

Personality Dimensions in Spotted Hyenas (*Crocuta crocuta*)

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Personality ratings of 34 spotted hyenas (*Crocuta crocuta*) were made by 4 observers who knew the animals well. Analyses suggest that (a) hyena personality traits were rated with generally high reliability; (b) 5 broad dimensions (Assertiveness, Excitability, Human-Directed Agreeableness, Sociability, and Curiosity) captured about 75% of the total variance; (c) this dimensional structure could not be explained in terms of dominance status, sex, age, or appearance; and (d) as expected, female hyenas were more assertive than male hyenas. Comparisons with previous research provide evidence for the cross-species generality of Excitability, Sociability, and especially Assertiveness. Discussion focuses on methodological issues in research on animal personality and on the potential contributions this research can make for understanding the biological and environmental bases of personality.

In 1950, Beach lamented the high proportion of animal studies that were performed on the albino rat, and he urged researchers to diversify the range of species they studied. In research on animal personality and temperament, Beach's recommendation was apparently heeded. Over the past 20 years, there has been a steady increase in published findings. A reasonably wide variety of species has been studied: octopuses (Mather & Anderson, 1993), snakes (Herzog & Burghardt, 1988), fish (Francis, 1990; Wilson, Coleman, Clark, & Biederman, 1993), rats (Garcia-Sevilla, 1984), mice (Whitney, 1970), cats (Feaver, Mendl, & Bateson, 1986), dogs (Hart & Miller, 1985), wolves (MacDonald, 1983), pigs (Forkman, Furuhaug, & Jensen, 1995), goats (Lyons, Price, & Moberg, 1988), primates (Bolig, Price, O'Neill, & Suomi, 1992; Buirski, Kellerman, Plutchik, Weininger, & Buirski, 1973; Byrne & Suomi, 1995; Caine, Earle, & Reite, 1983; Gold & Maple, 1994; King & Figueredo, 1997; McGuire, Raleigh, & Pollack, 1994; Nash & Chamove, 1981; Watson & Ward, 1996), and many others (see Gosling, 1998, for a comprehensive review). These studies typically aim to identify the major dimensions underlying personality descriptions of the target species. For example, in a seminal study, Stevenson-Hinde, Stillwell-Barnes, and Zunz (1980b) used two observers to obtain personality ratings of 46 captive rhesus monkeys and found

three major dimensions of personality: Confidence, Excitability, and Sociability.

The above list of animal studies is based on a rather broad definition of personality. In both the human and animal domains, the distinction between personality and temperament is often blurred. Moreover, some of the studies mentioned above refer to little more than individual differences in specific behaviors during a single testing situation. A more satisfactory definition of personality refers to an individual's distinctive pattern of behavior that is consistent across time and situations (Pervin & John, 1997).

The present study aims to contribute to the corpus of animal personality research by providing an analysis of the personality attributes of spotted hyenas (*Crocuta crocuta*), a previously unstudied species with a particularly interesting social structure. My main goal was to examine the major dimensions underlying individual differences in hyena personality. I also explored whether these dimensions could be artifactual, reflecting nonpersonality characteristics, such as sex, age, appearance, and dominance status. In addition, to test whether the personality dimensions identified in this research are unique to hyenas, I compared findings from this study with those from three previous studies of animal personality.

Using Personality Traits to Describe Animals

Personality traits can be thought of as aggregated summary trends in behavior (Buss & Craik, 1983), capturing an individual's characteristic patterns of behavior that persist across time and situations. Moreover, personality traits summarize behavior at a psychologically meaningful level (Funder & Colvin, 1991). That is, the various specific behaviors that are subsumed by a trait form a functionally coherent category; the behaviors of "biting people" and "scratching people" are both subsumed under the same term (*aggressive*) because, for most purposes, they can be treated as equivalent. But, at what level of specificity should researchers assess individual differences within a species of nonhuman animals? Does it make sense to focus on specific behaviors (e.g., "bit another individual"), or should research-

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ers aggregate these behaviors into broader categories (e.g., "aggressive")?

To avoid anthropomorphizing the animal subjects, early studies of individual differences often focused on specific behaviors rather than on broader personality traits. For example, the Yerkes Primate Laboratories (Orange Park, Florida; now located in Atlanta, Georgia) implemented a behavioral recording system in which specific behavioral acts of chimpanzees were recorded (Hebb, 1946). After 2 years, however, it became clear that the behavioral recording system was incapable of capturing distinctions that were important for describing interactions with chimpanzees. For example, researchers found that it was more useful to know whether a particular chimpanzee was "aggressive" before going into its cage than it was to be presented with a series of detailed behavioral recordings. In other words, the broader trait terms summarized the behavioral history of animals in an efficient and meaningful way (Hampson, John, & Goldberg, 1986).

Therefore, the present study aimed to test whether individual hyenas can be reliably described at the level of personality traits. If personality-trait ratings of individual hyenas are found to show high interrater reliabilities, it can be concluded that observers are able to consensually discriminate among individual animals on these traits, thereby suggesting that personality traits can be meaningfully applied to hyenas.

Hyena Social Structure

Spotted hyenas (*Crocuta crocuta*) are natives of the Central and Southern African savanna. They hunt communally and live in relatively stable clans that are dominated by an alpha female (Frank, 1986). Dominance rank, which is transmitted through a matrilineal system, plays a crucial role in the life of every member of a hyena clan. For example, dominant females and their young have priority access to food in the highly competitive feeding situations (Frank, 1986).

But is dominance the only major dimension differentiating one hyena from another? Research on primates suggests that there is meaningful personality variance beyond the dominance dimension. In their study of dominance in stumptailed macaques, Nash and Chamove (1981) concluded, "It is clear from the results that some of the behaviours which initially seemed to be correlated with dominance are a function of the personality of the individual in that dominance position and not of dominance per se" (p. 91). Similarly, on the basis of his research on olive baboons, Sapolsky (1990) suggested, "Social primates do not merely come in two flavors—dominant or subordinate—nor can they be reduced to a simple rank. These complex individuals differ in their behavioral *traits*" (p. 872). In the present study, I tested whether one dimension of dominance accounts for all the variance in hyena personality ratings or whether there are other dimensions of personality that reliably differentiate individual hyenas.

Sex differences—both physical and behavioral—are striking among spotted hyenas. I therefore expected that some of

the personality ratings would show sex differences. They should be particularly large on traits conceptually related to dominance status (e.g., assertiveness); that is, female hyenas should be rated as more assertive than male hyenas. Moreover, personality traits that refer to how animals respond to dominance-related incidents may also show sex differences. For example, males must constantly avoid being pushed around by the dominant females and may therefore behave more fearfully than females that are subjected to less physical threat than males. If sex differences are found in hyena personality, the important question then becomes whether sex differences account for all of the variance in the personality ratings.

Previous research on consistency and change in animal personality has shown that some traits are more stable over time than others (Stevenson-Hinde, Stillwell-Barnes, & Zunz, 1980a, 1980b; Suomi, 1991; Suomi, Novak, & Well, 1996). For example, Suomi et al. (1996) examined behavioral consistency and change in a colony of adult rhesus monkeys. Over the course of 15 years, Suomi et al. found evidence for both consistency (e.g., in social sex behavior) and change (e.g., in agonistic activity), implying that age may be an important factor in personality. I therefore examined the relation between hyena personality and age to see how much personality differences can be explained by age differences.

Finally, research on humans has shown that ratings of personality can be influenced by physical appearance of the target being rated. For example, attractive individuals are often assumed to have more socially desirable personality traits than less attractive individuals (e.g., Berry & Finch Wero, 1993; Feingold, 1992; Robins, Gosling, & Donahue, in press). Therefore, in addition to the personality ratings, I also obtained ratings of each hyena's physical appearance.

Method

Selection of Traits and Item Generation

The item-generation procedure consisted of three steps. The goal of Step 1 was to generate a comprehensive pool of behavioral traits from which a final pool could be selected for the rating study. Traits were obtained from three sources: previous research on animal personality, previous research on human personality, and expert nominations. Three experts, with an average of 9.3 years experience of working with hyenas, reviewed a list of 42 traits that had been used in previous research on animal personality. The experts selected those traits that they believed could be applied to individual differences in hyenas. They repeated this procedure for a list of 40 personality traits representative of the human personality domain (Saucier, 1994). Finally, they generated an additional set of traits to capture those hyena behaviors that were not already captured by the trait terms from the animal and human domains. Overall, Step 1 generated a total of 60 potential traits.

The goal of Step 2 was to reduce the pool of terms to a smaller, more manageable set of items. Two experts (one of whom had participated in Step 1) read through the list of potential traits with the aim of reducing redundancy. Where two or more items seemed have a very similar meaning in the context of hyena behavior, they were combined. For example, the traits fearful and apprehensive were judged not different enough to include as separate items.

Traits were retained if (a) they appeared to identify an important area of hyena behavior (e.g., persistent and scapegoating) or (b) they permitted theoretically interesting comparisons with research on the personality of other species, resulting in a reduced list of 44 personality traits. This reduced list was again reviewed by two experts (who had participated in Step 1) who modified the descriptions as they saw fit and ensured that the full domain of hyena functioning was captured.

The goal of Step 3 was to define the traits operationally in terms of species-specific behavior. The three experts and three of the four observers consensually defined each trait in terms of hyena behavior. The final list of 44 traits and their definitions is given in the Appendix. These traits refer to the general behavior of hyenas (38 traits) and how they interact with humans (6 traits). Also included in the Appendix are two traits that refer to the dominance status of the hyenas (dominant and submissive) and three that assess their appearance (attractive, clean, and scruffy).

Subjects

Subjects were 20 female and 14 male spotted hyenas (*Crocuta crocuta*) housed socially in groups of between 2 and 5 animals at the Field Station for Behavioral Research at the University of California, Berkeley, campus. Of the 34 hyenas, 3 females were ovariectomized, 1 male was castrated, and 4 females and 3 males had been treated with antiandrogens. The mean age of the animals was 6.9 years, ranging from 1.2 years to 11.9 years. Males reach puberty between 18 and 24 months, and females reach puberty between 30 and 36 months. Thus, all except 4 of the animals were postpubertal at the time the personality ratings were made. Further details of the colony can be found in Glickman et al. (1997) and Pederson, Glickman, Frank, and Beach (1990).

Personality Ratings

Across four species of primates, Martau, Caine, and Candland (1985) showed that high levels of interrater reliability can be obtained for personality ratings when the observers are familiar with the animals being rated (also see Feaver et al., 1986). Therefore, four observers, each of whom knew the hyenas well (mean acquaintance = 6.3 years), rated all 34 individuals in the colony. Before rating the hyenas, the observers clarified their understanding of the traits as defined in the present research and practiced using the rating scales by describing two dogs with which the observers were familiar. This allowed the observers to familiarize themselves with the rating-scale format and to practice applying the personality traits to individual animals.

The observers made their hyena ratings independently and were instructed not to discuss their ratings or the personality characteristics of the animals for the duration of the study. They were asked to base their ratings on the full length of their acquaintance with the hyenas. All ratings were completed over a 26-week period; each observer rated the hyenas in a different random order. Ratings were made on a 5-point scale ranging from *extremely uncharacteristic* (1) to *extremely characteristic* (5).¹ Observers were encouraged to use the full range of the scale where such a range could be meaningfully applied to the animals.

Results

Reliability of Observers' Ratings of Hyena Personality

To evaluate the reliability of the personality ratings by the four observers, I computed coefficient alpha reliabilities for

each trait across the 34 hyenas, treating the four observers as four independent observations. The reliabilities of their composite are shown in parentheses next to the trait labels in Table 1. The median alpha reliability was .71, ranging from a high of .90 for aggressive to a low of .05 for curious. These values are at least as high as those found for single-item ratings of humans (e.g., Gosling, John, Craik, & Robins, 1998, Table 3; John & Robins, 1993). The few items that had low reliabilities also had relatively low standard deviations, suggesting that the lack of reliability in the observers' ratings was due to restriction of range. Overall, however, the substantial interjudge reliability suggests that the observers were able to apply these personality traits consensually to the hyenas. In research on human personality, consensus on observer ratings is often considered to be the sine qua non of personality traits (McCrae, 1982; Wiggins, 1973).

Factor Structure

To identify the major dimensions in the ratings of the 44 personality traits, I conducted principal-components analyses on the composite observer ratings. The analyses were exploratory, and I made no specific predictions concerning the number of factors that would emerge. Determining the number of factors to retain is of utmost importance in such exploratory analyses because underextraction or overextraction may distort subsequent findings (Zwick & Velicer, 1986). I therefore used multiple converging criteria to decide on the appropriate number of factors to retain: scree test (Cattell, 1966), parallel analyses of Monte Carlo simulations (Horn, 1965), and the interpretability of the solutions (see Zwick & Velicer, 1986). The scree test is based on a plot of the eigenvalues of the factors; only those factors that are above a noticeable break or "elbow" in the line joining the eigenvalues are retained. Parallel analyses of Monte Carlo simulations provide a comparison standard in terms of the eigenvalues to be expected from purely random data with no underlying structure; here one retains only those observed factors that have eigenvalues greater than their randomly derived counterparts. Following these criteria, a five-factor solution was retained, which accounted for a total of 77% of the variance.

In accord with Pedhazur and Schmelkin (1991), both orthogonal (varimax) and oblique (oblimin) rotations were initially performed. However, the two solutions were very similar, and the mean correlation among the oblique factors

¹ McGuire et al. (1994) used a partially forced ranking procedure in which the observers were instructed to make their ratings conform to a normal distribution. Such partially forced rankings may be useful for increasing variance. However, the present study adopted a free-rating procedure because there was no a priori reason to believe that the hyenas were distributed normally within each trait.

Table 1
Factor Loadings of the 44 Hyena Personality Traits on Five Varimax-Rotated Principal Components

Trait labels (reliability) ^a	Assertiveness	Excitability	Human-Directed Agreeableness	Sociability	Curiosity
Assertive (.79)	0.95	-0.08	-0.14	-0.01	-0.01
Argumentative (.84)	0.93	0.13	-0.10	-0.02	-0.17
Aggressive (.90)	0.90	0.11	-0.22	0.03	-0.15
Bold (.81)	0.88	-0.32	0.08	0.11	0.05
Confident (.84)	0.88	-0.25	0.00	0.01	0.13
Persistent (.74)	0.84	0.07	-0.03	0.08	0.38
Fearful (.77)	-0.80	0.34	-0.31	-0.14	-0.08
Jealous (.71)	0.79	0.41	0.15	0.09	-0.09
Strong (.75)	0.77	-0.08	0.05	0.21	0.34
Irritable (.66)	0.74	0.19	-0.39	-0.27	-0.27
Greedy (.85)	0.69	0.27	0.20	0.00	0.19
Careful (.25)	-0.66	-0.25	-0.17	0.29	-0.30
Scapagoating (.76)	0.65	0.25	-0.27	-0.08	-0.23
Opportunistic (.60)	0.62	-0.06	0.31	0.18	0.52
Friendly (.67)	-0.57	-0.32	0.41	0.38	0.27
Vigilant (.60)	0.05	0.88	0.09	0.15	0.07
Excitable (.65)	0.34	0.87	-0.09	0.03	0.08
High Strung (.84)	-0.23	0.84	-0.27	-0.23	0.08
Slow (.75)	0.06	-0.82	0.24	-0.01	-0.17
Calm (.64)	-0.01	-0.82	0.06	0.36	0.20
Active (.83)	0.03	0.81	-0.21	0.10	0.28
Lazy (.75)	0.00	-0.75	0.25	-0.18	-0.30
Vocal (.65)	0.16	0.73	0.46	0.09	0.13
Nervous (.78)	-0.44	0.71	-0.34	-0.15	-0.06
Moody (.62)	0.27	0.67	-0.41	-0.17	-0.25
Nurturant (.71)	0.01	-0.52	0.11	0.23	0.50
Eccentric (.70)	0.15	0.50	0.45	0.24	0.17
Testing-H (.66)	0.22	0.21	-0.83	-0.01	0.11
Social-H (.77)	0.04	0.01	0.81	0.47	0.04
Tame-H (.71)	-0.12	-0.37	0.78	0.22	-0.10
Warm-H (.78)	-0.08	-0.11	0.75	0.50	0.05
Obedient-H (.79)	0.26	0.08	0.75	-0.12	0.40
Deceitful-H (.65)	0.18	0.36	-0.69	-0.18	0.00
Flexible (.68)	0.28	-0.20	0.68	-0.02	0.44
Warm (.70)	-0.08	0.09	0.16	0.86	0.15
Affiliative (.73)	0.15	0.16	0.19	0.86	0.03
Sociable (.57)	0.18	-0.10	-0.04	0.85	0.20
Cold (.58)	0.14	0.10	-0.45	-0.79	-0.06
Exploratory (.19)	0.09	0.23	0.17	0.00	0.79
Impulsive (.37)	0.13	0.31	-0.29	0.06	0.73
Curious (.05)	0.07	0.22	0.44	0.02	0.61
Imaginative (.72)	0.00	-0.13	0.29	0.34	0.52
Playful (.74)	-0.13	0.12	-0.08	0.14	0.51
Intelligent (.65)	0.22	-0.19	0.35	0.32	0.37

Note. The highest factor loading of each trait is listed in boldface type. Suffix "-H" denotes traits specifically referring to human-hyena interactions.

^aReliability of the aggregate of the four observers is expressed in terms of Cronbach's (1951) coefficient alpha.

was low ($r = .13$), suggesting that the orthogonal solution offered a good fit for these data.² The varimax-rotated factor loadings are shown in Table 1. To find consensual labels, I asked five experts to examine the factor structure and to generate labels for the factors. The labels that showed most agreement were Dominance, Excitability, Human-Directed Agreeableness, Sociability, and Curiosity. However, the first personality dimension was named "Assertiveness" to avoid confusing it with status in the dominance hierarchy. As in

most factor-analytic research, these broad labels inevitably fail to capture some of the facets that make up the

² A quartimax rotation is preferable for data structures in which a general factor is expected (Stewart, 1981). Given the overarching importance of dominance for hyenas, a quartimax rotation was also performed. However, the quartimax rotation yielded results that were essentially the same as the varimax rotation, and I therefore report findings from the more widely used varimax rotation.

Table 2
Intercorrelations Among Personality Factor Scales, Dominance, Sex, Age, and Appearance

Variable	Personality scales								
	1	2	3	4	5	6	7	8	9
Personality scales									
1. Assertiveness	(.95)								
2. Excitability	.06	(.93)							
3. Human-Directed Agreeableness	-.03	-.32	(.90)						
4. Sociability	.04	-.06	.42*	(.92)					
5. Curiosity	.11	.12	.30	.34	(.71)				
6. Dominance rank	.84*	.02	-.19	-.04	-.16	(.94)			
7. Sex	.60*	-.26	.02	.05	.04	.59*	(—)		
8. Age	-.02	.15	.21	-.15	-.22	-.12	-.07	(—)	
9. Appearance	.07	-.34	.01	.20	-.04	.21	.16	-.65*	(.83)

Note. Scale reliabilities (Cronbach's coefficient alpha) are shown in parentheses on the diagonal. Dashes indicate single items for which reliability could not be computed.

* $p < .05$.

dimensions and should thus be used only as a guide to the content of each dimension (John, 1990).

Interpretation of the Factor Structure: Dominance Hierarchy, Sex, Age, and Appearance

Should these five factors be interpreted as reflecting individual differences in hyena personality, or might they reflect nonpersonality differences among the animals? I examined four alternative explanations: differences in dominance status, sex, age, and appearance.

Dominance. What if dominance is the one overwhelming influence in hyena social life that underlies all of the meaningful distinctions observers make in their personality ratings? That is, the personality ratings made by the observers may amount to little more than elaborate ratings of dominance. To test this idea, I created unit-weighted scales to measure each of the five varimax factors; as one would expect, the alphas of the resulting scales were substantial, with a mean of .90 (see Table 2). Next, I computed an index of dominance status ($\alpha = .94$) by combining a measure of dominance rank (derived from each animal's rank in the dominance hierarchy of the group in which it lives) with the two observer ratings related to dominance: dominant and submissive (reverse scored). Then I correlated each of the five scale scores with the dominance index across hyenas. As shown in Table 2, the index of dominance status correlated substantially with the Assertiveness scale ($r = .84$, $p < .01$) but was not correlated with the other four scales.

In general, the correlations among the five hyena personality scales were low (mean $r = .18$) and similar in magnitude to the interscale correlations found in research on human personality (e.g., Goldberg, 1992), suggesting that in general, the five hyena dimensions were fairly independent. Note, however, the correlation of .42 between Human-Directed Agreeableness and Sociability. This correlation suggests that these two dimensions are related in that they both refer to a friendly and warm interaction style, one with humans and the other with hyenas. Nonetheless, the correla-

tion is of moderate size, suggesting that the two dimensions are conceptually and empirically distinct.

Sex differences. Given the substantial sex differences in spotted hyenas, perhaps the observers' personality ratings merely reflect sex differences in the animals. To test this explanation, I computed the point-biserial correlation between sex and the five scales (see Table 2). Only the Assertiveness factor was significantly related to sex, and the same pattern of results replicated when I excluded the 11 animals that had been castrated, ovariectomized, or treated with antiandrogens. As expected, female hyenas were more assertive than male hyenas ($r = .60$), a rather large effect size (Cohen's $d = 1.46$).

To provide more descriptive detail, Table 3 shows the significant sex differences at the level of the individual traits.³ Note that Table 3 shows that 10 of the 12 traits showing sex differences loaded primarily on the Assertiveness factor; the remaining two (nervous and high strung) came from the Excitability factor. In sum, the major difference between male and female hyenas was in terms of Assertiveness.

To further ensure that the structural findings could not be attributed to sex differences, I performed a second set of analyses in which I first controlled for sex differences in the trait ratings using multiple regression (i.e., predicting the aggregated trait ratings from sex and retaining the standardized residuals). I then performed a principal-components analysis on these sex-residualized ratings. Again, five factors emerged, and their definition was almost identical to the original analysis. In particular, the factor scores from the residual analysis correlated almost perfectly with the factor scores from the original analysis (mean $r = .99$), and 43 of the 44 traits had their strongest loading on the same factor in both analyses.⁴ In short, these findings show that the

³ A table showing the means, standard deviations, and sex differences for all 44 traits is available from the author.

⁴ The one exception was *nurturant*, which loaded strongly on Excitability and Curiosity in both analyses.

Table 3
Sex Differences for Individual Traits: Means and Standard Deviations for Female and Male Hyenas and Standardized Effect Size

Trait	Primary factor loading	Female		Male		Effect size (<i>d</i>)
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Females rated significantly higher than males						
Confident	Assertiveness	3.9	0.58	2.5	0.71	2.1
Bold	Assertiveness	3.7	0.62	2.4	0.73	1.9
Assertive	Assertiveness	3.3	0.65	2.2	0.73	1.6
Argumentative	Assertiveness	3.3	0.81	2.2	0.73	1.5
Aggressive	Assertiveness	3.4	1.01	2.1	0.87	1.4
Strong	Assertiveness	3.4	0.63	2.6	0.63	1.3
Persistent	Assertiveness	3.5	0.46	2.8	0.85	1.1
Irritable	Assertiveness	2.4	0.63	1.9	0.48	1.0
Males rated significantly higher than females						
Fearful	Assertiveness	2.2	0.70	3.4	0.74	-1.6
Nervous	Excitability	2.4	0.71	3.3	0.69	-1.3
Careful	Assertiveness	3.4	0.37	3.8	0.34	-1.0
High strung	Excitability	2.7	0.83	3.3	0.69	-0.9

Note. Traits are ordered in terms of descending magnitude of effect size, which is shown in terms of standardized mean differences (Cohen's *d*). Traits were rated on a 5-point scale ranging from 1 (*extremely uncharacteristic*) to 5 (*extremely characteristic*).

structural findings cannot be explained in terms of sex differences.

In conclusion, all sex differences were consistent with the matriarchal dominance hierarchy characteristic of spotted hyenas. However, the variability in hyena personality cannot be explained in terms of sex differences. The majority of the traits (32 of 44) and factors (4 of 5) did not show sex differences, suggesting that considerable variability in these traits exists independent of sex.

Age. Personality change over the life course has been documented in both humans (e.g., Helson & Roberts, 1994) and animals (e.g., Suomi et al., 1996). Thus, differences in rated personality may reflect differences between younger and older animals. To test this idea, I correlated the five personality scales with the age of the animals when they were rated. As shown in Table 2, none of the scales correlated significantly with age. Because all but 4 of the animals studied were postpubertal, a more focused comparison between prepubertal and postpubertal animals could not be made. Although I could not test for personality differences associated with puberty, I found no evidence for systematic personality differences over the course of adult life.

Appearance. The observers may have been influenced by the appearance of the animals, perhaps giving a generally positive personality profile to clean, attractive-looking animals and a generally negative profile to scruffy, unattractive animals. To examine whether the observers' personality ratings were driven by the appearance of the individual hyenas, I created an Appearance scale ($\alpha = .83$) from the three physical appearance items: attractive, clean, and scruffy (reverse scored). As shown in Table 2, the Appearance scale did not correlate significantly with any of the factor-based personality scales, suggesting that the personality ratings did not depend on physical characteristics of the hyenas.

Discussion

Cross-Species Comparison of Factor Structures

The present analyses of the hyena personality ratings suggested that the five-factor solution was the most appropriate and interpretable solution, accounting for 77% of the variation in the ratings. How does this factor structure compare with analyses of personality ratings in other species?

To facilitate such comparisons, I had included several of the traits used by Stevenson-Hinde and Zunz (1978) and a number of subsequent researchers (Bolig et al., 1992; Caine et al., 1983; Gold & Maple, 1994). This allowed me to compare the present findings with the other studies that had used this common set of traits. Thus, I compared the five hyena factors with the three rhesus monkey factors found by Stevenson-Hinde and Zunz (1978; see also Stevenson-Hinde et al., 1980b), the four rhesus monkey factors found by Bolig et al. (1992), and the four gorilla factors found by Gold and Maple (1994). For the quantitative comparison of hyena and primate factors, I computed scale scores for the hyena subjects in the present study using the factor definitions for these three sets of primate factors and recomputed the hyena factor-based scale scores excluding all items overlapping with the primate scales. In other words, the primate-based scales were computed from the items common to the primate studies and the present hyena study, and the hyena-based scales were computed from the items unique to the present hyena study. Thus, the recomputed hyena scales consisted of fewer items than the original scales, but scale reliabilities were still substantial (median $\alpha = .89$).

The reliabilities of the primate-based scales in the present sample provide an initial gauge of how well these (often short) scales reflect dimensions of individual differences that

cohere in hyenas. Not surprisingly, the primate-based scales had lower reliabilities (median $\alpha = .76$) than the hyena-based scales. Nonetheless, of the 10 primate-based scales for which reliability could be computed, 6 had alphas exceeding .70, suggesting that some of the traits covaried in similar ways in primates and hyenas.⁵ The 6 most reliable scales were those based on Stevenson-Hinde and Zunz's (1978) Confidence ($\alpha = .89$) and Excitability ($\alpha = .80$) factors, Bolig et al.'s (1992) Responsiveness ($\alpha = .78$) and Aggressiveness ($\alpha = .92$) factors, and Gold and Maple's (1994) Dominance ($\alpha = .78$) and Understanding ($\alpha = .73$) factors.

Next, I correlated the primate-based scales with the recomputed hyena-based scales and found a number of cross-species similarities. First, the hyena-based Assertiveness scale correlated .85 with Stevenson-Hinde and Zunz's (1978) Confidence scale, .86 with Bolig et al.'s (1992) Aggressiveness scale, and .94 with Gold and Maple's (1994) Dominance scale. Second, the hyena Excitability scale correlated .90 with Stevenson-Hinde and Zunz's Excitability scale but appeared to represent blends of Bolig et al.'s Responsiveness and Exuberance scales and of Gold and Maple's Extroversion, Fearfulness, and Understanding scales. Third, Stevenson-Hinde and Zunz's Sociability scale seems to combine elements of the hyena Sociability scale ($r = .62$) and Curiosity scale ($r = .60$); moreover, the hyena Sociability scale correlated $-.82$ with the single item, Solitary, that constitutes Bolig et al.'s fourth factor. Together, these correlations suggested that Assertiveness-Dominance is a robust construct, appearing in some form in all four studies, and that elements of Excitability and Sociability also enjoy a degree of cross-species generality.

Finally, the hyena Human-Directed Agreeableness scale did not correlate highly with any of the dimensions found in previous primate research, a finding probably due to the fact that the primate studies did not include items to tap this dimension. What is the relevance of the Human-Directed Agreeableness dimension? Is it only relevant to captive animals, or is it related to some aspect of hyena behavior in the wild? One possibility is that this dimension refers to a hyena's level of sensitivity to the social environment—the ability to detect each individual's position in the dominance hierarchy and to be agreeable toward relatively dominant individuals. Perhaps in captive populations in which humans make up part of the social environment and are, in some sense, relatively dominant, it is the socially sensitive animals that are agreeable toward humans. If so, individual differences in Human-Directed Agreeableness may be manifestations of individual differences in the more general domain of social sensitivity. Social carnivores, which are well-known for their ability to form relationships with humans (Fentress, 1992; Ginsburg & Hiestand, 1992), may be an interesting group in which to test this hypothesis further.

One may also ask how this study's hyena dimensions relate to the Shy-Bold dimension studied in a number of other species (Wilson, Clark, Coleman, & Dearstyne, 1994). Unfortunately, the present data do not permit a quantitative comparison of the hyena dimensions with the Shy-Bold dimension. However, one can get a rough idea of the relation among the dimensions by inspecting the items

that load on each of the hyena factors. The Shy-Bold dimension has been characterized as consisting of various facets reflecting an individual's level of boldness, anxiety or calmness, and degree to which it will take risks or explore new environments (Wilson et al., 1994). These facets are conceptually related to traits loading on the hyena dimensions of Assertiveness (e.g., bold, confident, fearful), Excitability (e.g., high-strung, nervous, calm), and Curiosity (e.g., curious, exploratory). To test the possibility that these three hyena dimensions were actually facets of one higher order Shy-Bold dimension, I ran a series of principal-components analyses, retaining two, three, and four factors. However, a Shy-Bold dimension did not emerge in any of these analyses. Thus, there is no clear hyena analogue of the Shy-Bold dimension as it has been conceptualized in the literature. Further research is needed to assess the size and nature of the relation between the Shy-Bold dimension and other personality dimensions and to enable researchers to conceptualize its facets more explicitly.

Another comparison of interest is between the hyena dimensions obtained in this study and the Big-Five factor structure in human personality (Goldberg, 1992; John, 1990; McCrae & Costa, 1996). The dimensions of this five-factor model are Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. Again, the present data do not permit a quantitative comparison. However, a rough comparison between the two models can be made by inspecting the items that load on each of the hyena factors. Hyena Assertiveness seems to combine elements from human Extraversion and low Agreeableness, hyena Excitability seems quite similar to human Neuroticism, and hyena Sociability and Human-Directed Agreeableness are both similar to human Agreeableness. Finally, the hyena dimension of Curiosity has some overlap with the human dimension of Openness to Experience. Thus, there seem to be some similarities, though limited, in the personality structures of hyenas and humans. For example, the dimensions of Excitability (or Neuroticism), Sociability (or Agreeableness), and Curiosity (or Openness to Experience) appear to form similar factors in both hyenas and humans. On the other hand, no equivalent to the human Conscientiousness dimension was found in hyena ratings, and the hyena Assertiveness dimension seems to combine elements from more than one human Big-Five dimension.

Methodological Issues in Animal Personality Research

As noted earlier, research on animal personality is on the rise. Apparently, it has become more scientifically acceptable, maybe even respectable, to study personality, temperament, and emotions in animals. Nonetheless, there are a number of methodological complexities that often make it difficult to conduct research on animal personality. At this

⁵ Reliability could not be computed for Bolig et al.'s (1992) fourth factor because it consisted of only one item.

formative stage, it is important for the field to develop conceptually and statistically strong foundations. Five issues seem particularly central.

One issue in factor-analytic research involves finding ways to ensure that the dimensions that are empirically identified adequately represent the full range of individual differences in the behavior of the target species. The present study tackled this problem by using an extensive item-generation procedure in which several hyena experts nominated and modified traits over multiple rounds. This procedure resulted in the inclusion of traits from the domain of human-animal interactions—a domain often overlooked yet of great importance in the lives of captive animals. Future research should take care to maximize the comprehensiveness of the initial item pool to ensure that important domains of a species's behavior are not overlooked.

A second issue involves facilitating intraspecies and interspecies comparisons across studies by using similar items and rating scales across studies. Animal personality research is more vulnerable than human personality research to the danger of using inconsistent trait concepts because there is typically much more variability in behavioral repertoires across species (e.g., between chimpanzees and octopuses) than there is across groups of humans (e.g., between Oregon university students and London university students). Moreover, before applying the same trait to different species, researchers must consider the different ways in which that trait will be manifested by species with different behavioral repertoires living in different physical and social environments. For example, one would expect nervousness to be manifested differently in chimpanzees and in octopuses. Despite these challenges, researchers should make every effort to ensure that their item pool is as comparable as possible with other research. To facilitate cross-species comparisons, the present study included traits used in earlier research on other animals. Ultimately, a standard taxonomy of terms should be available from which animal personality researchers can choose items.

Unfortunately, there is a natural tension between the demands of comprehensiveness and the demands of comparability. To capture the idiosyncrasies of a particular species, researchers may be forced to use traits that are not applicable to other species. A balance needs to be found in which a basic set of standard descriptors (operationally defined in species-appropriate terms) is supplemented by important species-specific descriptors.

The third issue in animal-personality research involves the psychometric details of research and instrument development. Of particular importance are the limitations imposed by the initial selection of the sample population. Thus, for example, further research is required to see if the present findings based on a colony of captive hyenas, housed in small groups, will generalize to much larger clans of wild hyenas. In addition, where factor-analytic procedures are used, researchers should employ multiple converging criteria for deciding on the number of factors to retain, choose appropriate methods of matrix rotation, and attend to the

reliability and intercorrelations of factor-based scales. To facilitate structural comparisons across studies, researchers should report their analyses in sufficient detail, such as including factor loadings of the items.

The fourth issue involves the need for replication studies. The analyses presented here are based on a relatively small sample of hyenas. Given the considerable resources required to collect animal personality ratings and the scarcity of large animal populations, most animal personality research uses sample sizes that are considerably smaller than is ideal for the statistics employed. Replication studies will, therefore, need to play a major role in future animal-personality research. For example, although the present findings were based on reliable, aggregated observer ratings, were obtained consistently across several different types of factor rotation, and formed conceptually coherent dimensions, they may not be the final word on hyena-personality structure. The present structural findings only represent the best current hypotheses until additional data are gathered. Until such replications studies are performed, researchers must obtain data from as many subjects as possible and generalize only cautiously from factor structures based on suboptimal sample sizes.

The fifth issue involves the subjectivity of personality ratings. To avoid the biases inherent in any one observer's ratings, researchers often prefer seemingly more objective measures of behavior, such as on-line monitoring of specific behaviors or acts. However, such behavioral-recording techniques can also be problematic (Gosling et al., 1998; Hebb, 1946). The present study addressed the issue of subjectivity by aggregating personality ratings across multiple observers who were well acquainted with the target animals. Such consensual ratings are considered by many to be the ultimate criterion in personality research (Funder, 1995; Hofstee, 1994; McCrae & Costa, 1989; John & Robins, 1994; Wiggins, 1973). Nonetheless, future research should test whether such observer-based personality ratings indeed converge with objective indexes of behavior (e.g., Drea, Hawk, & Glickman, 1996).

Implications for Research on Biological and Environmental Bases of Personality

With the above caveats in mind, the present analyses of personality ratings of spotted hyenas suggest the following conclusions: (a) Hyena personality traits can be rated with high levels of reliability by observers well acquainted with the animals; (b) five broad dimensions of personality can be distinguished, and together they capture about 75% of the total variance in the ratings; (c) this dimensional structure cannot be explained primarily in terms of dominance status, sex, age, or appearance; and (d) sex differences are substantial for the Assertiveness dimension but not for the other four dimensions. The present findings, based on a captive colony of hyenas, are encouraging for future personality research on this and other species. Such research will lay the groundwork for a better understanding of biological and environmental influences on personality (Wilson et al., 1994).

It has been suggested that for personality theory, "biology could be the royal road to respectability" (Callaway, 1984, p. 436). Studies of animal personality provide an important source of information about the biological and genetic bases of personality and temperament (e.g., Depue, 1995; Flint et al., 1995; Sapolsky, 1990; Suomi, 1987, 1991; Zuckerman, 1990). For example, in animal studies, researchers can exercise experimental controls and collect physiological measures that would be considered unethical or impractical in humans (Clarke & Boinski, 1995).

The ability to exercise control and carefully document personality development over time in the same individuals also facilitates the study of environmental and social influences on personality (e.g., MacDonald, 1983). For example, Bard and her colleagues (see Bard & Gardner, 1996) have argued that much can be learned about social influences on human development by studying chimpanzee development. In short, animal studies provide a useful framework in which to examine how an individual's personality is influenced by his or her biology, genes, social and nonsocial environment, and the interaction among these factors (Suomi, 1997).

However, before researchers can responsibly use animal models of personality, they must first ensure that the relevant dimensions of animal behavior are identified and measured reliably (Zuckerman, 1984). The present findings show this can be done. Similar studies, on a broad range of species, will pave the way for subsequent use of animal models in research on the biological and environmental influences on personality.

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Appendix

List of Traits and Definitions

Please rate the target animal on the following dimensions. Try to use the whole scale (the individuals who are highest on a trait should be rated as 5 and the individuals who are lowest should be rated as 1). Use the following scale to make your ratings:

Extremely uncharacteristic		In-between /neutral		Extremely characteristic
1	2	3	4	5

Category 1 (General Hyena Behavior)

- _____ **Active, energetic:** Moves about a lot, distance traveled by walking, running, climbing, or jumping. Not lethargic.
- _____ **Affiliative, companionable:** Agreeable, sociable. Appears to like the company of others. Seeks out social contact with, or showing preference for, another animal; for example, playing, walking next to, or sitting with another animal.
- _____ **Aggressive:** Causes harm or potential harm, high frequency of displays, threats, chasing, and biting another group member.
- _____ **Argumentative:** Tends to become involved in altercations. Does not back down. (This trait does not necessarily involve initiating incidents.)
- _____ **Assertive:** Assertiveness which runs contrary to the established order of dominance in a situation.
- _____ **Bold, brave, not shy:** Behaves in a positive, assured manner. Exhibits courage in the face of danger. Is daring, not restrained or tentative. Not timid, shy, or coy.
- _____ **Calm, equable:** Reacts to others in an even, calm way; is not easily disturbed. Not agitated. Restful, peaceful.
- _____ **Careful, cautious:** Animal exhibits care in its actions. Is orderly, not haphazard.
- _____ **Cold, harsh:** Is socially cold and distant. Not affectionate.
- _____ **Confident, not insecure:** Self-assured, certain, self-reliant. Does not hesitate to act alone; does not seek reassurance from others.
- _____ **Curious:** Is curious, nosy. Appears to be interested in new situations.
- _____ **Eccentric:** Shows unusual mannerisms.
- _____ **Excitable:** Readily roused into action, responsive to stimuli.
- _____ **Exploratory, inquisitive:** Exploratory, inquisitive, readily explores new situations, seeking out or investigating novel situations.
- _____ **Fearful, apprehensive, cautious:** Hesitant, indecisive, tentative, afraid. Fears and avoids any kind of risk, shows change in posture and movements. Exhibits a defensive reaction in anticipation of a dangerous stimulus. Overly alarmed, retreats readily from others or from outside disturbances, a reaction, generally excessive, to actual or potential danger or threats.

- _____ **Flexible, not rigid:** Adapts to situations. Is able to accommodate new ways of doing things.
- _____ **Friendly, gentle:** Friendly, amicable, and congenial toward other animals. Responds to others in an easy, kind, manner. Not hostile. Not antagonistic.
- _____ **Greedy:** Is greedy. Has a keen, excessive appetite; ravenous. Is gluttonous, devouring. Rapacious.
- _____ **High strung, tense, not relaxed:** Tense, highly sensitive. On edge. Not relaxed.
- _____ **Imaginative, creative:** Approaches situations and addresses problems in novel, creative ways; for example, finds many ways to escape.
- _____ **Impulsive:** Spontaneous and sudden behavior, where the quality of anticipation is absent; for example, one young juvenile suddenly leaping in play on another who might be involved in feeding.
- _____ **Intelligent:** Animal appears to learn easily. Is intelligent. Quick to understand. Not stupid or foolish.
- _____ **Irritable, not tolerant:** Reacts negatively with little provocation; for example, gives an aggressive response to mild or inadvertent provocation.
- _____ **Jealous:** Intolerant of rivalry; for example, a situation where one animal interrupts or interferes with the ongoing pleasurable activity of a second animal in order that the first animal might enjoy the pleasurable activity him- or herself.
- _____ **Lazy:** Disinclined to action or exertion; indolent, idle.
- _____ **Moody, temperamental:** Displays frequent mood swings. Not equable or even. Not predictable, patterned, or steady.
- _____ **Nervous, anxious, not calm:** Jittery, anxious, seems to be anxious about everything; impatient. Not at ease (e.g., pacing).
- _____ **Nurturant, maternal, motherly:** Provides a warm, receptive, secure base. Nurturant.
- _____ **Opportunistic:** Seizes chances as soon as they arise.
- _____ **Persistent, perseverative:** Persistence in gaining one's ends in the face of rejection; tends not to give up. For example, a less dominant animal persisting in some activity in the face of threats from a more dominant animal.
- _____ **Playful:** Wrestling, chasing with exaggerated movements, and rapid shifting of roles, initiates play and joins in when play is solicited, engaging in diverting or frolicsome activities.
- _____ **Scapagoating:** Animal will direct hostility away from self to another animal. For example, when an animal is attacked by a second animal, it will join with the attacking animal to attack a third animal.

Appendix continues

- _____ **Slow:** Moves and sits in a relaxed manner; moves slowly and deliberately; not easily hurried. Inactive, slow, sluggish.
- _____ **Sociable, not solitary, not avoidant, not withdrawn:** Seeks companionship/company of others, prefers not to spend time alone.
- _____ **Strong:** Depends on sturdiness and muscular strength.
- _____ **Vigilant, alert:** Ready, attentive, watchful, notices with special attention. Not oblivious to surroundings.
- _____ **Vocal, not quiet:** Vocal, not quiet.
- _____ **Warm, affectionate:** Seeks or elicits bodily closeness, touching, grooming; for example, one animal lying on another.

Category 2 (Traits Relevant to Hyena-Human Interactions)

- _____ **Deceitful:** Animal is deceitful toward humans; for example, appears to be seeking petting, but snaps at human.
- _____ **Obedient, cooperative, not belligerent, not obstinate, not defiant:** Willing to obey, cooperate with instructions. For example, animal will cooperate with attempts to move it from one place to another.
- _____ **Sociable, not solitary, not avoidant, not withdrawn:** Seeks companionship/company of humans, prefers not to be alone.
- _____ **Tame:** Domesticated. Not wild. Does not exhibit ferocity or timidity toward humans.
- _____ **Testing:** Provocative. For example, when a human goes in with an animal that is not extremely habituated (i.e., hand-reared), it will at first be shy, then gradually come in close and start nipping at clothing. This is what a wild one would do when confronted with a carcass or apparently dying animal, which it did not recognize; it

tests to see if it is dangerous, and only when convinced that it is not does it start eating. The same thing can occur in a social context when hyenas test humans to see what they can get away with.

- _____ **Warm, affectionate:** Bodily closeness, touching, grooming.

Dominance Status

- _____ **Dominant:** Direct, forceful (not hostile), unhesitant, determined, gets own way; can control others, ability to displace or threaten other animals, getting what one is entitled to by virtue of one's position in the social order; for example, a dominant animal displacing a less dominant animal from a preferred spot. (Note: Some animals dominate with threats and others dominate with their confident demeanor.)
- _____ **Submissive, subordinate:** Appeasing or acquiescing to a more dominant animal; for example, a less dominant animal yielding a preferred spot to a more dominant animal. Gives in readily to others. (Note: this involves a large range of behaviors.)

Appearance

- _____ **Attractive:** Animal is physically attractive.
- _____ **Clean:** Animal keeps itself clean.
- _____ **Scruffy:** Scruffy, shabby, untidy.

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