A psychometric analysis of the NEO five-factor inventory in an Austrian sample

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A sample of 442 Austrians received the German version of the NEO-FFI. Marked negative correlations between NEO-FFI scales were found. Two orthogonal higher order factors were extracted, one representing a stable, extraverted, conscientious and friendly type of personality, the other one standing for open-mindedness, possibly creativity, and a tendency to be disorganized. In principal components analysis with varimax rotation clearly five factors emerged and 55 of the 60 NEO-FFI items loaded on the expected dimensions. In confirmatory factor analysis, however, the measurement model suggested by the NEO-FFI scales could only be confirmed in 2 independent samples when 28 items with item-total correlations < .4 as well as 9 items with multiple loadings were deleted. It is concluded that NEO-FFI scales, especially the agreeableness scale, should be improved on the basis of this model.

The "Big Five" factors of personality - Neuroticism (N), Extraversion (E), Openness to Experience (O), Agreeableness (A), and Conscientiousness (C) - constitute one of the major paradigms in personality research which could be replicated, on a lexical basis, world wide (Tupes & Christal, 1992, for the U.S.A., Angleitner, Ostendorf & John, 1990, for Germany, Katigbak, Church, Guanzon-Lapena, Carlota & del Pilar, 2000, for the Philipines, and Somer & Goldberg, 1999, for Turkey, to name only a few examples).

The most widely used instruments to measure the "Big Five" are the Revised NEO Personality Inventory (NEO-PI-R) and its short version, the NEO Five-Factor Inventory (NEO-FFI) (Costa & McCrae, 1992). Whereas the NEO PI-R comprises 240 items measuring six subfactors or facets of each of the five broader dimensions, the NEO-FFI consists of 60 statements designed to measure N, E, O, A, and C without their facets. The NEO-FFI was developed by selecting from the NEO PI-R the twelve items with the highest factor loadings for each of the five factors. The short version proved to be beneficial for many purposes where a more detailed assessment of personality

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traits was not necessary and time did not permit to administer the far more complex NEO-PI-R.

The NEO PI-R has been translated into 13 different languages, including Russian, Hebrew, Japanese, Korean, and Chinese (Rolland, Parker & Stumpf, 1998). For non-English speaking countries also foreign versions of the NEO-FFI have been developed, for example by Borkenau and Ostendorf (1991, $N = 578$, and 1993, $N = 1076$) in German and by Rolland et al. (1998) in French (2 samples: $N = 447$ and $N = 268$). As the factorial structure of a questionnaire may vary from one sample to another, it seems advisable to re-examine an instrument's factorial validity in different cultures. For the German translation of the NEO-FFI, Borkenau and Ostendorf (1991) found that N and C were correlated negatively ($r = -.38$) and so were N and E ($r = -.24$). O and C were correlated negatively too ($r = -.17$). Borkenau and Ostendorf (1993) reported similar intercorrelations. Still, Borkenau and Ostendorf (1991), by multitrait multi-method comparisons using structural equation modeling, showed that the German version of the NEO-FFI measured the same latent constructs as Normans's (1963) adjectives rating scales. Borkenau and Ostendorf (1991 and 1993) also found by exploratory factor analysis (EFA) that 58 of the 60 German items had their primary factor loadings on the dimensions they were supposed to measure. Rolland et al. (1998), also using EFA, confirmed the factor structure of the NEO-PI-R and the NEO-FFI in French samples of university students and of military personnel.

Other studies, although they were using the original English version of the NEO-FFI in different countries, however, reported more problematic findings. Egan, Deary

and Austin (2000) found by EFA with orthogonal and oblique rotation and by confirmatory factor analysis (CFA) that only N, A, and C were measured adequately by the NEO-FFI in a British sample, whereas O and E were not (N =1025). N and E were correlated negatively (r = -.40), and so were N and C (r = -.36) as well as N and A (r = -.22). E and C were correlated positively (r = .30). Similar correlations were reported by Deary et al. (1996) for a sample of Scottish medical doctors (N = 344). In a U. S. sample, using CFA, Mooradian and Nezlek (1996) did not confirm the factorial structures of the NEO-FFI (N = 601). Holden and Fekken (1994), in a sample of Canadian university women, found affirmative results in EFA but could not confirm the NEO-FFI factorial structure in CFA (N = 243).

In summary it may be speculated that principal components analysis or EFA usually yielded satisfactory results whereas CFA disconfirmed the factorial structure of the NEO-FFI. The aim of the present study is to examine the NEO-FFI's factorial validity in an Austrian sample, both by EFA and CFA, and to find out possible modifications of the item pool in order to achieve a more replicable factorial structure.

METHOD

Participants

All participants were German speaking inhabitants of Carinthia, a region in the utmost South of Austria. Four hundred and forty-two people participated, 338 women and 86 men. Eighteen persons did not state their gender. Mean age was 29.9 years (SD = 10.9), ranging from 17 to 68 years[1]. Sixty-three had attended primary or secondary schools, 297 had a high-school diploma, and 73 participants had a university degree. Nine did not give their educational level. Three hundred and forty-three participants were psychology students at the University of Klagenfurt who received extra credits for their exams; at the time when they completed the test most of them had no special knowledge about the nature of the NEO-FFI or of factor analytic theories of personality. Thus it is unlikely that such knowledge influenced their answering behavior. 63 participants were members of the local Red Cross and 34 others were nurses at a local hospital. Two were private acquaintances of the author.

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[1] The sample is extremely heterogenous with regard to age (range = 51 yrs.). Personality factors, however, are nearly uncorrelated with age, with correlations ranging from r = -.07 for E to r = -.18 N, which is the only significant correlation between age and a personality dimension.

Instruments

The participants completed the German version of the NEO-FFI (Borkenau & Ostendorf, 1993) which provides a five-point Likert scale for each item ("strong approval", "approval", "neutral", "disapproval", "strong disapproval"). All the questionnaires were administered together with two other questionnaires which are not subject of the present study. Completion of the total set of questionnaires took approximately 90 minutes. With respect to this long period of time necessary and for practical reasons, the university students completed the questionnaires at home. Students were informed that they would receive a feedback of their test scores later on, and thus it was reasonably ensured that they answered the questions without the help of others. Red Cross and nursing staff volunteered to fill in the questionnaires predominantly during their working hours.

Statistical procedure

After assessing descriptive statistics and internal consistencies (Cronbach's α) for the five NEO-FFI scales, product moment correlation coefficients between them were computed in order to investigate the alleged independence of the scales. A principal components analysis with varimax rotation was computed on the level of NEO-FFI scales in order to search for second order factors (cf. Egan et al., 2000). In the next step, a principal component analysis with varimax rotation was computed on the item level and item-total correlations of the items loading on the new factors were assessed. In order to investigate the factorial validity of the instrument further, a confirmatory factor analysis was performed on the item level using AMOS 4.01 (Arbuckle & Wothke, 1999) software. With regard to own and previous findings (e.g. Borkenau and Ostendorf, 1991) the five factors were allowed to be correlated in CFA. As the assumption of multivariate normality was not fulfilled the estimates were computed by the bootstrapping procedure as suggested by Arbuckle & Wothke (1999) and Byrne (2001). Finally, a new measurement model was proposed and tested by confirmatory factor analysis in two independent parts of the sample.

RESULTS

Means, standard deviations, and internal consistencies (Cronbach's α) for each scale are given in Table 1.

Men and women in the present sample which was not representative with regard to age, educational level or gender, scored about half a standard deviation lower on Neuroticism than those who participated in the construction of

Table 1

Means, standard deviations, and internal consistencies of scores on the NEO-FFI scales

	N			E			O			A			C		
	M	SD	α	M	SD	α	M	SD	α	M	SD	α	M	SD	α
Male (N=86)	1.37	0.58	0.82	2.47	0.48	0.71	2.55	0.54	0.75	2.52	0.46	0.68	2.69	0.59	0.84
Female (N=338)	1.67	0.65	0.85	2.49	0.53	0.80	2.68	0.48	0.72	2.64	0.43	0.69	2.75	0.53	0.83
Total[1] (N=42)	1.61	0.65	0.85	2.50	0.52	0.78	2.66	0.50	0.73	2.61	0.44	0.69	2.73	0.54	0.82

[1] 18 participants did not give their gender

the NEO-FFI German version (Borkenau & Ostendorf, 1991). Scores on Openness were also lower in this study but the differences were less marked. As compared to the original sample, the present participants scored higher on Extraversion, Agreeableness and Conscientiousness, and differences were less than half a standard deviation. Internal consistencies did not differ substantially from those reported by Borkenau and Ostendorf (1993).

Intercorrelations of NEO-FFI scales

There were marked negative correlations between Neuroticism, on the one hand, and all the other scales, especially Extraversion and Conscientiousness, on the other.

Table 2

Intercorrelations between NEO-FFI scales (N = 442)

	N	E	O	A	C
N	1.00				
E	-.46**	1.00			
O	-.21**	.13**	1.00		
A	-.19**	.21**	.09	1.00	
C	-.35**	.32**	-.09	.21**	1.00

Note: ** $p < .01$, * $p < .05$ (two tailed)

Table 3

Rotated component matrix of NEO-FFI second order factors

	Component	
	1	2
N	-.76	-.22
E	.75	.12
C	.71	-.42
A	.50	.04

Extraversion was correlated positively with Conscientiousness, Agreeableness, and Openness, and Agreeableness and Conscientiousness correlated positively as well.

As the scores for the five dimensions failed to be independent, their factorial structure was examined in the next step and higher order factors were extracted. Two factors had eigenvalues 1 and explained 60.1% of the variance. Factor 1 explained 38.5%, and Factor 2 explained 21.6% of total variance. The rotated component matrix is shown in Table 3.

Component 1 stands for a good-natured, healthy, friendly, sociable and thorough type of personality whereas Component 2 indicates broad-mindedness, and possibly creativity in combination with a lesser degree of conscientiousness.

Factor analyses on the item level and computation of item-total correlations

Next, a principal component analysis with varimax rotation was computed. As can be seen from the scree plot in Figure 1, clearly five factors emerged which explained 36.3 % of the variance. Factor I explained 15.1%, Factor II 7.0%, Factor III 5.5%, Factor IV 4.4%, and Factor V 4.4% of the variance. The Kaiser-Guttman criterion yielded 15 components with eigenvalues 1 but this solution did not lead to interpretable results[2].

The factor loadings of the 60 NEO-FFI items are given in Table 4 together with the communalities and the original principal loadings of the NEO-FFI items. All twelve items that stem from the Neuroticism scale loaded on Component 1. Similarly, all the items belonging to Conscientiousness loaded satisfactorily on Component 2. Eleven of twelve E-items loaded on Component 3, one of them (27R)[3] on Com-
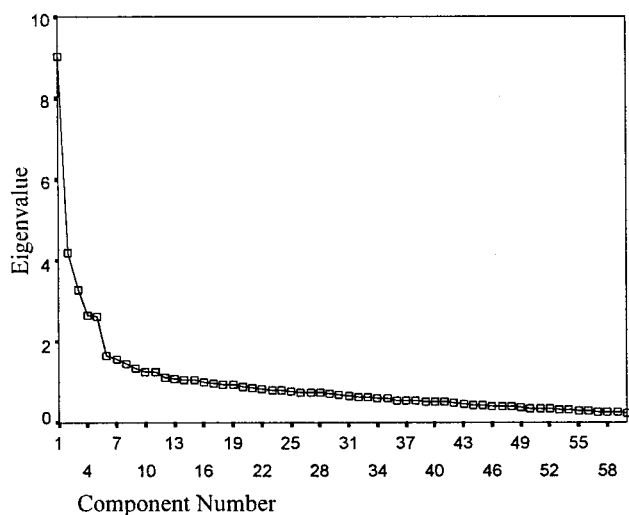
Figure 1. Scree plot for principal component analysis of NEO-FFI items

ponent 5 (A). Eleven of the items stemming from the factor Openness loaded primarily on Component 4, one of them (38R) on Component 2 (C). Nine of twelve items that were supposed to represent the factor Agreeableness loaded on

Component 5. Two others (9R and 29R) loaded negatively on Component 1 (N) and one (34) loaded on component 3 (E). For all the factors a considerable number of substantial multiple loadings could be found.

In a next step, from the new principal loadings of the NEO-FFI items, scales were constructed for each of the five factors and item-total correlations (r_{it}) were computed. They are given in the last column of Table 4. For eight items belonging to Component 1 (N) r_{it} was <.5; this was the case for four items of Component 2 (E) and four of Component 3 (E). Item-total correlations were .5 for three items of Component 4 (O). None of the items with their principal loading on A had item-total correlations <.5.

Confirmatory factor analyses

After splitting the sample on a random basis into two groups with approximately 50% of the participants, a confirmatory factor analysis (CFA) was computed with the first part of the sample ($N = 213$). Only those items with r_{it} ≥.3 and with primary loadings ≥ 5 were entered into a first CFA model. When 13 items were deleted because the modification indices suggested regression weights from
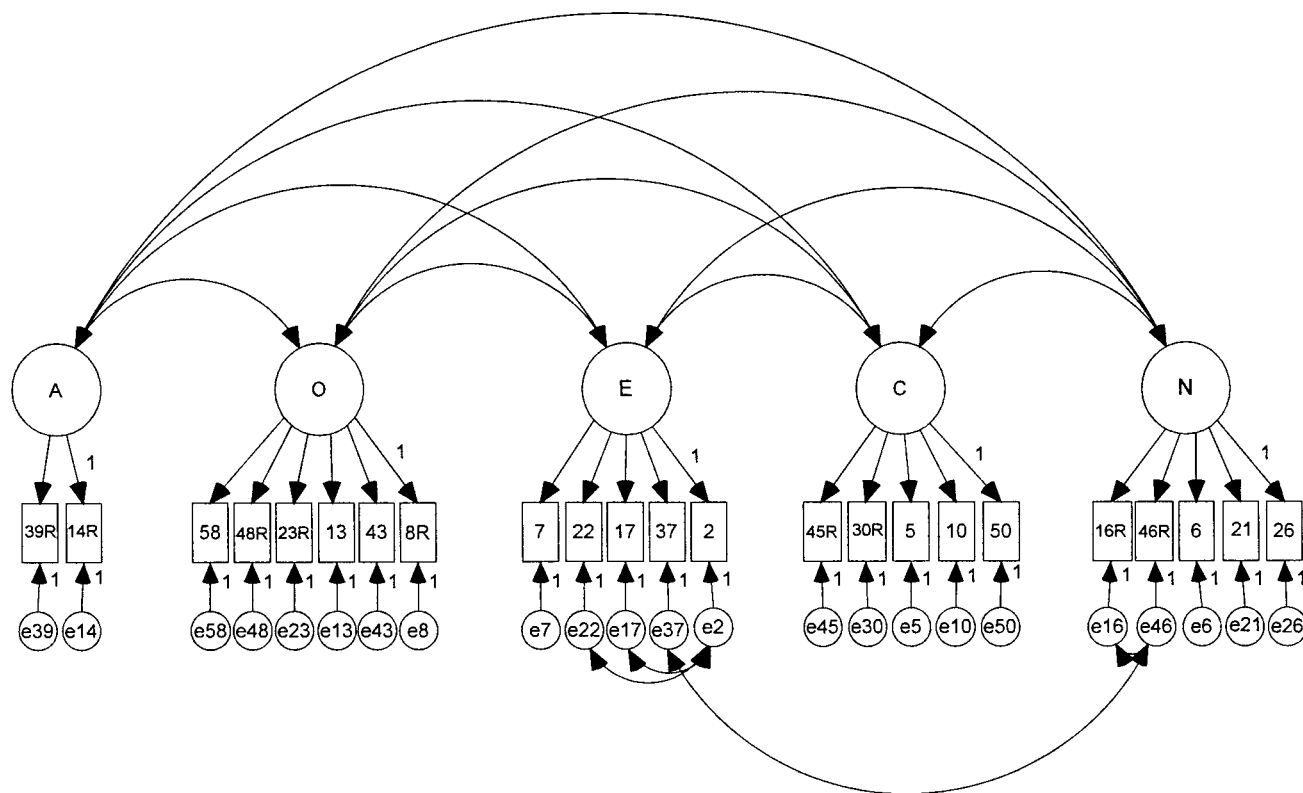

Figure 2. Measurement model for the "Big Five", confirmed by CFA

Table 4

Factor loadings, communalities, original principal loadings and item-total correlations of NEO-FFI items

Item number	Original principal loading	1 (N)	2 (C)	3 (E)	4 (O)	5 (A)	h²	rᵢₜ
51	N	**.71**	-.26	-.06	-.10	.01	**.59**	**.64**
21	N	**.69**	.01	-.15	-.00	-.05	**.51**	**.58**
41	N	**.65**	-.29	-.24	-.09	-.07	**.58**	**.63**
11	N	**.63**	-.00	-.03	-.12	.05	**.42**	**.50**
6	N	**.63**	-.10	-.14	-.19	.07	**.47**	**.56**
46R	N	**.57**	-.07	-.28	.10	.06	**.43**	**.51**
16R	N	**.57**	-.07	-.17	.02	.14	**.38**	**.53**
36	N	**.56**	.04	-.02	-.21	-.14	**.38**	.40
31R	N	.49	-.01	-.21	-.00	.13	**.30**	.48
56	N	.44	-.14	.07	.03	-.03	.22	.34
9R	A	-.41	.17	.05	-.03	.34	**.31**	-.37
29R	A	-.35	-.10	-.13	.14	.33	.28	-.22
1R	N	.23	-.07	-.17	-.07	-.05	.10	.24
50	C	-.08	**.69**	.20	-.09	-.01	**.53**	**.60**
35	C	-.12	**.68**	.17	.12	-.05	**.52**	**.57**
25	C	-.20	**.64**	.12	.12	-.06	**.48**	**.55**
20	C	.09	**.60**	.12	-.04	.14	**.41**	.49
10	C	-.28	**.60**	-.00	-.11	-.01	**.45**	**.52**
5	C	-.04	**.57**	.01	-.24	.13	**.40**	.46
30R	C	-.32	**.54**	-.03	-.13	.09	**.42**	.47
40	C	-.06	**.52**	.13	.06	.20	**.34**	.46
45R	C	-.12	**.52**	-.03	-.00	.10	.29	.44
60	C	.14	.48	.09	-.01	-.25	**.32**	.30
55R	C	-.36	.47	.05	.01	.21	**.40**	.48
15R	C	-.19	.41	-.01	-.05	-.10	.21	.36
38R	O	-.11	-.25	-.02	.22	-.12	.14	-.16
2	E	-.03	.03	**.74**	.07	.06	**.55**	**.56**
37	E	.25	.17	**.68**	.03	.14	**.57**	**.65**
17	E	-.15	.14	**.65**	.10	.27	**.54**	**.58**
22	E	-.04	-.03	**.58**	-.09	-.21	**.39**	.40
52	E	-.28	.33	**.54**	.09	-.05	**.49**	**.55**
7	E	-.04	-.01	**.51**	.05	.13	.28	.40
32	E	-.26	.23	.45	.20	-.19	**.40**	.44
12R	E	-.25	.04	.45	.12	.14	**.30**	.41
42R	E	-.36	.16	.44	.07	.12	**.37**	.46
57R	E	-.26	.11	.41	-.15	-.03	.27	.36
34	A	-.19	.16	.30	.11	.27	.23	.33
47	E	.17	.05	.28	.13	-.10	.14	.14
8R	O	-.15	-.08	-.04	**.65**	.09	**.46**	**.52**
43	O	.02	-.09	.06	**.64**	.01	**.43**	**.52**
13	O	-.09	.03	.07	**.62**	.07	**.41**	**.52**
23R	O	.01	.01	.00	**.61**	.14	**.39**	.47
48R	O	-.02	.01	-.00	**.59**	-.02	**.35**	.45
58	O	-.13	-.07	.10	**.57**	-.15	**.38**	.44
53	O	-.21	.29	.24	.46	-.11	**.41**	.34
33R	O	-.01	-.01	.15	.45	.26	.29	.35
3R	O	.15	-.25	-.12	.41	.01	.27	.25
18R	O	-.22	-.21	-.16	.29	-.00	.20	.20
28	O	-.19	.04	.22	.25	.05	.15	.20
14R	A	-.06	.02	-.03	-.01	**.61**	**.38**	.42
39R	A	-.14	.07	.10	.02	**.59**	**.39**	.46
19	A	.11	-.02	.05	.06	**.52**	.28	.34
59R	A	.09	.23	-.04	-.03	**.51**	**.33**	.37
24R	A	-.27	.16	.16	.06	**.50**	**.38**	.38
49	A	.20	.20	.03	.13	**.50**	**.35**	.38
44R	A	.01	-.19	.05	.15	.45	.27	.29
4	A	.12	.34	.17	-.08	.37	**.30**	.29
27R	E	-.11	-.20	.31	-.20	.35	**.31**	.22
54R	A	.04	-.05	-.22	-.11	.27	.13	.14

Note: Factor loadings and correlations ≥ 5 and communalities ≥ 3 are given in bold type.

"wrong" latent variables (e.g. items 41, 11, 25), in this part of the sample a satisfactory fit was achieved ($\chi^2 = 302$, df =219, Bollen-Stine bootstrapped $p= 0.199$).

As some changes had been made in the original measurement model in order to achieve satisfactory fit, it seemed desirable to confirm the new model independently in another sample. Thus CFA was repeated with the second part of the original sample ($N = 229$). For this part of the sample model fit was not achieved ($\chi^2 = 400$, $df = 219$, Bollen-Stine bootstrapped $p=0.005$).

Thus, only 32 items with item-total correlations $\geq .4$ were entered into the next measurement model. All of them had factor loadings $\geq .5$. When CFA was repeated the modification indices suggested to exclude a total of nine items because of substantial regression weights from a "wrong" latent variable (e.g. item 35, 52, 36) and to allow some error terms to be correlated. As these items resembled each other closely in content, it was deemed theoretically acceptable to allow their error terms to be correlated. Twenty-three items remained. For the final model which is shown in Figure 2, CFA indicated satisfactory fit ($\chi^2 =297$, $df=216$, Bollen-Stine bootstrapped $p = 0.194$).

In the second part of the sample ($N=229$) again a nonsignificant Bollen-Stine statistic and thus a satisfactory model fit was achieved ($\chi^2 = 329$, $df = 216$, Bollen-Stine bootstrapped $p = 0.060$). When the total sample was split by gender, again a satisfactory model fit was reached for both parts (women: $N =338$, $\chi^2 = 291$, $df = 216$, Bollen-Stine bootstrapped $p = 0.139$; men: $N = 86$, $\chi^2 = 283$, $df = 216$, Bollen-Stine bootstrapped $p = 0.443$).

Using data from the total sample again, internal consistencies were computed for the new scales which had been entered into the confirmed CFA model. Cronbach's á for N was .78, for C it was .71, for E it was .71, for O it was .76, and for A internal consistency was .60.

DISCUSSION

On the item level, principal components analysis yielded factors which clearly resembled the Big Five. Fifty five of the 60 items loaded on the expected dimensions. Internal consistencies of the scales were satisfactory. The highest item-total correlations were found for N and C and the lowest ones for O and A.

By eliminating items with poor item-total correlations or substantial multiple loadings or both, a measurement model was proposed which could be confirmed by CFA in two independent samples. This model suggested 5 item scales for N, C and E respectively, a 6-item scale for O, and a 2-item scale for A. Several items had to be excluded be-

cause of multiple loadings in order to achieve satisfactory model fit. Similarly, Church and Burke (1994), in a CFA of the NEO-PI, could confirm its factor structure only when they allowed for several substantial secondary loadings. Hence, they argued that the Big Five personality traits do not follow a perfect simple structure as implied by factor analytic methods (cf. Hofstee, deRaad, & Goldberg, 1992). Borkenau and Ostendorf (1990) as well as McCrae, Zonderman, Costa, Bond, and Paunonen (1996) who could not confirm the factorial structure of the NEO-PI by CFA questioned the appropriateness of CFA as a test of personality models because CFA did not account for the possibility of multiple factor loadings. In accordance with this allegation, in the present study a measurement model could be confirmed in CFA only, when items with multiple regression paths were deleted.

In accordance with Borkenau and Ostendorf (1991 and 1993), Deary et al. (1996) and Egan et al. (2000), substantial correlations were found among the NEO-FFI scales. Borkenau and Ostendorf (1991) reported similar correlations for Norman's (1963) scales. The orthogonal second order factors found in this study had been described almost identically by Egan et al. (2000), one indicating an extraverted, friendly, reliable and stable type of personality, and the other one standing for creativity and open-mindedness with a lesser degree of conscientiousness. In order to achieve a satisfactory model fit the latent variables had to be allowed to correlate. Although the Big Five factors are uncorrelated theoretically their psychometric measures have frequently been found to correlate. As none of the scales can have perfect factorial validity, such measures represent the corresponding original factors only partly and therefore they can be expected to be correlated.

In the final measurement model only short scales remained, their internal consistencies being less than ideal for N, C, E, and O and too low for practical purposes in the case of A. Still, the factorial structure of the NEO-FFI could be confirmed by CFA, provided that only factor marker items with sufficiently high item-total correlations where included and those with substantial regression paths from "wrong" latents were eliminated. Previous findings that indicated that the NEO-FFI factorial structure could not be confirmed at all by CFA should therefore be reconsidered.

One aim of future research should be to try to replicate the present measurement model in an independent sample, and another one to improve the psychometric properties of the new scales, especially with regard to the agreeableness dimension. For this, the present model may provide a starting point.

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