

The Five-Factor Model plus Dominance in Chimpanzee Personality

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Forty-three trait-descriptive adjectives with representative items from the human Big-Five model were used to assess the factor structure of personality in 100 zoo chimpanzees. Interrater reliabilities were acceptably high, with an overall η of .75 and those of individual adjectives ranging from .55 to .81. Analysis of variance showed no significant interaction between zoos and individual trait descriptors or between zoos and factors based on those adjectives. There were therefore no between-zoo differences in patterns of intercorrelation among trait descriptors or among factors. Factor analysis showed that the chimpanzee ratings were accurately described by six factors, five of which resembled the human Big Five. The sixth factor was dominance related and was consistent with the central role of dominance in chimpanzee personality. Convergent and discriminant validity of the factor structure was excellent. These results are the first quantitative evidence of profound similarities in the personality structure of humans and chimpanzees. © 1997 Academic Press

This paper addresses two fundamental questions about chimpanzee personality. First, can the personality structure of chimpanzees be measured with acceptable levels of interobserver reliability and validity? Second, how closely do chimpanzee personality factors resemble those in humans?

Interest in the contents of the animal mind following the Darwinian revolution quickly became focused on learning and related cognitive functions in the laboratory and on objectively defined overt behaviors, particularly fixed action patterns, in the natural habitat (Boakes, 1984), while individual differences in animal personality were virtually ignored. The neglect was partly

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attributable to the early assumption that personality was a deeply subjective phenomenon closely related to character (Bain, 1861), dynamic organization within the individual (Allport, 1937), and even the soul (Myers, 1903), all characteristics not readily attributable to non-humans. In addition, a distaste for anthropomorphism has been a fundamental tenet within animal psychology and personality is not easily described without recourse to anthropomorphic terminology.

A technique for objective assessment of animal personality emerged about 60 years ago when psychologists first began using individual adjectives as personality descriptors (Allport & Odbert, 1936). A strong rationale for describing human personality taxonomy with either self or peer ratings on adjectival descriptors was the lexical hypothesis stating that all individual differences in human personality that are salient and socially relevant will become encoded in a single word personality descriptor. Although the lexical hypothesis can be traced back to Galton (1884), it did not significantly influence human personality research until the 1930s (John, Angleiter, & Ostendirk, 1988). The procedure of rating subjects on personality descriptors can be applied to non-human as well as to human primates. However, at the time no attempt was made to exploit the possibility of using personality ratings for interspecies comparison.

Factor analytic studies of the personality descriptors that people applied to themselves and to other people eventually resulted in a consensus that five factors, the Big Five, could account for a substantial part of the variance within the myriad of possible personality descriptors (Goldberg, 1990; John, 1990). The Big Five, namely surgency, agreeableness, dependability, emotionality, and openness, emerge across a variety of different Western and non-Western cultures and across different age groups (see John, 1990; Costa & McCrae, 1992, for reviews). In addition, all five factors have heritabilities approaching .50 (Bouchard, 1994).

Within the past 20 years, several studies have been published describing ratings of non-human primates on personality descriptor adjectives (e.g., Bollig, Price, O'Neill, & Suomi, 1992; Figueredo, Cox, & Rhine, 1995; Gold & Maple, 1994; Stevenson-Hinde & Zunz, 1978; Stevenson-Hinde, Stillwell-Barnes, & Zunz, 1980). A detailed summary of the non-human personality literature is given by Figueredo *et al.* (1995).

Some of the factors from the non-human primate studies described above were similar to some of those of the human Big Five. However, no conclusion about the generality of the Big Five to non-human primates emerges on the basis of these existing studies for two reasons. First, except for the Gold and Maple study, sample sizes were small and the variance of the factor loadings was consequently high. Second, although each of the adjectives used in the non-human primate studies can be assigned to one of the Big

Five factors, not all of the Big Five were represented nor were both poles of the represented factors adequately sampled.

The issue of whether all or part of the human Big Five factors is expressed in chimpanzees is potentially important in understanding human behavioral evolution. Chimpanzees have been recently shown to have a remarkably sophisticated social intelligence including elements of a theory of mind (Premack, 1988), coalitions based on anticipated future usefulness of partners (Harcourt, 1992), delayed reciprocity of both helpful and harmful acts (de Waal, 1991, 1992), intentional deception (Byrne & Whitten, 1992), and empathy (Povinelli, Nelson, & Boysen, 1992). All of these social and cognitive phenomena could only have evolved in intelligent species in which individuals experience intense and prolonged social interactions within a small cohesive group. Furthermore, it is within this type of social group that a strongly diversified set of personality traits might be expected to emerge. In fact, the descriptive literature on social intelligence in chimpanzees is replete with examples of complex behavioral exchanges that readily suggest human personality descriptors. The discovery of the human Big Five personality structure in chimpanzees would thus parallel discoveries of advanced social intelligence in this species and would imply that the human pattern of personality organization long antedated the recent emergence of *Homo sapiens*, just as the current research on ape behavior indicates that advanced social intelligence extends far back in our hominid ancestry.

METHOD

Subjects

Subjects were 100 chimpanzees at 12 zoological parks participating in the ChimpanZoo program of the Jane Goodall Institute. The sample contained 41 males with a mean age of 18.0 years and 59 females with a mean age of 18.7 years. Ages ranged from 3 to 55 years ($SD = 12.0$ years). Sexual maturity occurs at about 8 years in chimpanzees and old age begins at about 30 or 35 years. The sample thus included chimpanzees ranging from juveniles to those in well-advanced old age.

Raters

Ratings were made by 53 raters with a mean of 4.05 raters per chimpanzee. Raters were either zoo employees who regularly worked in the chimpanzee enclosure or ChimpanZoo volunteers who had extensive previous experience observing chimpanzees as part of a separate behavioral observation project.

Rating Forms

The rating forms contained 43 adjectives that were scored on a 7-point scale. All but 2 of the adjectives, clumsy and autistic, were taken from Goldberg's (1990) taxonomy, which was a subset of Norman's (1967) large adjective list. In order to make the adjectives representative of each factor, items were selected from as many clusters or facets within each factor as

possible. Forty adjectives are listed in Table 1, which also indicates the membership of each within the human five-factor model. Clumsy, autistic, and manipulative were the three additional adjectives.

Each adjective on the rating forms was followed by a two- or three-sentence definition. The definitions clarified the meanings of the adjectives in the context of chimpanzee behavior but were based on and consistent with dictionary definitions. For example, the descriptor definition of "stingy" stated that "Subject is excessively desirous of food, favored locations, or other resources in the enclosure. Subject is unwilling to share these resources with others." The definition of "cautious" stated that "Subject often seems attentive to possible harm or danger from its actions. Subject avoids risky behaviors." The instructions also emphasized that ratings should be based on overall impressions, not on estimated frequencies of particular behaviors. Two rating forms differing only in order of adjective presentation were used. The instructions firmly cautioned the raters not to discuss their ratings with other raters.

RESULTS

Interrater Reliability

All reliability estimates were based on an analysis of variance. Because the number of chimpanzees and the number of raters per chimpanzee varied across zoos, it was necessary to use a General Linear Model analysis (SAS Institute, 1985) to obtain a hierarchical partitioning of the different variance sources. The variance sources extracted that did not involve raters were zoos, chimpanzees (nested within zoos), descriptor items, and the interactions of items with zoos and with chimpanzees. The sum of variances associated with these nonrater effects was assumed to be true score variance in accordance with the logic of Generalizability Theory (Shavelson, Webb, & Rowley, 1989). All remaining variance sources involved rater effects and their sum was assumed to be an estimate of error variance. Interrater reliability was then estimated by the sum of squares associated with true variance (total sum of squares for nonrater effects) divided by the total sum of squares (Cohen & Cohen, 1983). The square root of this proportion is equivalent to η , a classic test theory measure of reliability. The obtained η of .75 indicated a quite high value of overall interrater reliability.

A comparable reliability analysis was performed for each of the 43 descriptor items. The η values formed a continuous distribution ranging from .55 to .81.

Between-Zoo Differences

The General Linear Model analysis described above was also used to test the significance of the interaction between zoos and items with interaction of items by chimpanzees within zoos used as an error term. This interaction was not significant, $F(462, 3696) = 1.10, p = .083$, despite the enormous number of degrees of freedom and it accounted for only 4.5% of the total variance. In other words, the profile of differences among the 43 items did not differ significantly between zoos. This null result could be viewed as

additional indirect evidence for interobserver reliability because it shows that raters at different zoos did not contribute to systematic differences in the pattern of item ratings among the 43 items.

The largest nonrater effect was the interaction between items and chimpanzees within zoos which accounted for 32.5% of all variance. This large interaction representing individual differences among chimpanzees in their personality profiles across items provided the basis for subsequent factor analytic study of those individual differences.

Factor Analysis

A principal factors procedure with varimax rotation was used to extract six factors. Each chimpanzee's item scores were means based on the data of all raters scoring that chimpanzee. Because the number of raters varied between chimpanzees at different zoos, the covariance matrix based on these mean scores was weighted by the number of observer ratings contributing to each mean score. The weighted covariance matrix was then used as input for the factor analysis.

Table 1 shows all factor loadings equal to .52 or greater. Two of the items not having any loadings meeting this criterion, autistic and clumsy, were not part of the original Goldberg (1990) taxonomy and the third, manipulative, had the lowest interrater reliability of all 43 items. Six clearly defined factors emerged accounting for 72.4% of the total variance. In order to clarify the relationship between the six chimpanzee factors in Table 1 and the human Big Five, each of the items is followed by a designation of the human factor with which it is associated in the human literature (Goldberg, 1990).

The first and strongest chimpanzee factor accounted for 20.8% of the variance but is obviously not one of the Big Five. In fact, the 12 items having large loadings on this factor are drawn from all five of the human Big Five. The large loadings for dominant and submissive as well as the other items that define an independent, confident, and fearless chimpanzee all support the interpretation of this factor as a dominance factor.

The remaining five factors, however, bear a striking similarity to the human Big Five. The second factor, which we have labeled surgency, describes an active, sociable, and playful chimpanzee, all characteristics that are consistent with the human definition of this factor. The third factor has a clear similarity to the human dependability or conscientiousness factor although the chimpanzee factor is more narrowly defined. The human dependability factor has facets reflecting trustworthiness and sense of responsibility that obviously are not applicable to chimpanzees. However, the chimpanzee dependability factor does describe the erratic, unpredictable, and disorganized elements at the negative pole of this factor. The fourth chimpanzee factor in which the sympathetic, helpful and sensitive items all have high loadings is similar to the human agreeableness factor. The fifth chimpanzee factor

TABLE 1
Factor Weights for Six Chimpanzee Factors

Item	Dom.	Surg.	Dep.	Agree.	Emot.	Open.
Dominant	.90 (Surg.)					
Submissive	-.86 (Surg.)					
Dependent	-.86 (Emot.)					
Independent	.83 (Emot.)					
Fearful	-.82 (Emot.)					
Decisive	.82 (Dep.)					
Timid	-.81 (Surg.)					
Cautious	-.63 (Dep.)					
Intelligent	.63 (Open.)					
Persistent	.61 (Dep.)					
Bullying	.58 (Agree.)					
Stingy	.52 (Agree.)					
Solitary		-.85 (Surg.)				
Lazy		-.83 (Dep.)				
Active		.83 (Surg.)				
Playful		.81 (Surg.)				
Sociable		.80 (Surg.)				
Depressed		-.78 (Surg.)				
Friendly		.65 (Agree.)				.56
Affectionate		.60 (Agree.)				
Imitative		.52 (Open.)				

Impulsive			
Defiant	-.78 (Surg.)		
Reckless	-.74 (Agree.)		
Erratic	-.73 (Dep.)		
Irritable	-.72 (Dep.)		
Predictable	-.62 (Agree.)		
Aggressive	.61 (Dep.)		
Jealous	-.60 (Agree.)		
	-.58 (Emot.)		
	-.53 (Dep.)		
Disorganized		.84 (Agree.)	
Sympathetic		.74 (Agree.)	
Helpful		.74 (Agree.)	
Sensitive		.70 (Agree.)	
Protective		.61 (Agree.)	
Gentle	.57		
Stable		.73 (Emot.)	
Excitable		-.71 (Emot.)	
Unemotional		.57 (Emot.)	
Inventive			.65 (Open.)
Inquisitive			.64 (Open.)

Note. Factor designations in parentheses following each factor weight indicate factor membership of the item in the Goldberg (1990) human taxonomy. Dom., dominance; Surg., surgency; Dep., dependability; Agree., agreeableness; Emot., emotionality; Open., openness.

TABLE 2
Factor Intercorrelation Matrix for Six-Factor Chimpanzee Personality Model

Factor	Dom.	Surg.	Depend.	Agree.	Emot.
Dominance					
Surgency	.04				
Dependability	.15	.05			
Agreeableness	.00	.13	-.45		
Emotionality	.07	.09	-.17	.15	
Openness	-.04	.36	.10	.06	.16

characterized by the items stable, excitable, and unemotional resembles the human emotionality or neuroticism factor. Finally, the final chimpanzee factor defined by the items inventive and inquisitive corresponds to at least one facet of the human openness factor.

An important question about the six chimpanzee factors is the extent to which they are intercorrelated. The varimax rotation produced orthogonal factors which by definitions have zero intercorrelations. However, an additional promax oblique rotation produced only small changes in the factor structure and as shown in Table 2, the correlations were quite small. The mean absolute value of the intercorrelations among the six factors was .135.

Interrater Reliability Revisited

Factor scores were obtained by unit weighting of all items in the factor with loadings greater than .52. Factors were then substituted for items in the general linear model used previously to assess item reliability. The overall reliability of the factors ($\eta = .739$) was virtually the same as the overall reliability of the items. The zoo by factors interaction was not significant, $F(60, 440) = .93$; $p > .63$, showing a total absence of between-zoo differences in the pattern of factor score differences. This result is consistent with the previously noted nonsignificance of the zoo by items interaction.

Table 3 shows reliabilities of all six factors as defined by η . A notable degree of homogeneity is apparent in these factor reliabilities that ranged from .67 (Agreeableness) to .83 (Dominance).

Interobserver reliabilities were also measured by two types of intraclass correlations based on a two-way analysis of variance with chimpanzees assumed to be a random variable and raters a fixed variable (Shrout & Fleiss, 1979). Specifically, reliabilities of ratings from individual observers were estimated by $ICC(3, 1) = (CMS - EMS) / [CMS + (k - 1)EMS]$ where CMS is the between chimpanzees mean square, EMS is the error or residual mean square, and k is the mean number of observers per chimpanzee (viz. 4.05). Reliabilities of mean ratings based on a mean of 4.05 observers per

TABLE 3
Interrater Reliabilities of Chimpanzee Personality Factors

Factor	η	ICC(3, 1)	ICC(3, k)
Dominance	.83	.64	.88
Surgency	.81	.56	.84
Dependability	.70	.39	.72
Agreeableness	.67	.33	.67
Emotionality	.69	.36	.69
Openness	.75	.52	.82

Note. ICC(3, 1) and ICC(3, k) are intraclass correlations estimating reliabilities of scores from one rater and scores from a mean of 4.05 raters, respectively.

chimpanzee were estimated by $ICC(3, k) = (CMS - EMS)/CMS$ which is equivalent to Cronbach's α . Table 3 shows the CT reliability and the two intraclass correlations for each of the six personality factors.

DISCUSSION

The first question that we proposed to address was whether zoo chimpanzees could be rated on adjectival personality descriptors with acceptable standards of interobserver reliability and validity. The mean overall reliability coefficient (η) was .74 and comparable reliabilities for the six factors were quite uniform ranging from .67 to .83. These reliabilities are analogous to peer/peer reliabilities for human personality data that are usually expressed as intraclass correlations. Intraclass correlations for the six factors were at the high end of the range of correlations reported for the factors of the human five-factor model (Costa and McCrae, 1992; McCrae and Costa, 1987, 1989). Zoo workers are unquestionably able to rate adjectival personality traits of chimpanzees with reliabilities as great as or possibly greater than comparable peer/peer ratings of humans.

One dimension of the validity of the chimpanzee six-factor model is expressed by the convergent and discriminant validities of the factors (Campbell & Fiske, 1959). Convergent validity can be estimated by the magnitudes of the item factor loadings on the factors to which they are assigned (Feretich, Figueredo, & Knapp, 1991; Figueredo *et al.*, 1991). Of the 43 descriptors on which the chimpanzees were rated, 40 had loadings of .52 or greater on one of the factors. Furthermore, two of the three descriptors without large loadings on any factor (clumsy and autistic) were not part of the original Big Five taxonomy and the third descriptor (manipulative) had the lowest interrater reliability. Only three descriptors had factor loadings exceeding .52 on more than one factor. The overall pattern of factor loadings therefore revealed good evidence of convergent validity.

Discriminant validity of the six chimpanzee factors as indicated by factor

independence was shown by the low factor intercorrelations when an oblique factor solution was obtained. Human data on correlations between factors based on confirmatory factor analysis (Borkenau & Ostendorf, 1990) and on independently measured factors (Costa, McCrae, & Dye, 1991; Graziano & Ward, 1992) typically show at least two or three moderately high interfactor correlations (*viz.* approaching .50). The only chimpanzee between factor correlation approaching this value was the correlation of $-.45$ between agreeableness and dependability.

The clear lack of complete orthogonality among human personality factors has resulted in sometime heated speculation about whether the basic, irreducible number of personality factors is five or some smaller number. For example, Eysenk (1992) claims that extroversion (or surgency) and openness are two facets of a single extroversion factor and that agreeableness and dependability are facets of a psychoticism factor, a pattern not present in the chimpanzee data. Although the factor intercorrelations for the chimpanzee six-factor model obviously cannot be used to assess Eysenk's claim, the overall size of those correlations suggests that the discriminant validity of the two chimpanzee models are at least as good as that for the human five-factor model.

The second question addressed by this research was how closely the chimpanzee personality factors resembled the human five-factor model. The descriptors placed in the chimpanzee factors two through six supported an interpretation of these factors consistent with the human Big Five. However, as noted before, nine items had their highest loadings on factors different from those in the Goldberg (1990) taxonomy. The deviations from the human pattern of factor loadings may be partly attributable to differences between the meanings of some descriptors depending upon whether they are applied to humans or to chimpanzees. For example, the adjective "lazy" when applied to humans has connotations of irresponsibility and a preference of play over work, failings that are consistent with its placement at the negative pole of the human dependability factor. However, these two human attributes cannot be meaningfully applied to chimpanzees. Consequently, the raters' attributions of laziness to chimpanzees probably involved a narrowed definition centered around perceived lethargy and lack of activity, characteristics consistent with the negative pole of the surgency factor. In fact, "lazy" did have a large negative loading on the chimpanzee surgency factor. Of course, conclusions about the anthropomorphic generalizability of personality descriptors from humans to chimpanzees should not be pursued too vigorously on the basis of a single data set because of the notoriously high variability of factor loadings. However, with the additions of further independent data the interspecies comparison of factor loadings on the Big Five may become a basis for a quantitative measure of anthropomorphic generalizability of personality descriptors between human and ape.

Although the preceding discussion supports the reliability and validity of

the chimpanzee five- and six-factor models, a more basic concern might be raised. Is it scientifically defensible to generalize a human-based five-factor personality model to a different, inarticulate species that to many people seems alarmingly non-human? In a discussion of whether a personality trait is "basic," Zuckerman (1992) claimed that one defining characteristic of a basic factor is identification of a comparable trait in non-human species. Nevertheless, a critic of interspecies factor generalization could note that some components or facets of the human five-factor model are obviously not applicable to chimpanzees (e.g., self-consciousness, values, modesty). However, as Costa and McCrae (1992) note, the five-factor model should not be equated to any one specific version, nor should it be regarded as equivalent to any particular set of item loadings. Even within the human population, differences in the five-factor model occur between Western and non-Western cultures (Church & Katigbak, 1989; Narayanan, Menon, & Levine, 1995; Yang & Bond, 1990).

Thus, the five-factor model is best regarded as a rule for grouping personality descriptors into five broadly defined classes with at least moderately high correlations within factors and no more than moderately high correlations between factors. Viewed within this perspective, our application of the five-factor model to chimpanzees is an obvious test of the generality of the five-factor model and a confirmation of the basic nature of the factors.

An argument might also be made that the five factors present in the chimpanzee ratings were simply artifacts of the implicit personality theories of the human raters. Implicit personality theory refers to a person's expectations about correlations among different personality descriptors. These expectations are based in part on semantic similarities and differences among personality descriptors (D'Andrade, 1965) and in part on life experiences in which two or more personality descriptors are confirmed by the same set of behavioral acts, a phenomenon that Borkeu (1992) referred to as referential overlap.

Ratings consistent with implicit personality theory and the five-factor model occur even when raters have virtually no knowledge of those being rated (Passini & Norman, 1966). Norman and Goldberg (1966), using a Monte Carlo procedure, constructed an artificial data set in which the correlational structure among the descriptors mimicked the five-factor model, although the interrater reliability was zero. These two studies demonstrated, in different ways, that a five-factor correlational structure can exist when the ratings have little relationship to properties of the individuals being rated. Several personality researchers have argued that implicit personality theories do distort human personality ratings (e.g., Mirels, 1976; Mischel, 1968; Shweder, 1975). However, abundant recent evidence shows that implicit personality theories do not significantly distort ratings (see Borkeu, 1992 for a review).

Nevertheless, the controversy about distorting effects of implicit personal-

ity theories could be reignited in the context of ape personality ratings. Were the raters simply perceiving the apes as imaginary humans and then using their implicit personality theories to generate the pattern of item intercorrelations? We believe that the answer to this fundamental question is no. The high interrater reliability of the chimpanzee raters is one reason for our optimism. Norman and Goldberg (1966) showed that interrater reliabilities systematically increased as raters' degree of acquaintanceship with their targets increased. Although high interrater reliability is, by itself, not sufficient evidence that ratings accurately reflect the traits of the targets, it is clearly a necessary condition and its presence therefore provides inductive evidence for the accuracy of the ratings.

Emergence of the powerful chimpanzee dominance factor containing descriptors from all of the human five factors also suggests that the chimpanzee factors were not artifacts of the raters' implicit personality theories since ratings generated by expectations of a human five-factor structure would not have produced the chimpanzee dominance factor. Although dominance has been used as a dimension in circumplex models of personality (Wiggins 1991), conventional human factor models have incorporated dominance with the surgency factor. The pervasive role of dominance and dominance-related activities in the social organization of wild chimpanzees (Buirski, Plutchik, & Kellerman, 1978) may be further enhanced in zoo habitats where dispersal is not possible (De Waal, 1986, 1989).

The best evidence that the chimpanzee personality factor scores are accurate descriptions and not misleading artifacts of the raters' implicit personality theories must ultimately come from construct validation procedures (Campbell & Fisk, 1959). The previously noted convergent and discriminant validities of the chimpanzee factors exemplified one aspect of construct validity. However, the most convincing validation for personality factors comes from correlation of those factors with observable behaviors in different contexts. Correlations consistent with the a priori interpretation of the factors would constitute inductive construct validation (Cronbach, 1988; Ozer, 1989) because the meaning of the factor is defined through the accumulation of correlations.

The search for postulated correlations between human personality variables and behavior has a long history with only modest success (Nisbett & Ross, 1991). We believe that much of the problem comes from the disparity between the highly limited domains in which human behaviors can be feasibly sampled and the vastly larger and more varied set of domains that are the basis for self, peer, or spouse personality ratings. This large disparity between human personality and human behavior sampling domains would not occur in laboratory, zoo, or field-based animal studies. Consequently, the emergence of relevant personality-behavior correlations and resolution of the implicit personality theory question may occur more quickly for chimpanzees than it did for human personality measures.

Finally, many psychologists may be skeptical about application of personality descriptors and a human five-factor model to an uncivilized animal that often displays clearly nonhuman behaviors. Nevertheless it should be borne in mind that chimpanzees are humans' closest phylogenetic relatives, sharing a common ancestor species that lived as recently as 5 to 7 million years ago and having DNA about 98% compatible with that of humans (Miyamota, Slighton, & Goodman, 1987; Sarich & Wilson, 1967; Sibley & Ahlquist, 1984). In light of the remarkable social intelligence of chimpanzees noted in the introduction it should not be surprising to find that they have reliable personality traits that are intercorrelated along in a way consistent with the human five-factor model.

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