Aping Humans: Age and Sex Effects in Chimpanzee (Pan troglodytes) and Human (Homo sapiens) Personality

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Ratings of 202 chimpanzees on 43 personality descriptor adjectives were used to calculate scores on five domains analogous to the human Five-Factor Model and a chimpanzee-specific Dominance domain. Male and female chimpanzees were divided into five age groups ranging from juvenile to old adult. Internal consistencies and interrater reliabilities of factors were stable across age groups and ~6.8 year retest reliabilities were high. Age-related declines in Extraversion and Openness and increases in Agreeableness and Conscientiousness paralleled human age differences. The mean change in absolute standardized units for all five factors was virtually identical in humans and chimpanzees after adjustment for different developmental rates. Consistent with their aggressive behavior in the wild, male chimpanzees were rated as more aggressive, emotional, and impulsive than females. Chimpanzee sex differences in personality were greater than comparable human gender differences. These findings suggest that chimpanzee and human personality develop via an unfolding maturational process.

Keywords: development, personality, chimpanzee, Five-Factor Model

Among living species, chimpanzees are the closest phylogenetic relatives of humans, sharing a common ancestor possibly as recently as 4 million years ago (Hobolth, Christensen, Mailund, & Schierup, 2007). Consequently, extensive genetic similarities exist between humans and chimpanzees (Chimpanzee Sequencing & Analysis Consortium, 2005).

Not surprisingly, there are several personality similarities between the two species. Specifically, personality studies of chimpanzees in zoos (King & Figueredo, 1997), a naturalistic sanctuary in Africa (King, Weiss, & Farmer, 2005), and a laboratory facility (Weiss, King, & Hopkins, 2007) have revealed five factors resembling the human Five-Factor Model (FFM; Digman, 1990; Goldberg, 1990, 1993; McCrae & Costa, 2003) in addition to a broad chimpanzee-specific Dominance domain.

While animal personalities are evident to most people who spend even a modest amount of time observing the antics and behavioral expressions of animals, some writers (e.g., Davis, 1997; Heyes, 1998; Kennedy, 1992) have sounded alarms about the dangers of creeping anthropomorphism. However, converging lines of evidence have demonstrated the scientific reliability and validity of animal personality ratings (Gosling, 2001; Gosling & John, 1999; Gosling, Lilienfeld, & Marino, 2003). This evidence includes acceptable interrater reliabilities that have been reported in a large variety of mammalian and nonmammalian species, including chimpanzees (see Gosling, 2001, for a review). The validity of animal personality ratings has also been supported by evidence that ratings predict several types of independent measures. For example, a rhesus monkey factor described as “confidence” is positively related to immune system efficiency (Capitanio, Mendoza, & Baronocelli, 1999; Maninger, Capitanio, & Mendoza, 2003), a result consistent with abundant human literature on the relationship between positive personality traits and immune efficiency (Segerstrom, 2000). Personality ratings in rhesus monkeys (Capitanio, 1999) as well as zoo-housed chimpanzees (Pederson, King, & Landau, 2005) are likewise correlated with overt behaviors in a pattern consistent with the meanings of the traits defining the factors.

Another concern has focused on whether the personality taxonomies are based on real correlations between specific traits in judged individuals or preexisting expectations about the correlational patterns, that is, an implicit theory of personality. However, evidence indicates that human personality judgments are not primarily driven by implicit personality theory (Borkenau, 1992; McCrae et al., 2001; Rowe, 1982). In personality studies of apes one compelling fact that counters the implicit personality explanations is that the factor structures of chimpanzees (King & Figueredo, 1997) and orangutans (Weiss, King, & Perkins, 2006) differ from each other and are both different from the human five factors.
We believe that the genetic and personality similarities between chimpanzees and humans can provide information relevant to an ongoing debate about the interpretation of human personality development. Cross-sectional (Labouvie-Vief, Diel, Tarnowski, & Shen, 2000; McCrae et al., 1999, 2000; Srivastava, John, Gosling, & Potter, 2003) and longitudinal studies (Costa, Herbst, McCrae, & Siegler, 2000; Roberts, Walton, & Viechtbauer, 2006; Terracciano, McCrae, Brant, & Costa, 2005) have shown that, beginning in adolescence, human Agreeableness and Conscientiousness increase; Extraversion and Neuroticism decrease; and Openness increases and then later decreases.

While these researchers generally agree on the observed developmental trends, they disagree on their interpretation. McCrae et al. (1999, 2004, 2000) have argued that personality development is largely driven by biologically controlled maturational processes that change little after the age of 30. Thus, the direction of change and its nonlinear development are interpreted as evidence of unfolding biological processes. Support for the biological maturation hypothesis comes from evidence that personality changes over the human life span are constant across diverse cultures (McCrae et al., 1999, 2000), a result that would be expected if personality change were driven mainly by endogenous biological processes.

Other researchers (e.g., Helson, Jones, & Kwan, 2002), while not denying the influence of biologically driven maturation, emphasize the additional importance of cultural-historical influences, including culturally influenced coping strategies, the effects of role models and stereotypes, life histories, and the interaction of personality and environmental influences. However, separating developmental influences emerging out of basic maturation from those emerging out of environmental influences is difficult. Arguments for the culture-environmental view have been supported by evidence that developmental change in human personality continue throughout adulthood with no levelling off after age 30 (Helson et al., 2002; Srivastava et al., 2003). These results are more consistent with the continuing impact of environmental and social influences than with a self-limiting biological growth process.

Comparison of age differences in humans and chimpanzees may provide potential insights into the effects of environmental/social variables and biological/evolutionary variables on personality development as well as gender differences in humans. There are two advantages to comparing age and sex differences in human and chimpanzee personality. First, age and gender differences within a single human culture and time are potentially affected by shared experiences within that culture. This cohort effect is lessened when development is compared across different cultures. However, the magnitudes of cultural differences among human populations are much smaller than those between human society and chimpanzee zoo habitats. Therefore, cross-sectional comparison of age differences in different species are much less likely to be affected by the societal and other cohort effects that potentially contaminate studies within human groups. Consequently, this study can be viewed as a cross-species extension of cross-cultural research in humans.

Second, comparable age and sex differences would be informative with respect to addressing questions about the evolutionary origins of human personality development. Similarly, similar developmental trends and similar sex differences in humans and chimpanzees would indicate that those characteristics were present in a common ancestor species some 4 to 7 million years ago.

The present study will address these issues by presenting age- and sex-related differences in chimpanzee personality. The chimpanzee data will be compared with previously published data on age and gender related differences in human personality.

Method

Subjects

The sample contained 78 male and 124 female chimpanzees (Pan troglodytes) housed at 17 zoos in the United States and 1 zoo in Australia. The mean number of chimpanzees within zoos was 11.2 (SD = 5.8). The mean number of males was 4.3 (SD = 4.3), and the mean number of females was 6.9 (SD = 5.8). The sample included the 100 chimpanzees used in the King and Figueredo (1997) study. Ages ranged from 0.8 to 55.2 years (M = 16.5; SD = 12.2). In addition, the sample included 138 who were captive born, 55 who were wild-born, and 9 whose place of birth was unknown (Ross, 2006). Ages of the latter two groups were estimated at the time of arrival at their initial captive location. Mean ages of the wild, captive born, and unknown origin chimpanzees were 31.0, 10.1, and 26.3 years, respectively. All chimpanzees who were wild born or who had unknown origins had been in zoos for at least 20 years before the personality ratings. Estimated mean time interval between birth and arrival at a zoo was 4.6 years for the wild born chimpanzees as well as the chimpanzees with unknown site of birth. The mean interval between arrival at a zoo and the personality ratings was 27.3 years for the wild-born chimpanzees and 20.6 years for the chimpanzees with unknown site of birth.

Raters

Ratings were made by 90 raters who were either zoo personnel who regularly participated in the maintenance of the chimpanzees or volunteers who observed the chimpanzees as part of a separate behavior observation project. The length of time during which the raters had observed chimpanzees was available for 43 raters who had observed 141 chimpanzees (M = 5.9 years; SD = 4.2). Data were provided by a mean of 3.9 raters per chimpanzee and the mean number of chimpanzees for each rater was 8.7. The mean number of raters for each zoo was 4.7. In a second rating of a chimpanzee subgroup, data were provided by 15 of the original 90 raters and by 18 new raters.

Rating Forms

The personality rating forms contained 43 adjectival personality descriptors that were rated on a seven-point Likert scale. Each adjective was followed by one to three sentences that clarified its definition and made the adjective meaningful in terms of chimpanzee behavior while retaining consistency with its dictionary definition. All but two of the adjectives, clumsy and autistic, were taken from Goldberg’s (1990) taxonomy of descriptors for the Big-Five, and care was taken to choose adjectives that represented all five dimensions (see King & Figueredo, 1997, for additional details).

Factor Scores

We used the same unit-weighted factor definitions that were used in the original (King & Figueredo, 1997) and later studies of
chimpanzee personality (King & Landau, 2003; King, Weiss, & Farmer, 2005; Pederson et al., 2005; Weiss, King, & Figueredo, 2000).

Unfortunately, despite the similarities between chimpanzee and human personality, some variation in the names of the factors has occurred. To prevent a proliferation of factor names across species and maintain consistency, we adopted a consistent naming convention for the chimpanzee factors. We refer to the five factors that are similar in humans and chimpanzees by the first letter of the most common names of the five human factors: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness to Experience. Subscripts then indicate whether it is the chimpanzee (CH) or human (HU) variant of that factor. Thus, chimpanzee factors previously designated as Dominance, Surgency, Agreeableness, Dependability, Emotionality, and Openness (King & Figueredo, 1997) will now be designated as $D_{CH}$, $E_{CH}$, $A_{CH}$, $C_{CH}$, $N_{CH}$, and $O_{CH}$, respectively (see Table 1 for their definitions). The subscripts call attention to the fact that, although the five factors are similar across species, they are not identical.

**Cross-species Standardization**

The human personality scores were based on NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) self-report data of 5,085 members of five cultures: German, British, Spanish, Czech, and Turkish (McCrae et al., 2000). The NEO-FFI $T$-scores ($M = 50; SD = 10$) reported in this study were based on means and SDs from individuals over 21 years old (Costa & McCrae, 1992) and reported for five age groups: 14–17 years, 18–21 years, 22–29 years, 30–49 years, and 50 years or older. We calculated the factor $T$-scores in each age group by taking the unweighted means across all cultural groups based on Figures presented in the McCrae et al. (2000) paper. The two younger groups (14 to 21 years) were combined in order to produce four age groups comparable to the four oldest chimpanzee age groups described below. The estimated means are presented in Figures 1 through 5.

**Table 1**

*Factor Definitions Based on King and Figueredo (1997)*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Dominance</th>
<th>Extraversion</th>
<th>Agreeableness</th>
<th>Conscientiousness</th>
<th>Neuroticism</th>
<th>Openness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive loadings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td></td>
<td>Active</td>
<td>Sympathetic</td>
<td>Predictable</td>
<td>Excitable</td>
<td>Inventive</td>
</tr>
<tr>
<td>Independent</td>
<td></td>
<td>Playful</td>
<td>Helpfulness</td>
<td>Helpful</td>
<td>Excitable</td>
<td>Inquisitive</td>
</tr>
<tr>
<td>Decisive</td>
<td></td>
<td>Sociable</td>
<td>Sensitive</td>
<td>Stable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligent</td>
<td></td>
<td>Affectionate</td>
<td>Protective</td>
<td>Stable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent</td>
<td></td>
<td>Aggressive</td>
<td>Gentle</td>
<td>Stable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bullying</td>
<td></td>
<td>Imitative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stingy</td>
<td></td>
<td>Friendly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative loadings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submissive</td>
<td></td>
<td>Solitary</td>
<td></td>
<td>Impulsive</td>
<td>Stable</td>
<td>Unemotional</td>
</tr>
<tr>
<td>Dependent</td>
<td></td>
<td>Lazy</td>
<td></td>
<td>Defiant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fearful</td>
<td></td>
<td>Depressed</td>
<td></td>
<td>Reckless</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timid</td>
<td></td>
<td></td>
<td></td>
<td>Erratic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cautious</td>
<td></td>
<td></td>
<td></td>
<td>Irritable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Standardized Extraversion scores for chimpanzees and humans across five age groups.

Development differs somewhat between species, so any comparisons will not be exact. Chimpanzees mature at a rate approximately 50% higher than in humans (Napier & Napier, 1967), with puberty being reached at between 6 and 7 years (Earnhardt, Ross, Lonsdorf, & Pusey, 2003). However, differences in growth rate may vary considerably across indices. For example, brain growth is completed at about 6 years in chimpanzees, whereas human brain growth extends into the teens (Coqueugniot, Hublin, Vellion, Houët, & Jacob, 2004).

We computed $T$-scores based on the mean scores of chimpanzees over 12 years old in order to be consistent with the standard-
The chimpanzee T-scores therefore approximated the factor T-scores reported by McCrae et al. (2000). We divided chimpanzees into five age groups. The first age group (Group 1) contained 26 males and 38 females with ages ranging from 0.8 to 7.9 years ($M = 4.7; SD = 2.0$). This age group extended from late infancy to early adolescence (Goodall, 1986). Group 2 contained 23 males and 25 females with ages ranging from 8.0 to 14.8 years ($M = 10.9; SD = 2.0$). This group extended from early to late adolescence. Group 3 contained 15 males and 27 females with ages ranging from 15.2 to 24.7 years ($M = 20.7; SD = 2.8$) who were young adults. Group 4 contained 7 males and 22 females with ages ranging from 25.1 to 34.4 years ($M = 29.2; SD = 3.0$) who were middle aged, fully mature adults. Finally, Group 5 contained 7 males and 12 females from 35.2 to 55.2 years ($M = 42.1; SD = 5.9$) who would be classified as old.

Because conversion of chimpanzee factor scores to T-scores entailed only a linear transformation of all scores, the between-age differences in the figures are equivalent to differences in the original scores. Comparisons between the chimpanzee and human 

![Figure 2](image2.png)  
**Figure 2.** Standardized Conscientiousness scores for chimpanzees and humans across five age groups.

![Figure 3](image3.png)  
**Figure 3.** Standardized Agreeableness scores for chimpanzees and humans across five age groups.

![Figure 4](image4.png)  
**Figure 4.** Standardized Neuroticism scores for chimpanzees and humans across five age groups.

![Figure 5](image5.png)  
**Figure 5.** Standardized Openness scores for chimpanzees and humans across five age groups.
scores, however, only allow between-species comparisons of rate and amount of age related change in SD units.

**Results**

**Age and Interrater Reliability**

We calculated interrater reliabilities using ICC(3.1), an intraclass correlation that estimates reliabilities of ratings by one individual and ICC(3,k), an intraclass correlation estimating the reliability of mean ratings based on a mean of k ratings for each chimpanzee (Shrout & Fleiss, 1979). Mean squares for chimpanzees (zoo) served as subject variance and Rater \( \times \) Chimpanzees (zoo) served as the error variance. Table 2 shows both types of reliabilities broken down by age group and factor. The reliabilities are generally high and within acceptable ranges. The only exception is the low reliability for N\(_{ch}\) in the youngest (late infancy and early adolescence) and the oldest (over 35 years old) age groups. However, there were no consistent changes in inter-rater reliabilities across age groups. Interrater reliabilities were highest for D\(_{ch}\) and lowest for N\(_{ch}\), with the remaining factors assuming intermediate values.

**Retest Reliability**

Fifty-one chimpanzees from the original sample were rated again after intervals ranging from 3.0 to 11.2 years. For 35 chimpanzees, one or more observers provided ratings on both occasions whereas for 37 chimpanzees one or more observers provided ratings only on the second occasion. The overlapping 21 chimpanzees received ratings from a combination of past and new observers.

When chimpanzees are rated by the same person on both occasions, we would expect the temporal stability to be greater than when two different people provide ratings on the two occasions. Individual differences among raters, including subjective thresholds for applying different rating numbers, would diminish between rater stability but would not affect within rater stability.

The stability of individual personality scores can be measured in several ways (Robins, Fraley, Roberts, & Trzesniewski, 2001). The most fundamental measure is normative change, the stability of a sample mean across time. In our sample, the mean interval between ratings was 6.8 years, although the variability of the intervals was high (SD = 3.0). Table 3 shows mean T-scores for the first and second ratings. The first set of means was based on data from 35 chimpanzees rated by the same raters on both occasions. The second set of scores was based on data from 37 chimpanzees rated by different raters on the two occasions. The final two columns show means based on all ratings of the full set of 51 chimpanzees. In all cases, there was little change between ratings. For the same-rater data, the only significant change was a decrease in C\(_{ch}\), \( \eta^2_{ch} = .13, F(1, 34) = 5.19, p = .03 \). For the different-rater data, the only significant changes was a decrease in C\(_{ch}\), \( \eta^2_{ch} = .14, F(1, 36) = 6.02, p = .02 \).

Rank order stability is typically measured by the correlation between individuals across two ratings. In common with the changes in mean value across time, three types of correlations were calculated: the first based on the data from common raters for each chimpanzee on the two occasions; the second based on data from different raters for each chimpanzee; and the third based on combined data from all raters. The correlations are shown in Table 4. Correlations based on all data were all significant with highest being D\(_{ch}\) (r = .74) and lowest A\(_{ch}\) (r = .39).

**Age and Internal Consistency**

Table 5 shows the internal consistency as measured by Cronbach’s alpha of the six factors for each age group and the full sample. There was no consistent overall variation in alpha values across age groups. As expected, the pattern of internal consistencies paralleled that for interrater reliabilities: alpha values were highest for D\(_{ch}\) and lowest for N\(_{ch}\).

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### Table 2

**Interrater Reliabilities for The Five Age Groups**

<table>
<thead>
<tr>
<th>Factor</th>
<th>( \leq 8 )</th>
<th>8–15</th>
<th>15–25</th>
<th>25–35</th>
<th>( \geq 35 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>.55 (.81)</td>
<td>.57 (.85)</td>
<td>.80 (.93)</td>
<td>.71 (.91)</td>
<td>.73 (.90)</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.64 (.86)</td>
<td>.47 (.78)</td>
<td>.24 (.53)</td>
<td>.26 (.58)</td>
<td>.53 (.80)</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.30 (.61)</td>
<td>.36 (.68)</td>
<td>.42 (.72)</td>
<td>.45 (.76)</td>
<td>.64 (.87)</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.50 (.78)</td>
<td>.44 (.76)</td>
<td>.51 (.79)</td>
<td>.55 (.83)</td>
<td>.70 (.89)</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.11 (.31)</td>
<td>.55 (.45)</td>
<td>.54 (.80)</td>
<td>.44 (.75)</td>
<td>.06 (.18)</td>
</tr>
<tr>
<td>Openness</td>
<td>.55 (.81)</td>
<td>.47 (.78)</td>
<td>.45 (.17)</td>
<td>.59 (.85)</td>
<td>.41 (.71)</td>
</tr>
<tr>
<td>M</td>
<td>.44 (.70)</td>
<td>.41 (.71)</td>
<td>.49 (.75)</td>
<td>.50 (.78)</td>
<td>.51 (.72)</td>
</tr>
</tbody>
</table>

**Note.** Values outside parentheses are ICC(3,1) and values inside parentheses are ICC(3,k).

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### Table 3

**Mean Factor T-Scores for First and Second Ratings**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Same</th>
<th>Different</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>50.4</td>
<td>49.6</td>
<td>50.1</td>
</tr>
<tr>
<td>Extraversion</td>
<td>49.5</td>
<td>50.5</td>
<td>52.7</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>50.8</td>
<td>49.2</td>
<td>49.2</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>52.5</td>
<td>47.4*</td>
<td>48.7</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>51.2</td>
<td>48.8</td>
<td>51.6</td>
</tr>
<tr>
<td>Openness</td>
<td>50.3</td>
<td>49.7</td>
<td>49.7</td>
</tr>
</tbody>
</table>

**Note.** * Difference between first and second ratings is significant at \( p < .05 \).

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### Table 4

**Correlations Between First and Second Ratings**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Same</th>
<th>Different</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>.84***</td>
<td>.55***</td>
<td>.74***</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.63***</td>
<td>.38*</td>
<td>.48***</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.43*</td>
<td>.28</td>
<td>.39*</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.41*</td>
<td>.58***</td>
<td>.51***</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.47**</td>
<td>.18</td>
<td>.50**</td>
</tr>
<tr>
<td>Openness</td>
<td>.66***</td>
<td>.52***</td>
<td>.70***</td>
</tr>
</tbody>
</table>

\* \( p < .05 \). \** \( p < .01 \). \*** \( p < .001 \).
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Table 5
Internal Consistency Alpha Values for the Five Age Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>≤8</th>
<th>8–15</th>
<th>15–25</th>
<th>25–35</th>
<th>≥35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>.87</td>
<td>.91</td>
<td>.91</td>
<td>.89</td>
<td>.89</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.86</td>
<td>.90</td>
<td>.86</td>
<td>.82</td>
<td>.90</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.71</td>
<td>.80</td>
<td>.83</td>
<td>.83</td>
<td>.90</td>
</tr>
<tr>
<td>Neuroticity</td>
<td>.81</td>
<td>.54</td>
<td>.84</td>
<td>.82</td>
<td>.77</td>
</tr>
<tr>
<td>Openness</td>
<td>.77</td>
<td>.89</td>
<td>.85</td>
<td>.86</td>
<td>.80</td>
</tr>
<tr>
<td>M</td>
<td>.78</td>
<td>.82</td>
<td>.87</td>
<td>.87</td>
<td>.85</td>
</tr>
</tbody>
</table>

Age and Rearing Condition

The concentration of zoo-born chimpanzees in the younger age groups caused an artificial correlation between age and rearing condition thereby posing a potential problem in assessing age-related personality changes. Specifically, a problem would exist if rearing status affected personality independently of age. To test whether rearing status had this effect, we performed a hierarchical General Linear Model (GLM) with age-related variance removed before assessment of rearing condition effects based on data from all three subgroups: zoo-born, wild-born, and unknown birth location. The age-corrected rearing variable was not significant for any of the six factors (all ps > .05). In addition, the effect of rearing condition was independently assessed for chimpanzees within age Groups 3 and 4. These age groups were chosen because both rearing conditions were well represented in each group. For chimpanzees within these two age groups, none of the six factors was significantly affected by rearing condition (all ps > .05). Furthermore, similar age-corrected hierarchical analyses were conducted on all three pairwise comparisons formed from the three conditions. Again, there was no significant rearing effect for any of the factors (all ps > .05). The absence of a rearing condition effect was expected in light of the young estimated ages of the wild chimpanzees as well as the chimpanzees with unknown birth location when they arrived at a zoo. In addition, a period of at least 20 years elapsed between their capture and their personality rat-

Age and Sex Effects on Personality

Effects of age and sex were assessed with a GLM (Type III) with zoo effects and all possible interactions of age, sex and zoo included as predictors. Figure 1 shows the cross-sectional developmental changes for $E_{CH}$. A sustained linear decline occurred across age groups for all chimpanzees, $\eta_p^2 = .57, F(4, 105) = 33.28, p < .0001$. Between sex differences, $\eta_p^2 = .01, F(1, 105) = 0.61, p = .44$ and the Age × Sex interaction, $\eta_p^2 = .07, F(4, 105) = 1.99, p = .105$, were not significant.

The linear decrease of $E_{CH}$ across the four oldest chimpanzee age groups was virtually identical to that in the comparable human age groups. Ungrouped ages were negatively correlated with $E_{CH}$ for the four oldest groups ($r = -.38, p < .0001$).

The items that define $E_{CH}$ (see Table 1) fall into two distinct groups or facets. The first facet reflects gregariousness and contains the terms playful, sociable, affectionate, initiative, friendly, (not) solitary, and (not) depressed. The other facet reflects activity and contains the terms active and (not) lazy. Both the gregariousness, $\eta_p^2 = .41, F(4, 105) = 17.60, p < .0001$, and the activity, $\eta_p^2 = .69, F(4, 105) = 60.82, p < .0001$, facets decreased markedly over age groups. In addition, the activity facet, $\eta_p^2 = .13, F(4, 105) = 16.05, p < .0001$, but not the gregariousness facet, $\eta_p^2 = .00, F(1, 105) = 0.04, p = .85$, was higher in males than in females. Finally, females showed greater decreases in the activity facet over age groups than did males leading to an Age × Sex interaction, $\eta_p^2 = .15, F(4, 105) = 4.54, p = .002$. The Age × Sex interaction was not significant for the gregariousness facet, $\eta_p^2 = .05, F(4, 105) = 1.36, p = .25$.

Cross-sectional age differences in $C_{CH}$ are depicted in Figure 2. The increase in $C_{CH}$ across age groups was just short of being statistically significant, $\eta_p^2 = .08, F(4, 105) = 2.35, p = .059$ and $C_{CH}$ was lower in males than in females, $\eta_p^2 = .13, F(1, 105) = 15.25, p = .0002$. The Age × Sex interaction was not significant, $\eta_p^2 = .06, F(4, 105) = 1.73, p = .15$. The slopes of the age functions for $C_{FH}$ and $C_{CH}$ were similar with no suggestion of an Age × Species interaction. $C_{CH}$ was positively correlated with ungrouped ages across the four oldest groups, $r = -.25, p = .0035$.

The defining adjectives for $C_{CH}$ shown in Table 1 indicate two facets. The first included the adjectives predictable, (not) impulsive, (not) reckless, (not) erratic, and (not) disorganized. The second included the adjectives (not) jealous, (not) aggressive, and (not) dependent. We have named these two $C_{CH}$ facets predictability and tameness, respectively.

Predictability increased over age groups, $\eta_p^2 = .11, F(4, 105) = 3.17, p = .017$, and was higher in female than in male chimpanzees, $\eta_p^2 = .08, F(1, 105) = 9.59, p = .002$. The Age × Sex interaction was not significant, $\eta_p^2 = .05, F(4, 105) = 1.30, p = .276$. The tameness facet of $C_{CH}$ also increased over age groups, $\eta_p^2 = .11, F(4, 105) = 3.09, p = .019$ and was higher in female than in male chimpanzees, $\eta_p^2 = .13, F(1, 105) = 15.75, p < .0001$. The Age × Sex interaction for tameness was not significant, $\eta_p^2 = .08, F(4, 105) = 2.30, p = .063$.

$A_{CH}$ scores, depicted in Figure 3, increased across age groups, $\eta_p^2 = .14, F(4, 105) = 4.38, p = .003$, and were higher in females than in males, $\eta_p^2 = .07, F(1, 105) = 7.99, p = .006$. An Age × Sex interaction emerged, $\eta_p^2 = .10, F(4, 105) = 3.01, p = .022$, as a result of $A_{CH}$ scores increasing more for females than males across age groups. The age functions for chimpanzees and humans were highly similar. $A_{CH}$ was positively correlated with ungrouped ages among the four oldest age groups ($r = -.27, p = .001$).

$N_{CH}$ scores, shown in Figure 4, were higher in male than in female chimpanzees, $\eta_p^2 = .05, F(1, 105) = 5.33, p = .023$. Neither the age effect, $\eta_p^2 = .07, F(4, 105) = 1.93, p = .112$, nor the Age × Sex interaction, $\eta_p^2 = .03, F(4, 105) = 0.72, p = .581$, approached significance. The age functions for chimpanzees and humans were highly similar. Ungrouped ages were negatively correlated with $N_{CH}$ across the four oldest age groups, $r = -.25, p = .003$.

$O_{CH}$ scores, shown in Figure 5, declined significantly across age groups, $\eta_p^2 = .19, F(4, 105) = 6.03, p = .0002$, but the sex difference, $\eta_p^2 = .00, F(1, 105) = 0.04, p = .849$, and the Age × Sex interaction, $\eta_p^2 = .04, F(4, 105) = 1.03, p = .396$, were not significant. Consistent with all of the other four factors, the human and chimpanzee age functions displayed no marked differences. $O_{CH}$ was not significantly correlated with age across the four
The age-related personality changes described by this study addressed two basic issues: first, the magnitude and direction of those changes in chimpanzees and second, the similarities of those changes to comparable personality changes in humans. Reliability of the scores evidenced by the lack of systematic changes in interrater reliabilities and factor internal consistencies across chimpanzee age groups provided necessary evidence that meaningful comparisons of chimpanzee personality are possible across their life span. Similarly, retest reliability data showed stability of factor scores across the short (6.8 years) mean interval between ratings. The correlations between the first and second ratings had a mean of .56 based on all data. This correlation compares favorably with the within the age ranges of human longitudinal data over a mean of 6.7 years that varied from .31 to .74 as the subjects matured (Roberts & DelVecchio, 2000).

The cross-sectional data show small but reliable differences in chimpanzee personality across age groups encompassing almost the entire chimpanzee life span. When the youngest chimpanzee age group was excluded, combined data from the five factors comparable to the human five factors indicated an overall mean change, in absolute units, of about .20 T-score units per year. Since 10 T-score units are equivalent to one SD, the mean unsigned change between the second and fifth age groups within factors was .020 SDs per year. This value is similar to the mean change of about .019 SDs per year reported by McCrae et al. (1999) in their cross-cultural personality study. If we assume that the chimpanzee growth rate is about 50% higher than the human growth rate (Napier & Napier, 1967) and that therefore one chimpanzee year is approximately equal to 1.5 human years, then human and chimpanzee personality changed at about .0192 and .0134 SDs per human year or human year equivalent respectively, a remarkably similar rate of change.

The mean correlation between age and the six chimpanzee personality factors was .31 when the entire sample was included. When the sample was restricted to chimpanzees greater than 8 years old the mean correlation decreased to .25. This low correlation is only slightly greater than the mean correlation of .16 between age and the five human factors reported by McCrae et al. (2000). The change in personality T-scores over time and the age-personality correlations clearly indicate that the often-reported human resistance to large changes in basic personality dimensions over time (Bazana & Stelmack, 2004; Costa & McCrae, 2002; McCrae et al., 1999, 2000; Roberts, Robins, Tresniewski, & Caspi, 2003) is shared with chimpanzees.

The directions of developmental changes in chimpanzee personality factors were similar to those in humans. The chimpanzees, in common with the humans, displayed declines in E\textsubscript{CH} across age groups. Furthermore, age-related decreases occurred for both the gregariousness and activity facets of E\textsubscript{CH} which are analogues of the gregariousness (E2) and activity (E4) facets of the Revised NEO Personality Inventory (NEO-PI-R, Costa & McCrae, 1992) Extraversion domain. The decrease in the chimpanzee gregariousness facet is somewhat surprising because it contrasts with a lack of any change in E2 in the human longitudinal data reported by Terracciano et al. (2005). Furthermore, Roberts et al. (2006) reported an increase in a social vitality facet of Extraversion in an extensive meta-analysis of human longitudinal data.

Although there was no overall sex difference in chimpanzee E\textsubscript{CH}, males scored higher than females on the activity but not the gregariousness facet. Human males, in contrast, show a small but consistent tendency to score lower than females on the E2 and the E4 facets of the NEO-PI-R (Costa, Terracciano, & McCrae, 2001). However, the species difference in the male and female activity scores may, in part, be a result of the narrow definition of the chimpanzee activity facet that only included gross amount of physical activity.

The decreases in O\textsubscript{CH} across age groups were similar to those for E\textsubscript{CH} with no sex-related differences. Furthermore, the slope of the age-related decreases did not differ from that of humans (McCrae et al., 2000). However, there is evidence of an increase in O\textsubscript{CH} up to age 20 followed by a decrease over the rest of the life span (Costa & McCrae, 2002), a phenomenon not present in the chimpanzee data. Furthermore, a slight increase in O\textsubscript{HU} was also evident in the human data (McCrae et al., 2000) used in our comparisons with chimpanzees.

Although the overall age-related increase in C\textsubscript{CH} barely failed to reach statistical significance, both facets of C\textsubscript{CH}, predictability, and tameness, did increase significantly over age groups. Furthermore, C\textsubscript{CH} was positively correlated with the within the age ranges comparable to those of the human sample (McCrae et al., 2000). Males were rated lower than females on C\textsubscript{CH} as well as on its two facets, tameness and predictability. Furthermore the difference between male and female tameness increased over age groups.

Discussion

The age-related personality changes described by this study addressed two basic issues: first, the magnitude and direction of those changes in chimpanzees and second, the similarities of those changes to comparable personality changes in humans. Reliability of the scores evidenced by the lack of systematic changes in interrater reliabilities and factor internal consistencies across chimpanzee age groups provided necessary evidence that meaningful comparisons of chimpanzee personality are possible across their life span. Similarly, retest reliability data showed stability of factor scores across the short (6.8 years) mean interval between ratings. The correlations between the first and second ratings had a mean of .56 based on all data. This correlation compares favorably with the within the age ranges of human longitudinal data over a mean of 6.7 years that varied from .31 to .74 as the subjects matured (Roberts & DelVecchio, 2000).

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There is some evidence that women likewise score higher on C_{HU} than men (Feingold, 1994; Goodwin & Gotlib, 2004; Srivastava et al., 2003).

A_{CH} scores also increased over age groups and were higher in female than in male chimpanzees. The sex difference in A_{CH} also increased over age groups. Similarly, A_{HU} increases with age (McCrae et al., 2000) and is consistently higher in women than in men (Costa et al., 2001; Feingold, 1994; Goodwin & Gotlib, 2004; Srivastava et al., 2003).

N_{CH} scores were higher in male than in female chimpanzees but did not differ across age groups, although age was negatively correlated with N_{CH} across the age range comparable to humans. The age-related changes were similar in the chimpanzee and the human data. The higher N_{CH} scores of male chimpanzees contrasts with the typical finding that women have higher N_{HU} scores than men (Costa et al., 2001; Feingold, 1994; Srivastava et al., 2003). Furthermore although the impulsiveness facet (N5) of N_{HU} is higher in females than males (Costa et al., 2001), the semantically opposite predictability facet of C_{CH} is also higher in female than in male chimpanzees. In addition, N_{HU} in women decreases across age groups more rapidly than it does in men (Srivastava et al., 2003; Viken, Rose, Kaprio, & Koskenvuo, 1994; Wink & Helson, 1993), although the evidence is not uniform (Roberts et al., 2006).

Finally, the Dominance factor was higher in male than female chimpanzees. Although there is no corresponding factor in humans, a close analogue, the assertiveness facet (E3) of E_{HU}, is also higher in males (Costa et al., 2001).

These data show that there is a substantial but not perfect congruence between chimpanzee and human personality for age related differences. Significant decreases in E_{CH} and O_{CH} as well as increases in A_{CH} were conserved across species. Likewise the two facets of C_{CH} decreased across age groups while the correlational but not the age grouped data showed decreases in N_{CH}. This cross-species convergence suggests that the direction of age effects on human personality are not primarily driven by social-cultural effects but are instead manifestations of more general biologically and evolutionarily influenced processes (McCrae, Terracciano, & 78 Members of the Personality Profiles of Cultures Project 2005). Specifically, the chimpanzee data suggest that age-related human personality changes may be minimally affected by social effects including a social roles model (Eagly & Wood, 1991) or an expectancy model based on stereotyped gender roles (Costa et al., 2001; Hoffman & Hurst, 1990).

The similar developmental trends for personality in chimpanzees and humans pose interesting but still unanswered questions about evolutionary processes that may have fostered that similarity, especially the increases in Agreeableness and Conscientiousness. A simple answer based on social structure is not sufficient in light of numerous large between-species differences in behaviors including pair bonding, paternal infant care, extended infant dependency, and subgroup composition (Goodall, 1986). The human and chimpanzee developmental patterns for personality are most likely phylogenetically old, present in many species, and thus a fruitful area of future research.

Although chimpanzees displayed sex differences in some personality dimensions similar to corresponding gender differences in humans, the elevated scores of male chimpanzees on a cluster of aggression related traits were broader than a comparable cluster in humans. Male chimpanzees were rated as higher on D_{CH} and N_{CH}, but lower on A_{CH} and C_{CH}. Scores on D_{CH}, measuring social assertiveness, confidence, lack of caution, and bullying tendencies, not only were higher in males than females but the sex difference increased over age groups. The two facets of C_{CH}, predictability and tameness, were both lower in male chimpanzees reflecting increased male aggressive, irritable, erratic, and unpredictable tendencies. In contrast to the reduced predictability of male chimpanzees, the semantically opposite human impulsiveness facet (N5) of N_{HU} is higher in females (Costa et al., 2001). Likewise, in contrast to the human data (Costa et al., 2001), scores on N_{CH} were elevated in male chimpanzees compared to females, thus indicating greater excitability and emotionality in males. In short, male chimpanzees are more aggressive, unpredictable, and emotional than females whereas male humans are higher only on aggression related traits. The relationship of this triad to overt aggression is supported by previous zoo-based observations that in male chimpanzees overt aggression is negatively correlated with C_{CH} and A_{CH} and positively correlated with N_{CH} (Pederson et al., 2005). Furthermore, it is consistent with levels of male intragroup aggression that are dramatically higher in chimpanzees than in hunter-gatherer human groups (Wrangham, Wilson, & Muller, 2006).

Past personality research focused on the taxonomy or factor structure of human personality and the relationships between taxonomic units and several proximate variables. Yet, personality differences among humans are not an isolated island unconnected to personality differences in closely related species. Human personality is simply one part of a complex phylogenetic network that includes personality in the great apes. Although present day apes are not direct human ancestors, they are close cousins in the context of our evolutionary history. A full understanding of human personality therefore awaits research on the taxonomy, development, and ultimately the evolution of personality in our closest phylogenetic relatives. We believe that this study is one step in that direction.

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