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Sex differences in the Big Five personality factors: Testing an evolutionary hypothesis

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Abstract

Sex differences in the Big Five personality structure, as assessed by combined JPI and PRF scales, were examined in a student population ($N = 528$) using factor analytic and covariance structure analysis techniques. An evolutionary hypothesis was tested, that the factor which lies between classical Agreeableness vs. Hostility and Neuroticism vs. Emotional Stability is the basic dimension of dominance-related aggressiveness maintained by frequency-dependent selection. The hypothesis predicts that this factor should explain more variance in males than in females. It was found that females were characterized by higher scores on the factor of Agreeableness and low Emotional Stability vs. Hostility and high Emotional Stability. As predicted, the factor of Agreeableness and low Emotional Stability explained significantly more variance in males than in females, both absolutely and in relation to other personality factors. The between-sex differences in personality factors are discussed in relation to studies of temperament, dominance and aggressiveness in non-human animals.

Keywords: Personality; Five-Factor model; Sex differences; Evolution; Frequency-dependent selection; Aggressiveness; Dominance

1. Introduction

A consensus appeared during recent decades concerning the number and nature of the basic personality factors. The prevailing view postulates (see Digman, 1990; Goldberg, 1993) that human personality variation may be summarized by five major dimensions known as the Big Five: Extraversion (or Surgency), Neuroticism vs. Emotional Stability, Agreeableness, Conscientiousness and Intellect (or Openness to Experience). The extreme ubiquity and

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stability of the Big Five personality dimensions may suggest that they have an important adaptive significance (Buss, 1991): it is known that high levels of individual variability can be maintained by natural selection by means of density- or frequency-dependent mechanisms (Krebs and Davies, 1993; also see Wilson et al., 1994 for risk-taking). Many behavioral and cognitive processes traditionally studied by psychologists have evolved through natural selection to meet specific adaptive needs of our ancestors (Barkow et al., 1992). However, although the patterns of individual variability cannot be *a priori* considered an exception, at present it is not known what features of personality structure and to what extent, depend on the action of adaptive and non-adaptive (e.g. physiological or genetic constraints) mechanisms.

Sex differences in personality and temperament have been documented in many empirical studies (Buss and Plomin, 1984; Eysenck and Eysenck, 1985; Zuckerman, 1994; see also a recent meta-analysis by Feingold, 1994). There is no doubt that they have evolved in context of the major activities which influenced fitness of our ancestral species, such as social dominance, social exchange, mate choice etc. (Buss, 1991; Barkow et al., 1992). In most mammalian species, including *Homo sapiens*, males tend to be physically larger, more aggressive, dominance-oriented, risk-prone and exhibit lower investment in offspring than females; this is adaptive and reflects different reproductive strategies of the two sexes (Daly and Wilson, 1983; Eibl-Eibesfeldt, 1989).

As long as patterns of individual differences in aggressiveness are considered, there is a close correspondence between the dimensions of personality and aggression. Specifically, two basic dimensions of aggressive behavior were identified in humans, "Emotional Responsivity" and "Proneness to Aggression" and these dimensions are nearly isomorphic with Neuroticism and Agreeableness factors of the Big Five model (Caprara et al., 1994). Furthermore, a few studies (e.g. Caprara and Perugini, 1994; Ashton et al., 1998) have produced two factors at axes rotated at 45° from the traditional Agreeableness and Emotional Stability vectors. This rotation forms a factor of high Emotional Stability and Hostility (as well as a factor of high Emotional Stability and Agreeableness). Also, the study of Zuckerman et al. (1988) revealed two coherent clusters of traits in the high Psychoticism — high Neuroticism and high Psychoticism — low Neuroticism quadrants, which seem to be related to, respectively, psychopathic and dominance-related aggression. Thus, the broad factor which lies between Neuroticism and Agreeableness, may represent the basic dimension of dominance-oriented aggressive behavior in humans, which reflects adaptive individual differences and is presumably maintained by frequency-dependent selection. Indeed, in most animal species social dominance is associated not with just a high level of basic aggressiveness, but rather with a combination of aggressiveness and boldness (an analogue of Emotional Stability and Novelty Seeking), so that boldness often correlates with aggressiveness (Archer, 1988).

2. Hypothesis and prediction

Frequency-dependent selection occurs when the behavioral trait in question (e.g. dominance vs. submissive tendencies) has both benefits (priority to valued resources, e.g. mating) as well as costs (risk of physical injury, detrimental consequences of social stress, risk to "lose everything" etc.) and the higher proportion of individuals exhibit it (i.e. tend to become

dominant), the more cost it incurs on them through, for example, more intense competition. At some point the fitness costs of competition may become sufficiently high to outweigh the benefits of dominance. Thus, a high level of individual variation or alternative strategies are expected. Males are more concerned about dominance relationships, the selection pressure for dominance and aggression is high as, for example, it is they who compete for potentially limited access to good mates (see Daly and Wilson, 1983). This means that frequency-dependent selection would create a wide range of dominance-oriented and subordinate strategies in this sex and no single strategy would be evolutionary stable (ESS, a strategy that is resistant to invasion by any other strategy, see Krebs and Davies, 1993). However, such selection pressure is likely to be relaxed in females (Daly and Wilson, 1983), which would presumably bring about some intermediate range of these behavioral tendencies. In many animal species, frequency-dependent selection mechanisms account for individual variability and alternative strategies, for example producers and scroungers, territorial and sneaky breeders, etc. (see Krebs and Davies, 1993 for more examples). Alternative male, but not female, reproductive strategies, including a mixture of territorial dominance-oriented individuals and subordinates have been documented in many species (Dunbar, 1982). Also, it was suggested that frequency-dependent selection can maintain individual variability along the shyness-boldness temperament trait (Wilson et al., 1994) and psychopathy (Mealey, 1995).

Thus, if the factor of Hostility and high Emotional Stability (vs. Agreeableness and low Emotional Stability) really represents the dimension of dominance-oriented aggressive behavior, maintained by frequency-dependent selection, one can predict that there should be pronounced sex differences on it, which must go beyond the trivial differences in mean scores. First, the differences between males and females should be relatively large along this axis. Second, the ''size'' of this factor should differ between the sexes, both absolutely and relatively. That is, it must explain more variance in males than in females and in males it should explain more variance than other Big Five factors (i.e. it must be among the first factors extracted).

The aim of the present investigation was to test this evolutionary hypothesis. I have chosen to combine scales from the Jackson Personality Inventory (JPI, see Jackson, 1970, 1994) and the Personality Research Form (PRF, see Jackson, 1967, 1984). Both demonstrated excellent psychometric properties and are widely used in basic and applied research. The analysis of these scales offers several important advantages. First, although they were not specifically devised to measure the Big Five personality factors, factor analytic studies reveal exactly five dimensions that are very similar to the classical Big Five and correlate closely with their markers (see Ashton et al., 1998). Second, neither of these scales was developed to measure masculinity and femininity or other gender-related domains. Thus, the variable selection was largely ''agnostic''. Furthermore, this combined set of scales reveals factors which are rotated at approximately 45° to the classical Neuroticism and Agreeableness (Ashton et al., 1998), making it possible to analyze specifically the dimension of Agreeableness and low Emotional Stability vs. Hostility and high Emotional Stability.

3. Method

3.1. Subjects and the inventories

Three groups of undergraduate students participated in this study: (a) 214 students (100 males, 114 females) at colleges throughout the United States, who took part during the early 1970s, (b) 178 University of Western Ontario students (82 males, 96 females), who participated during the mid-1980s and (c) 136 University of Western Ontario students (43 males, 93 females) participating in 1997. All participants of the study completed both the Jackson Personality Inventory (JPI) and the Personality Research Form (PRF) under standard conditions. The data were collected by M.C. Ashton, D.N. Jackson, E. Helmes and S.V. Paunonen and generously provided for the present analysis by M.C. Ashton.

3.2. Statistical analysis

First, to ascertain the extent to which the results of testing were consistent across the three samples, I computed factor analyses of each of the three samples separately and the factors extracted were matched across samples. I used several measures of factor comparison: the Ahmavaara factor invariance coefficient (Wherry, 1984), Tucker congruence, Pearson correlation and Kaiser–Hunka–Bianchini (KHB) factor matching coefficients for particular pairs of factors, as well as the KHB mean solution cosine for the overall agreement (Barrett, 1986). It was desirable to compute several independent indices, since each one may have certain advantages and drawbacks (see Barrett, 1986). Prior to factor analysis, psychometric adequacy of correlation matrices was assessed using the Kaiser–Meyer–Olkin measure (KMO). I also inspected off-diagonal elements of the anti-image covariance matrices (and calculated the percentage of covariances not exceeding the conventional value 0.09, AIC) and computed Bartlett's sphericity test (see Dziuban and Shirkey, 1974).

I used the MINRES algorithm (in which the initial estimates of factor loadings are adjusted iteratively to minimize the residual sum of squares) for factor extraction and the factor pattern matrix was rotated according to the normalized Varimax criterion (Wherry, 1984). Several other extraction and rotation methods yielded identical results. The number of factors to extract was determined using (a) Kaiser's eigenvalue-one rule, (b) the scree test and (c) the approach based on parallel component analysis of simulated data (PA, see Zwick and Velicer, 1986), involving 100 random samples in each case. Two-way MANOVA was used to compare the factor scores across the sample and gender groups.

To test the second prediction (i.e. that the factor of Hostility and high Emotional Stability must explain a larger proportion of variance in males than in females), it was necessary to place both groups into the same coordinate system, which could be achieved through analysis of covariance matrices. First, all variables analyzed were standardized over the total sample ($N = 528$) to diminish the effect of differences in scale variances. Second, the common principal component analysis model with maximum likelihood parameter estimation (see Flury, 1988) was applied to compare the covariance structures between the two sexes.

The hypotheses of equality and proportionality of the two matrices and that they share N principal components in common were tested using a hierarchy of χ^2 tests. Here, equality

means that the covariance matrices of males and females are the same and proportionality implies that they share the same eigenvectors, but the eigenvalues differ by a proportional constant. Common principal components (CPC) suggest that both sexes have identical eigenvectors but significantly different eigenvalues. In this context, the hypothesis is confirmed if both equality and proportionality are rejected (i.e. if the nature of factors is the same, but their size differs between the sexes). In addition to this simple hypothesis-testing procedure, I used the model-building approach (as advocated by Flury, 1988). A series of partial CPC models was computed and the overall best-fitting model was selected on the basis of the Akaike information criterion.

4. Results

4.1. Analysis of the combined sample

The preliminary analysis confirmed very good psychometric properties of the combined JPI and PRF scales: sampling adequacy of correlation matrices was high and the factors were perfectly matched across the years of the study (almost all factor matching coefficients exceeded 0.8, none was less than 0.7). Not surprisingly, the total correlation matrices of females and males also had excellent properties (females: $N = 303$, KMO = 0.84, $\chi^2(630) = 5745$, AIC = 3.8%; males: $N = 225$, KMO = 0.83, $\chi^2(630) = 4499$, AIC = 4.3%).

Five factors with eigenvalues exceeding unity were extracted in the combined data set, including both males and females ($N = 528$), which accounted for 50.6% of the total variance. The scree test also clearly suggested five factors, but the PA method indicated an additional small and poorly-defined (maximum loading = 0.49, no other exceeded 0.3) factor, which was not retained (PA sometimes has a tendency to retain poorly-identified factors, see Zwick and Velicer, 1986). In accordance with previous studies (Ashton et al., 1998), the interpretation of these factors is straightforward (see also Table 2).

The two-way MANOVA revealed significant effects of both sex and sample [sex: Wilks lambda (5,518) = 0.83, $P < 0.0001$; sample: Wilks lambda (10,1036) = 0.75, $P < 0.0001$]. However, their interaction was not significant [Wilks lambda (10,1036) = 0.98, $P = 0.46$, *ns*], indicating that the sex differences were consistent across the years of the study. ANOVAs for separate factors (Table 1) revealed that the sex differences were significant for only two, (a) Extraversion and (b) Agreeableness and low Emotional Stability. As expected, the effect size is

Table 1
The differences in the average scores of females and males on the five Varimax factors: ANOVA results

	$F(1,522)$	P-value
Factor 1: Intellect	0.00	0.966
Factor 2: Conscientiousness	0.00	0.999
Factor 3: Extraversion	12.07	0.001
Factor 4: Hostility and Neuroticism	2.40	0.122
Factor 5: Agreeableness and low Emotional Stability	89.96	0.000

Table 2
Loadings of the combined JPI-PRF scales on five rotated factors in females and males

	Females					Males				
	F1	F2	F3	F4	F5	F1	F2	F3	F4	F5
JPI Anxiety	−0.13	0.01	−0.19	0.35	**0.53**	**−0.42**	−0.04	0.38	−0.25	0.04
JPI Breadth of Interest	**0.77**	0.02	0.07	−0.21	0.12	0.25	0.12	−0.05	0.27	**0.70**
JPI Complexity	**0.70**	0.06	−0.02	0.01	0.05	0.07	0.02	−0.04	0.02	**0.73**
JPI Conformity	**−0.56**	−0.18	−0.17	0.13	**0.43**	−0.20	0.09	**0.61**	−0.23	−0.22
JPI Energy Level	0.38	−0.19	0.34	−0.29	−0.10	**0.55**	0.33	−0.05	0.17	0.32
JPI Innovation	**0.65**	0.03	0.18	−0.02	−0.01	0.35	−0.09	−0.08	0.05	**0.56**
JPI Interpersonal Affect	0.17	0.04	0.24	−0.02	**0.71**	0.01	−0.04	**0.68**	0.24	0.25
JPI Organization	−0.13	**−0.76**	0.03	0.05	−0.03	0.12	**0.78**	0.02	0.04	−0.11
JPI Responsibility	0.08	−0.30	−0.06	**−0.45**	0.30	0.05	**0.52**	0.15	**0.49**	0.07
JPI Risk Taking	**0.47**	0.37	0.30	0.08	−0.19	**0.44**	**−0.43**	−0.16	−0.21	0.27
JPI Self Esteem	0.31	0.04	**0.81**	0.05	−0.11	**0.81**	−0.01	0.16	−0.05	0.23
JPI Social Adroitness	0.05	0.09	0.14	0.28	0.16	0.25	0.00	0.30	−0.25	0.18
JPI Social Participation	−0.21	0.09	**0.64**	−0.04	0.32	0.19	−0.20	**0.68**	0.06	0.01
JPI Tolerance	0.34	0.16	0.08	**−0.52**	−0.01	0.04	0.02	0.05	**0.51**	**0.45**
JPI Value Orthodoxy	−0.38	−0.28	−0.00	−0.19	0.27	0.04	0.25	0.27	0.15	−0.32
PRF Abasement	0.06	0.15	−0.17	**−0.56**	0.24	−0.07	0.01	0.12	**0.59**	0.19
PRF Achievement	**0.42**	**−0.41**	0.12	−0.07	0.13	0.29	**0.60**	−0.06	0.07	0.31
PRF Affiliation	−0.10	0.07	**0.78**	−0.09	0.31	**0.42**	−0.23	**0.60**	0.19	−0.05
PRF Aggression	0.02	0.14	0.02	**0.68**	0.03	0.10	−0.20	0.02	**−0.67**	−0.02
PRF Autonomy	**0.56**	0.37	−0.09	0.07	**−0.48**	0.14	−0.16	**−0.73**	−0.07	0.30
PRF Change	**0.52**	0.30	0.16	−0.16	−0.08	0.27	−0.18	−0.05	0.06	**0.41**
PRF Cognitive Structure	−0.20	**−0.69**	−0.17	0.16	0.20	−0.12	**0.73**	0.16	−0.09	−0.11
PRF Dependence	−0.05	−0.03	−0.01	**0.71**	0.07	0.02	−0.06	0.06	**−0.69**	−0.07
PRF Dominance	0.33	−0.11	**0.53**	0.29	−0.00	**0.60**	0.17	0.00	−0.27	0.16
PRF Endurance	**0.46**	**−0.41**	0.06	−0.23	0.07	0.29	**0.53**	−0.21	0.09	0.28
PRF Exhibition	0.18	0.12	**0.78**	0.21	0.03	**0.59**	−0.28	0.30	−0.30	0.08
PRF Harm Avoidance	**−0.50**	−0.29	−0.11	0.15	0.10	**−0.40**	0.32	0.23	−0.03	−0.27
PRF Impulsivity	0.09	**0.68**	0.18	0.19	0.10	0.12	**−0.76**	0.09	−0.16	−0.04
PRF Nurturance	0.24	−0.04	0.19	−0.28	**0.59**	0.24	0.08	**0.51**	0.36	0.29
PRF Order	−0.16	**−0.66**	0.05	0.06	−0.00	0.01	**0.71**	0.03	0.03	−0.12
PRF Play	−0.06	**0.52**	**0.49**	0.09	−0.01	0.24	**−0.73**	0.22	−0.04	0.02
PRF Sentience	**0.47**	0.12	0.01	0.05	0.19	0.08	−0.15	0.13	0.17	**0.55**
PRF Social recognition	**−0.44**	−0.21	0.04	0.39	0.32	0.05	0.15	**0.54**	**−0.41**	−0.15
PRF Succorance	**−0.47**	−0.09	0.15	0.17	**0.51**	−0.10	−0.04	**0.70**	−0.02	−0.13
PRF Understanding	**0.70**	−0.13	0.05	0.01	−0.01	0.04	0.28	−0.24	0.09	**0.72**
PRF Desirability	0.13	**−0.43**	**0.41**	−0.34	−0.09	0.39	**0.42**	0.06	0.38	0.09

Females: F1 = Intellect, F2 = Conscientiousness (reversed), F3 = Extraversion, F4 = Hostility and Neuroticism, F5 = Agreeableness and low Emotional Stability; Males: F1 = Extraversion, F2 = Conscientiousness, F3 = Agreeableness and low Emotional Stability, F4 = Agreeableness and Emotional Stability, F5 = Intellect. Factor loadings >0.4 are given in bold.

Table 3
Correspondence between the Big Five factors in females and males

	Factor comparison coefficient			
	Ahm	Tucker	Pearson	KHB
Intellect	0.87	0.93	0.93	0.92
Conscientiousness	−0.99	−0.95	−0.95	−0.98
Extraversion	0.87	0.85	0.79	0.92
Hostility and Neuroticism	−0.99	−0.95	−0.96	−0.99
Agreeableness and low Emotional Stability	0.92	0.88	0.84	0.88

Ahm = Ahmavaara factor invariance coefficient, KHB = Kaiser–Hunka–Bianchini coefficient. The overall KHB mean solution cosine = 0.96.

significantly larger for the Agreeableness and low Emotional Stability factor (on which females averaged 0.76 total-sample standard deviation higher than males) than for the Extraversion factor (on which males averaged 0.21 total-sample standard deviation higher than females). Sex explained 14.4% of variance of the former factor and only 2.1% of variance of the latter factor. Separate analyses of variance of four variables which had the highest loadings (>0.5) on the Extraversion factor indicated that sex exerted the strongest effect on the PRF Dominance scale, explaining 5.1% of its variance [$F(1,522) = 29.13$, $P < 0.001$]. Sex also explained 0.8%, 1.1% and 0.8% of variance in JPI Self Esteem, PRF Exhibition and PRF Affiliation scales, respectively (all Ps < 0.036). Specifically, males scored higher than females on PRF Dominance (0.46 S.D.), JPI Self Esteem (0.19 S.D.) and PRF Exhibition (0.22 S.D.) but lower on PRF Affiliation scales (0.18 S.D.).

4.2. Factor analysis by sex

Five factors (accounting for 49.8% of variance) with eigenvalues exceeding unity were extracted in females. The scree test also clearly indicated five factors, but the PA method suggested an additional small and poorly-defined factor which was not retained. All three criteria agreed that five factors (accounting for 51.7% of variance) should be extracted in males. The factor structures were virtually identical in the two sexes (Tables 2 and 3). Thus, the nature of the personality factors is the same. However, the factor sizes did differ, just in the predicted direction (Table 4). After rotation, the factor Agreeableness and low Emotional Stability was the second factor in males but the last in females. A similar trend was observed in the unrotated factors. As to the absolute value of the difference, this factor explained almost 2 times more variance in males than in females. Even though the difference is not, in fact, very large absolutely, it is exactly in the predicted direction and, therefore, important in the evolutionary sense.

To ascertain whether the above structural difference between males and females is statistically significant, common principal component analysis was applied. The hypothesis of equality of their covariance matrices was rejected [$\chi^2(666) = 764.66$, $P = 0.005$], as was proportionality [$\chi^2(665) = 764.48$, $P = 0.004$]. However, the value of the log-likelihood ratio

Table 4
Comparison of the MINRES-based eigenvalues obtained in separate factor analyses of data for males and females

	Male				Female			
	unrotated		rotated		unrotated		rotated	
	Eigenvalue	% variance	Eigenvalue	% variance	Eigenvalue	% variance	Eigenvalue	% variance
Intellect	5.64	15.7	3.59	10.0	6.60	18.3	5.32	14.8
Conscientiousness	5.01	13.9	4.79	13.3	3.70	10.3	3.63	10.1
Agreeableness and low Em. Stability	**4.06**	**11.3**	**4.01**	**11.1**	**1.80**	**5.0**	**2.57**	**7.1**
Hostility and Neuroticism	2.57	7.1	2.92	8.1	2.23	6.2	2.83	7.9
Extraversion	1.31	3.6	3.29	9.1	3.59	10.0	3.57	9.9

The factor Agreeableness and low Emotional Stability is given in bold type.

statistic for the common principal components model indicated a very good fit: $\chi^2(630) = 588.83$, $P = 0.88$, *ns*. The model-building approach confirmed this result: the Akaike information criterion reached its minimum value for the CPC model (see Fig. 1), which means

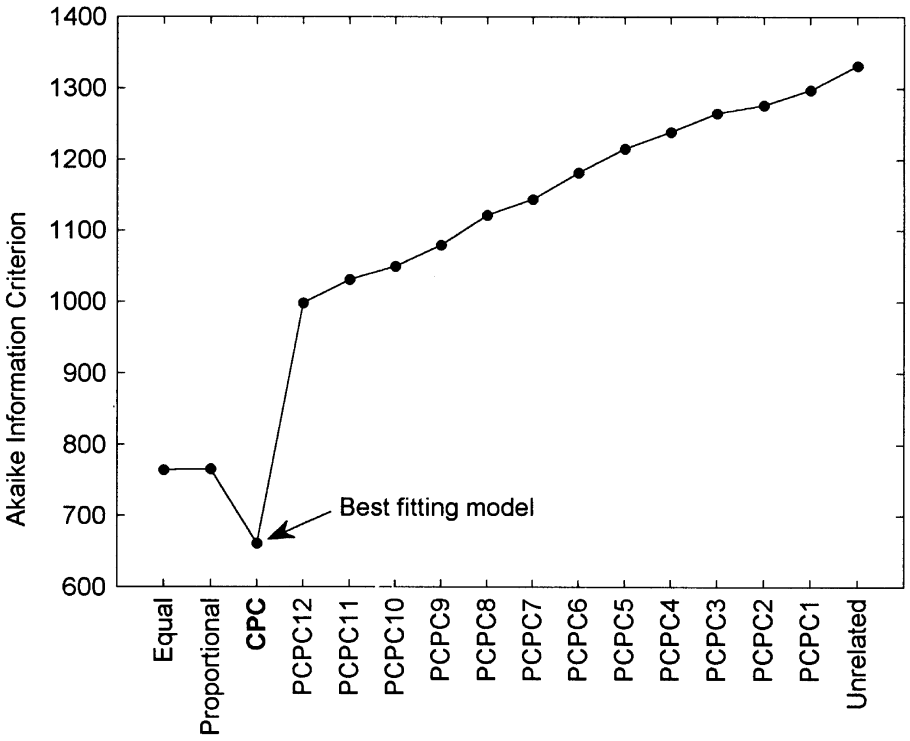

Fig. 1. Comparison of common principal component models. The full CPC model shows the best fit, as indicated by the Akaike information criterion. (Partial CPC models with up to 12 common components are presented).

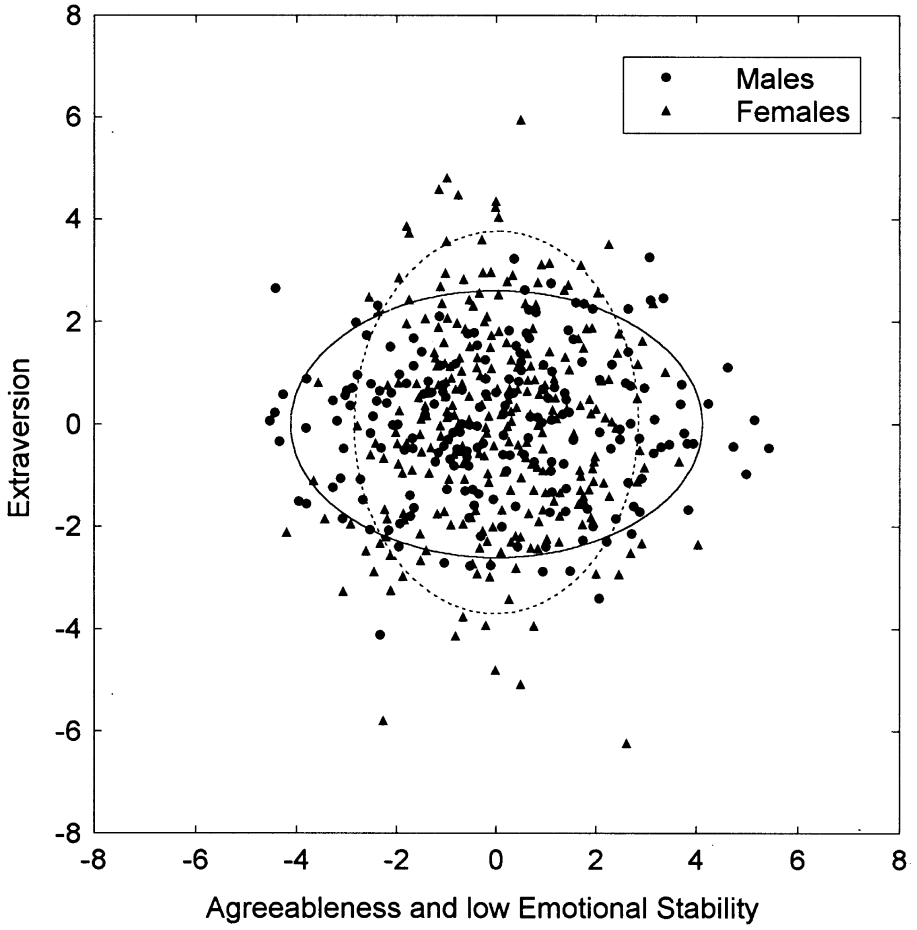

Fig. 2. Scatterplot of factors based on separate principal component analyses of covariance matrices of males and females. It is seen that the factor Agreeableness and low Emotional Stability explains more variance in males than in females. The 95% confidence ellipses (solid line in males, striped line in females) are also shown.

that it showed the best fit. Separate CPC analyses for each of the three samples revealed similar results, which evidences that this pattern is stable across the years of the study. Inspection of unrotated and rotated component patterns based on covariance matrices revealed that they did not differ from the MINRES factor pattern matrices and the same number of principal components was indicated.

Thus, the covariance matrices of males and females differ significantly in eigenvalues, but not in eigenvectors (factor structure). This can be conceived geometrically as if the elliptical clouds formed by males and females in a multidimensional space had the same major axes corresponding to the Big Five factors, but "stretched" in different directions (see Fig. 2).

5. Discussion

The present analysis clearly confirmed the hypothesis concerning the pattern of sex differences in the Big Five personality factors. First, females showed, on average, significantly higher scores on the Agreeableness and low Emotional Stability factor than did males. Second, the differences between males and females were maximized along this factor and were not significant on all other factors except Extraversion, on which they were much smaller (but if Extraversion is considered as "boldness", such sex difference is also expected on evolutionary grounds and is often found in non-humans). Third, the personality factor patterns did not differ between males and females and the same Big Five dimensions were extracted in both. Yet, there were significant structural differences: the factor Agreeableness and low Emotional Stability accounted for more variance in males than in females, both in absolute value and in relation to other factors of the Big Five model. All this suggests that the factor Agreeableness and Low Emotional Stability (vs. Hostility and high Emotional Stability) is an important axis, reflecting adaptive individual differences in dominance-related aggressiveness in the human species, maintained by frequency-dependent selection mechanisms.

It is important to note, however, that the PRF Dominance scale did not correlate with the factor Agreeableness and low Emotional Stability (see Table 2). Accordingly, this axis seems to be related to one's *potential* ability to dominate others and his/her predisposition to exploit them callously. However, it is unrelated to the actual tendency to be surgent or bold, as measured by the PRF Dominance scale. From the evolutionary viewpoint, the behavioral traits that promote dominance need not necessarily involve conscious willingness and aggressiveness (including instrumental aggression) would facilitate social dominance in our ancestral species. Even so, the PRF Dominance scale showed the largest magnitude of sex differences among the four markers of Extraversion.

As in most mammals, human males tend to be physically larger, more aggressive (both verbally and physically), risk-prone and engage in more dominance contests, which is consistent across cultures (Daly and Wilson, 1983; Eibl-Eibesfeldt, 1989). This is mirrored in personality differences: it is commonly observed that males show higher levels of aggressiveness, assertiveness and self-esteem but lower levels of anxiety, trust and tender-mindedness, especially nurturance (see Feingold, 1994). Very similar trends were observed in many nonhuman primates (e.g. Buirski et al., 1978; McGuire et al., 1994).

Thus, the broad personality factor which lies between Neuroticism and Agreeableness (see Caprara and Perugini, 1994; Ashton et al., 1998, for Varimax solutions that have obtained this factor) may represent the basic dimension of dominance-oriented aggressive behavior in humans. In majority of animal species social dominance is associated not with just a high level of basic aggressiveness, but rather with a combination of aggressiveness and emotional stability, so that the latter typically correlates with aggressiveness (see Archer, 1988 for an extensive review). An example of this relationship is a recent study of temperament dimensions in a fish (the guppy), conducted using the classical psychometric methodology (see Budaev, 1997; Budaev and Zhuikov, 1998). We found that the tendencies to contact with shoaling conspecifics and with the mirror image (the tendency to contact with mirror typically reflects aggressiveness in fishes) formed a single factor of Sociability. But in another behavioral domain this factor was split between Approach (an analogue of extraversion encompassing tendency to

shoal, activity and novelty seeking) and Fear (tendency to contact with mirror image, freezing, escape, more rapid avoidance learning).

Even though aggressiveness itself is likely to be an important prerequisite for social dominance, emotional stability and stress resistance is required to maintain high status for more or less prolonged time. For example, dominant and subordinate baboons show dissimilar stress responsiveness reflected in different levels and dynamics of cortisol (Sapolsky, 1990, 1993). Similar trends were observed in inhibited and bold children (Kagan et al., 1988). Finally, according to the psychophysiological model developed by Mazur (1994), dominance relationships are formed through manipulation of stress during the contest, so that the individual who ''outstresses'' the opponent becomes the winner. Also important is that, to have an adaptive function, the trait must show nonzero heritability and many studies have shown that aggressiveness, neuroticism-anxiety and dominance tendencies have relatively high heritability levels (Plomin, 1986; Eaves et al., 1989).

If the factor of Agreeableness and low Emotional Stability really represents the basic dimension of dominance-related aggressiveness, it might be mediated to some extent by testosterone level. As discussed in the recent review by Mazur and Booth (1998), there is evidence that circulating levels of this hormone correlates with aggressiveness, dominance, antisocial behavior, as well as with responses to social challenge and stress resistance. However, this link is highly variable between studies (Archer, 1991) and preliminary results from an ongoing meta-analysis (Archer, personal communication) indicate that dominance does not correlate better than aggressiveness. If this inconsistency at least in part depends on the use of scales which are only weakly related to dominance-related aggressiveness, it might be expected that the rotated personality factor of Agreeableness and low Emotional Stability could exhibit a more stable relationship with testosterone. Special analysis is necessary, however.

Finally, low poles of the two rotated dimensions, Agreeableness and low Emotional Stability and Agreeableness and high Emotional Stability, seem to represent two types of sociopathy. The high scores on hostility and high emotional stability resemble the description of primary sociopathy — cold and detached, with manipulative style of interpersonal relationships, Machiavellianism and lack of social emotions, whereas high scores on hostility and low emotional stability are similar to secondary sociopathy — psychopathy and antisocial behavior with no deficit in social emotions, such as anxiety, shame and guilt (Mealey, 1995; secondary psychopaths show increased levels of anxiety and guilt, see Gudjonsson and Roberts, 1983). In accord with the present results, sociopathy is significantly more common in males (see Mealey, 1995 and commentaries therein). Furthermore, it has been suggested (Archer, 1995), that primary sociopathy could be related to dominant behavior and represent an alternative frequency-dependent strategy with relatively high reproductive success, whereas the secondary sociopathy may be related to submissive behavior and, in the evolutionary sense, to ''making the best of a bad job''. Thus, primary sociopathy might be conceived as an exaggerated dominance tendency: propensity to control others, to obtain power or influence, in order to ultimately achieve high priority to valued resources. Several studies corroborate this view, indicating that psychopathy correlates with hostile dominance (i.e. dominance and lack of nurturance, very similar to the present factor of Hostility and Emotional Stability vs. Agreeableness and low Emotional Stability, see Hoyenga, 1995 for references) and is a two-dimensional construct (Newman et al., 1985).

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