stevenson–Hinde and Zunz (1978) and our analyses has the greatest differences between reactivity levels (Tables III and VII). Low-reactive animals were rated the highest in the confident dimension and the lowest on the tense-fearful dimension of Stevenson–Hinde and Zunz Component I. Similarly, in our analyses, low reactors scored the highest on the confident-popular dimension of Component I and the lowest on the

Table VIII. Mean Scores for High-, Middle-, and Low-Ranking Animals: Current
Personality Components

	High ranking (n = 10)		Moderate ranking (n = 3)		Low ranking (n = 9)	
Component I						
Confident-popular	4.51	$(1.54)^a$	3.87	(0.76)	3.13	$(1.32)^c$
Tense-insecure	3.20	(1.64)	4.31	(0.78)	4.83	$(1.34)^c$
Component II						
Motherly-eccentric	3.54	(1.35)	4.04	(1.82)	3.06	$(1.34)^b$
Playful-active	4.67	(1.56)	4.67	(1.42)	4.41	(1.35)
Component III						
Aggessive-irritable	3.76	(1.44)	2.72	(0.71)	3.63	(1.61)
Component IV						
Solitary	3.22	(1.22)	2.44	(0.38)	3.57	(1.89)

^{a} Standard deviation shown in parentheses.
^{b} 0.05 level of significance.
^{c} 0.01 level of significance.

tense-insecure dimension. Low reactors were rated the most equable in Stevenson–Hinde and Zunz components and scored as least aggressive-irritable in our analysis.

For maternal dominance rank (Tables IV and VIII), low-ranking animals scored the lowest on the Stevenson–Hinde and Zunz confident/aggressive dimension of Component I. Similarly, the low-dominance animals scored the lowest on the confident-popular and the highest on the tense-insecure dimensions of Component I in our analyses. Although there were no significant differences in Stevenson–Hinde and Zunz Component II due to maternal dominance rnak, in our analyses in Component II there is a significant difference, with low-ranking animals being the least motherly-eccentric.

In Stevenson–Hinde and Zunz Component I (Table V) there was a significant difference in the tense-fearful dimension due to age/gender class. Adolescents (male and female) and juvenile females were ranked as the most tense-fearful. There were also significant differences in the Component III dimensions of playful and solitary: juveniles and adolescent males were perceived as the most playful and adolescent and adult males as the most solitary. In our analyses Components I, II, and IV had

Table IX. Mean Scores for Males and Females by Age: Current Personality
Components

	Adults		Adolescents		Juveniles	
	M	F	M	F	M	F
	($n=4$)	($n=4$)	($n=4$)	($n=1$)	($n=4$)	($n=5$)
Component I						
Confident-popular	3.95	4.63	3.45	2.07	4.48	3.08[b]
	(1.66)[a]	(1.53)	(1.50)	(0.76)	(1.16)	(0.93)
Tense-insecure	3.69	3.56	4.30	6.17	3.07	5.09[b]
	(1.80)	(1.59)	(1.50)	(0.46)	(1.26)	(0.86)
Component II						
Motherly-eccentric	3.80	4.83	2.69	4.00	2.42	4.11[b]
	(1.39)	(1.69)	(0.78)	(0.88)	(0.35)	(1.33)
Playful-active	3.61	3.56	4.83	3.00	6.08	4.96[b]
	(1.62)	(1.21)	(0.96)	(1.15)	(0.70)	(0.82)
Component III						
Aggressive-irritable	2.92	3.79	4.33	5.33	2.58	3.70
	(1.53)	(1.74)	(1.08)	(1.41)	(0.96)	(1.31)
Component V						
Solitary	5.58	2.08	4.08	2.00	2.92	2.67[b]
	(0.57)	(0.32)	(1.57)	—	(0.50)	(0.55)

[a] Standard deviation shown in parentheses.
[b] 0.05 level of significance.
[c] 0.01 level of significance.

significant differences due to age/gender class (Table IX). Like the subject
of Stevenson–Hinde and Zunz, our adolescent and juvenile females were
the most tense-insecure and least confident-popular; juveniles and
adolescent males were the most playful-active; and adolescent males and
adult males were viewed as the most solitary. Further, in Component I of
these analyses, adolescent females were the least confident-popular;
adolescent females and adults were rated as the most motherly-eccentric
(Component II).

As with components of Stevenson–Hinde and Zunz (1978), although
comprised of slightly different traits, the first component for both reactivity
level and social status was most salient (Tables VII–IX). However, there
were also significant monotonic relationships by social rank in motherly-
eccentric and by reactivity level in aggressive-irritable.

Table X. Results of Discriminant Analysis for Personality Traits Distinguishing High, Moderate, and Low Reactors[a]

Variable	Partial R^2	F (df = 2,17)	P
Apprehensive	0.6048	13.01	0.0004
Confident	0.5325	9.68	0.002
Curious	0.3171	3.95	0.04
Equable	0.6761	17.74	0.0001
Excitable	0.6222	14.00	0.0003
Fearful	0.3841	5.31	0.02
Insecure	0.5615	10.88	0.0009
Irritable	0.5690	11.22	0.0008
Tense	0.4589	7.21	0.005
Understanding	0.2517	2.86	0.09

[a] Wilks lambda F = 2.64; df = 20,16; P = 0.03.

Discriminant Analysis of Reactivity Groups

In order to determine differences or similarities in patterns of variations in personality traits *between* the groups designated as high, moderate, and low-reactor animals in the present analysis, we employed a discriminant analysis (Kleinbaum *et al.*, 1988). Personality traits (n = 10), which significantly correlated to reactivity level, were entered. A multivariate test for between-reactivity group differences was significant for the 10 traits (Wilks lambda F = 2.64, df = 20, df = 16, P = 0.03). Average R^2 was 0.50 unweighted and 0.52 weighted by variance. Individual contributions in traits to R^2 varied from 25% (understanding) to 68% (equable), with nine traits significant at the 0.05 level or below (Table X). With these 10 personality traits, there was a 100% assignment of animals to reactivity level. However, 100% assignment of animals to reactivity group was possible with as few as three traits (e.g., equable, excitable, insecure, or understanding).

DISCUSSION

The hypotheses for this study were that subjective assessment of reactivity would be related to that of personality traits and that reactivity assessment would particularly be related to traits that were responsive, intense, or rapidly changing, as opposed to those associated with strength or dominance.

The component "confident-tense/fearful" in the comparisons utilizing Stevenson–Hinde and Zunz's (1978) components had the greatest

impact in discriminating differences among maternal social ranks and reactivity levels. For example, high reactors were the least confident and the most fearful and high rankers were the most confident and the least fearful. However, strength of the correlations and levels of significance, indicated that there was a stronger relationship between personality traits and reactivity level than with social rank and personality traits. In this instance, maternal social rank was used instead of a specific behavioral measure of dominance, which may have been more precise in determining relative positions.

Correlational analyses between personality traits and age and gender revealed several traits to be significantly related. Greater stability in traits might be expected by adulthood. Both human and nonhuman adolescents are commonly the most difficult to categorize, as was found in this and other analyses (Martau et al., 1985). The adults in this study might have been expected to be the least likely to be categorizable due to the low incidence of salient behaviors. However, perhaps because of greater overall stability in traits, all but one was categorized. Juveniles were more active and were continually meeting social demands; hence salient behaviors were likely to be more common. Behavioral instability, associated with rapid social and physical change, probably contributed to the relative high incidence of noncategorization. Stereotyping by the observers may also have existed. For example, assessment of females as more highly reactive than males may be affected by expectations.

Principal-component analysis of behaviorally defined personality traits produced four major components, while Stevenson–Hinde and Zunz (1978) found three. In both our and the Stevenson–Hinde and Zunz analyses, Component I was comprised of the greatest number of traits. Thirty-two percent (n = 8) of the 25 traits were first components in both of these analyses. These traits—tense, apprehensive, irritable, fearful, subordinate, popular, effective, and confident—may be the most easily discernable from observation and, hence, the most important in any future studies of subjective or objective analyses of rhesus monkeys.

Our results, combined with Caine and co-workers' (1983) assertions of conceptual validity, Mautau and co-workers' (1985) interrater reliability only for familiar observers, and Stevenson–Hinde and Zunz' (1978) and Stevenson–Hinde and co-workers' (1980) principal-component analyses, argue cogently for the use of subjective assessment. Further, by relating the reactivity level assessment to the personality traits inventory, as well as to maternal social rank, convergent and discriminant construct validity has been furthered. The reactivity level assessment converged in measurement of specific traits included in the personality inventory and in theoretical anticipated directions. For example, low reactors were the least tense.

Animals rated as high, moderate, or low in reactivity would be expected to vary systematically in personality traits that had particular tempo or change aspects, as opposed to those that might reflect physical strength or aggression. Animals varying in tempo personality traits could thus be assumed to vary in reactivity level. In these data there was not a significant relationship between the reactivity level assessment and the maternal social rank; these assessments may not be measuring similar or overlapping constructs. Principal-component and discriminant analyses, including 100% assignment of animals to reactivity level with assessment of 10 personality traits, strengthen the probability of predictive validity.

As Mautau et al. (1985) also found in a study utilizing the personality traits inventory, there was the least agreement among present raters on young males and animals undergoing social and/or physiological change. However, with the reactivity level assessment, only one animal was not categorizable due to each rater having ranked him differently. Thus, the simpler, three-level, reactivity measure, while simultaneously capturing salient personality characteristics, appears to be a reliable instrument, comparable to the 25-item personality assessment. In addition, unlike the raters in the studies by Stevenson–Hinde et al. (1978, 1980) and Caine et al. (1983), who discussed personality traits before rating, we did not do so. Therefore, the independent determination of reactivity level and personality traits with the resultant levels of interrater reliability strengthens the argument for these measures having both face and construct validity.

CONCLUSION

Subjective assessment has been employed frequently to characterize individual differences in nonhuman primates (Caine et al., 1983). A variety of studies has provided empirical support for this methodology. Experienced observers are indeed capable of making valid and reliable assessments of animals' personality traits. Results of our study extend this area of inquiry to include subjective assessment of reactivity level. Reactivity level had a greater monotonic relationship with personality traits than social ranking, age, or gender did, and there were greater differences between means of traits by levels of reactivity than by maternal dominance rank. In future analyses, subjective assessment of reactivity will be compared to physiological measurement of reactivity and compared to behavioral data collected in the same time frame as that in which these assessments were made.

APPENDIX

Directions

Consider each item according to its definition, and independently of any other item. Rate over one item before proceeding to the next. For each item, assign the following ratings according to a normal distribution over all the animals, giving 4 to about 30% of them: 1-extreme antithesis to the behavior; 2-the item is weakly represented, though traces are present; 3-the item is distinctly present, but falls a little below average; 4-the individual falls just about halfway between the two extremes; 5-the item is strong, though not outstanding; 6-the item is very strong, and conspicuous, approaching the extreme; 7-extreme manifestation of the behavior (Stevenson-Hinde and Zunz, 1978, p. 481).

Behaviors

1. ACTIVE: moves about a lot.
2. AGGRESSIVE: causes harm or potential harm.
3. APPREHENSIVE: seems to be anxious about everything; fears and avoids any kind of risk.
4. CONFIDENT: behaves in a positive, assured manner, not restrained or tentative.
5. CURIOUS: readily explores new situations.
6. ECCENTRIC: shows stereotypes or unusual mannerisms.
7. EFFECTIVE: gets own way; can control others.
8. EQUABLE: reacts to others in an even, calm way; is not easily disturbed.
9. EXCITABLE: overreacts to change.
10. FEARFUL: fear grins, retreats readily from others or from outside disturbances.
11. INSECURE: hesitates to act alone; seeks reassurance from others.
12. IRRITABLE: reacts negatively with little provocation.
13. MOTHERLY: provides a warm, receptive, secure base.
14. OPPORTUNISTIC: sizes a chance as soon as it arises.
15. PERMISSIVE: could but does not interfere with the behavior of others.
16. PLAYFUL; initiates play and joins in when play is solicited.
17. POPULAR: is sought out as a companion by others.
18. PROTECTIVE: prevents harm or possible harm to others.

19. SLOW: moves and sits in a relaxed manner; moves slowly and deliberately; not easily hurried.
20. SOCIABLE: seeks companionship of others.
21. SOLITARY: spends time alone.
22. STRONG: depends upon sturdiness and muscular strength.
23. SUBORDINATE: gives in readily to others.
24. TENSE: shows restraint in posture and movements.
25. UNDERSTANDING: responds in a discriminating and appropriate manner to the behavior of others.

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