Against All Odds:
Bifactors in EFAs of Big Five Data

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The Big Five

Extraversion, Agreeableness, Conscientiousness
Neuroticism/Stability, Openness/Intellect

The foundation dimensions of the study of normal personality

Found in analyses of nearly all cultures

High convergent validity across multiple questionnaires

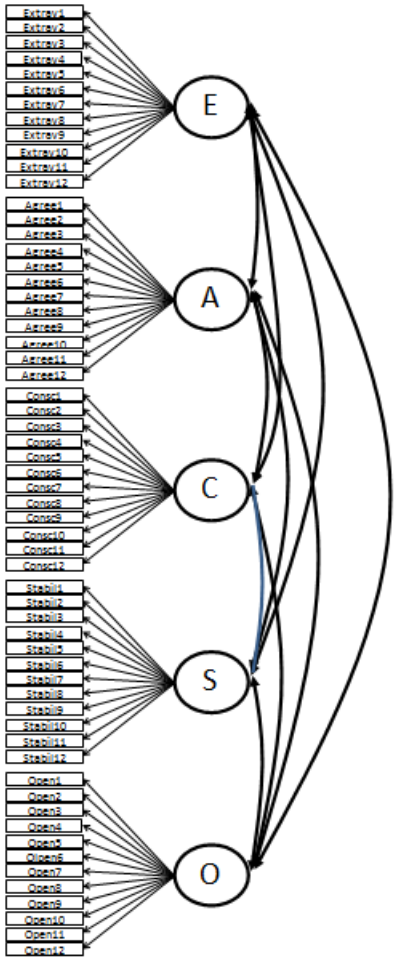
This presentation concerns the NEO-FFI questionnaire

Modeling Big 5 questionnaire data

The focus of this presentation is on factor analytic models of NEO-FFI item responses.

We model **item responses** as opposed to parcels or scale scores in the belief that averaging across items to create scales or parcels obscures what individual items can tell us about the persons responding to our questionnaire.

A “regular” CFA model of the NEO-FFI items



60 items

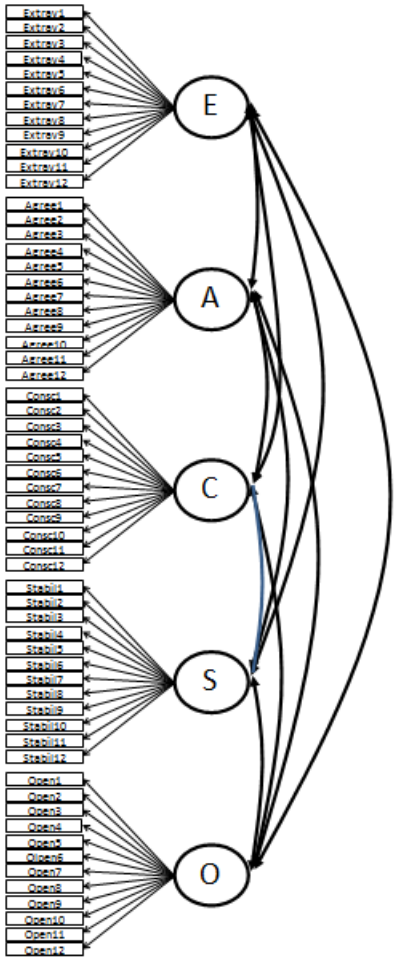
12 items per dimension

Neuroticism items have been reversed here and the dimension called Stability

Symbols representing residuals have been omitted.

Factors allowed to correlate.

More on the “regular” CFA

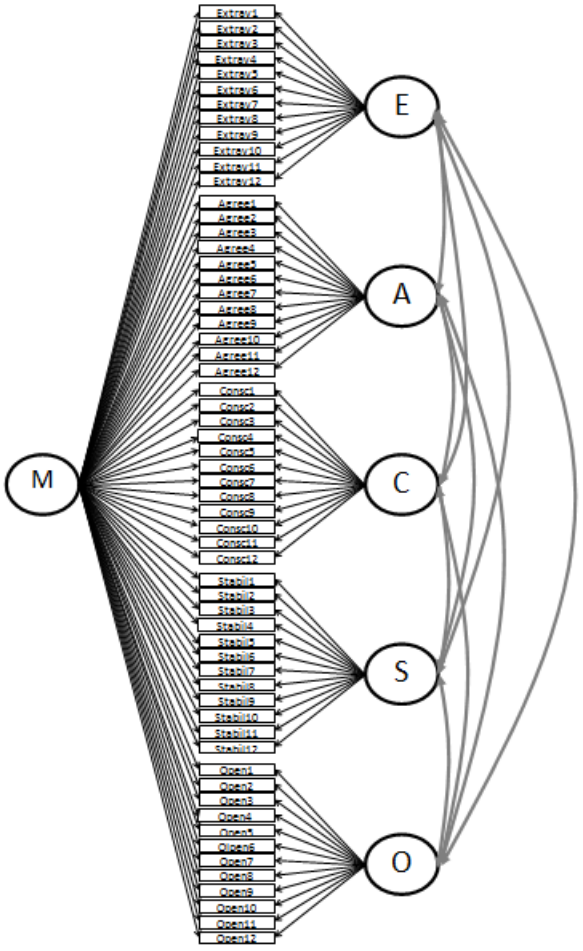


Each item is influenced by one characteristic

Interitem correlations are accounted for in the model by pathways through loadings and interfactor correlations.

Awkward to account for variance common to ALL the items in this model.

A bifactor CFA model of NEO-FFI items



Bifactor CFA model is a CFA model with an added general factor on which all items load.

General factor is estimated as orthogonal to the group factors representing the Big Five dimensions.

General factor is called M here because it's analogous to a method factor

Note: Individual differences in M lead to variance common to all items

Why a bifactor model?

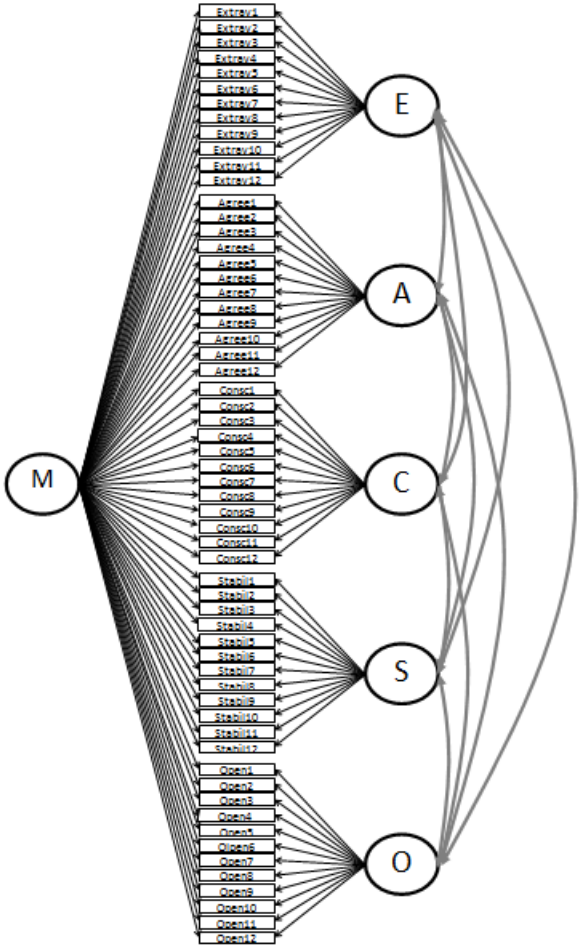
Impetus from attempts to model faking: Faking leads to systematic changes in responses to all items – common variance.

So a general factor was added to CFA models of faking data to account for the common variance associated with faking (Biderman & Nguyen, 2004).

Original belief was that there was little common variance in honest response conditions.

Surprise result –adding a general factor significantly increased goodness-of-fit to “honest response” data (Biderman, 2007).

Results of evaluations of bifactor CFA models



Biderman, Nguyen, Cunningham, & Ghorbhani (2011) found

1) Significant improvement in goodness-of-fit of CFA models of 5 IPIP-50 datasets

2) Significant improvement in goodness-of-fit of a CFA model to a single NEO-FFI dataset;

Bifactor CFA vs. regular CFA Comparison

Model	χ^2	df	CFI	TLI	RMSEA	SRMR
CFA	3223.910	1700	0.639	0.624	0.068	0.093
Bifactor CFA	2897.786	1640	0.702	0.679	0.063	0.075
Difference	326.124	60	0.063	0.055	0.005	0.018

Data from Biderman et al. (2011; Dataset 6). N=196.

Adding a general factor to a correlated factors CFA of the NEO-FFI yields significantly better goodness-of-fit.

Alternatives to bifactor models

The bifactor model accounts for correlations between items that are not easily accommodated through interfactor correlations.

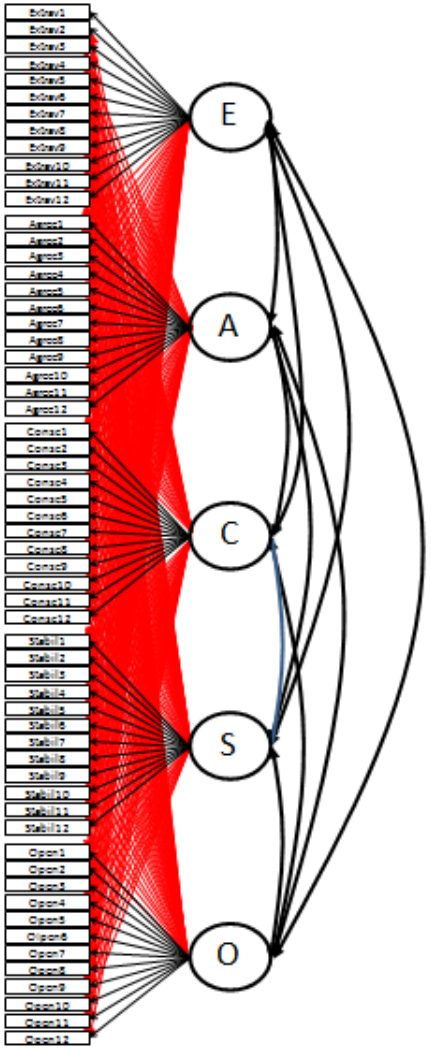
But perhaps there are other ways of accounting for correlations between items and common variance among them.

Perhaps we don’t need a general factor after all.

Please don’t take my baby from me!!

Hypotheses 1: What about an EFA model?

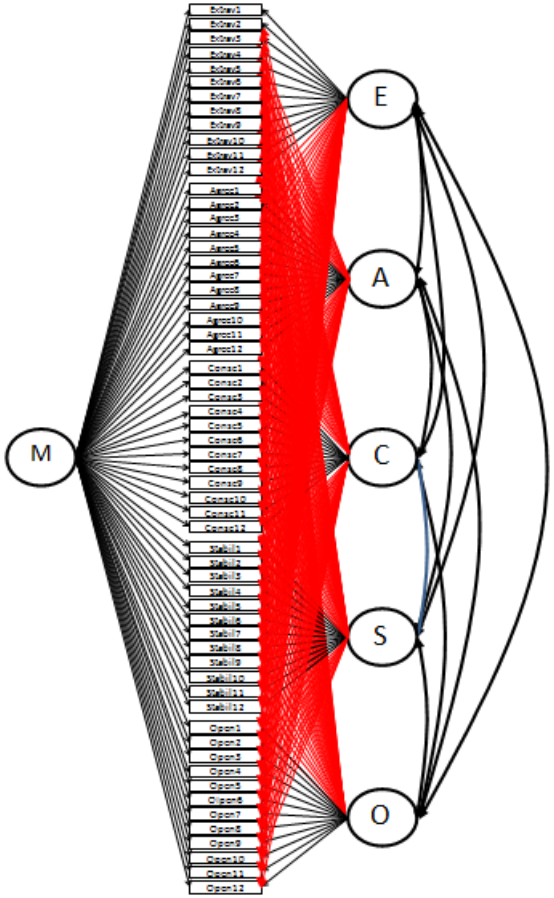
Perhaps cross loadings will remove the need for a general factor .



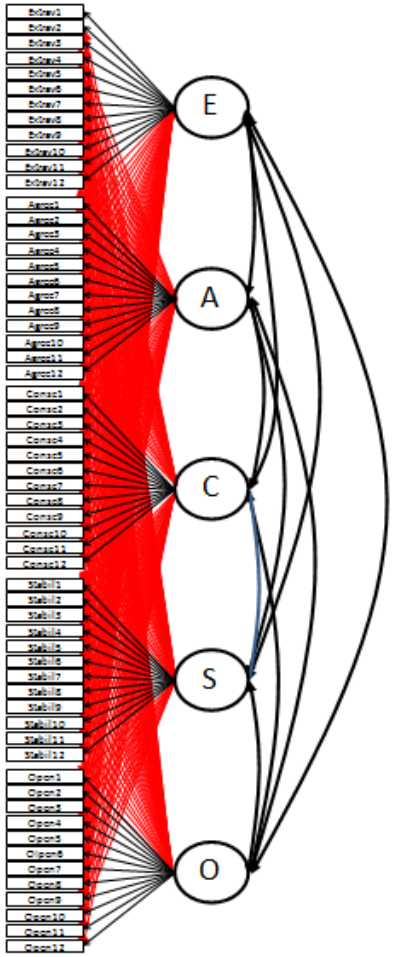
A path diagram of an EFA model. Red arrows represent cross loadings – all 5*48 = 240 of them.

Whew!!

The bifactor EFA model



The two models being compared.



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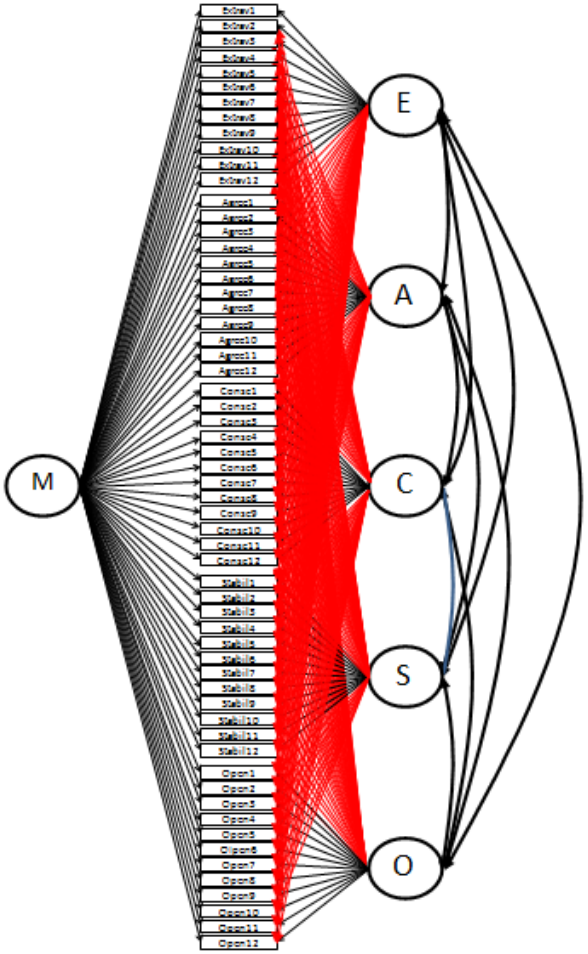


Model comparison details

Models were compared using Mplus V 7

Key to treating M as a general factor was

ROTATION = BI-GEOMIN(Oblique)

Bifactor EFA vs. regular EFA models

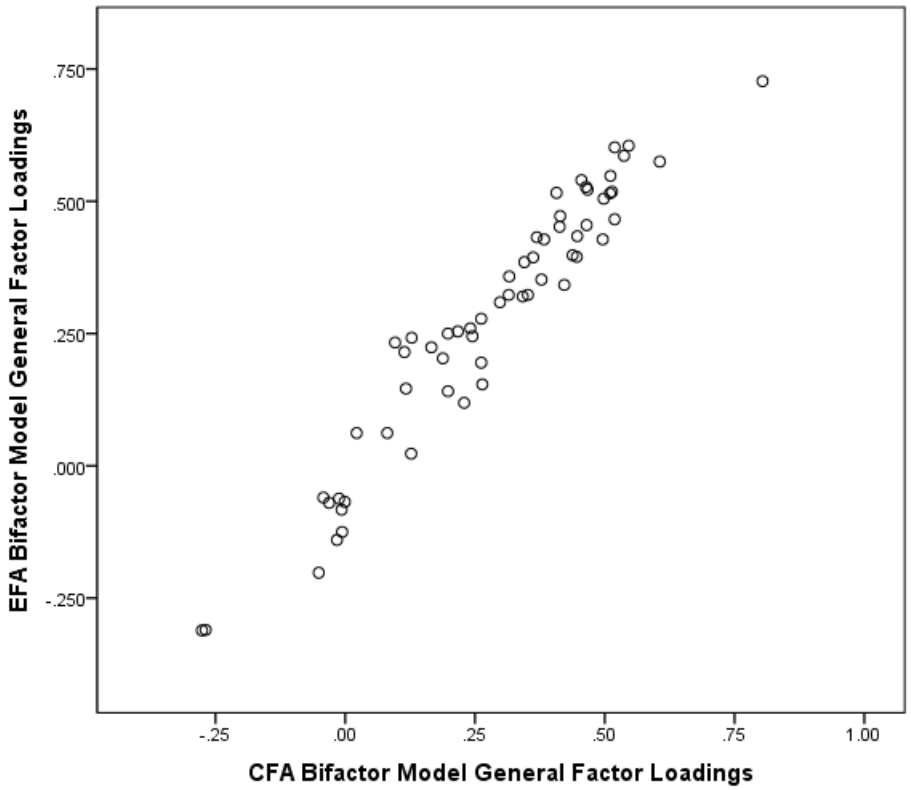
Model	χ^2	df	CFI	TLI	RMSEA	SRMR
EFA	2494.515	1480	0.760	0.713	0.059	0.051
Bifactor EFA	2327.143	1425	0.786	0.735	0.057	0.047
Difference	167.372	55	0.026	0.022	0.002	0.004

N=196

Adding a general factor to an EFA model of the NEO-FFI significantly improves goodness-of-fit.

Invariance of general factor Loadings

Just to confirm that the CFA general factor and the EFA general factor are the same. Pearson r = .966.



Alternative Hypotheses 2:

What about correlated residuals of selected pairs of items?

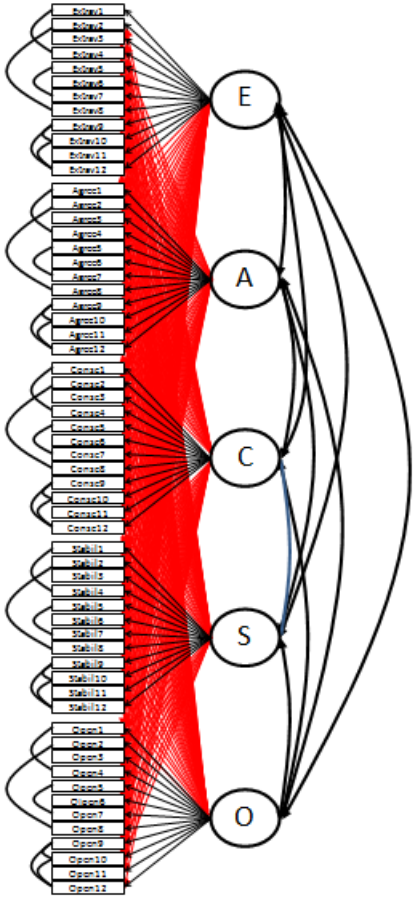
Perhaps the bifactor loadings are just poor substitutes for correlated residuals between certain pairs of items.

Argh: Which residuals should be allowed to be correlated?

Correlated residuals were estimated for 57 pairs of items identified by Marsh, Lüdtke, Muthén, Asparouhov, Morin, & Trautwein (2010) as representing identical facets.

The Mplus ESEM procedure was used, allowing the correlated residuals to be added to an EFA of the 60 NEO-FFI items.

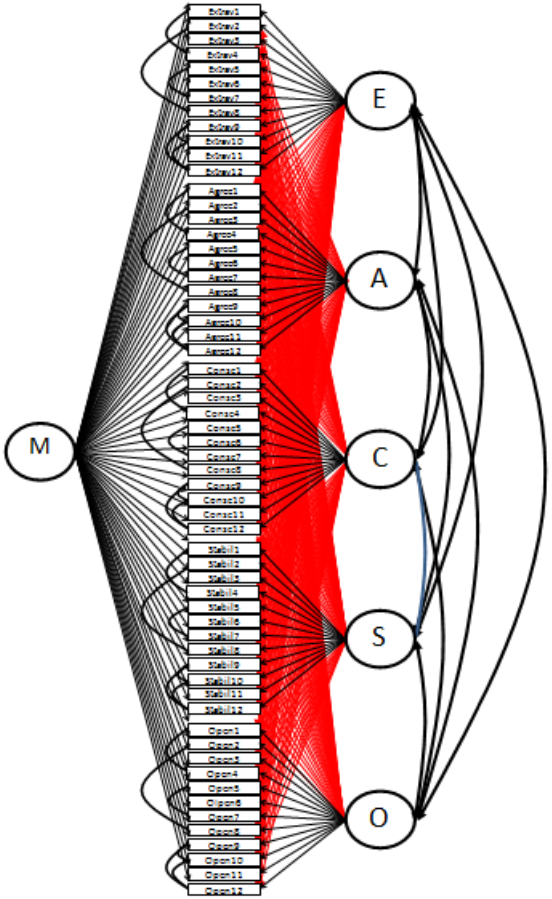
EFA model with correlated residuals



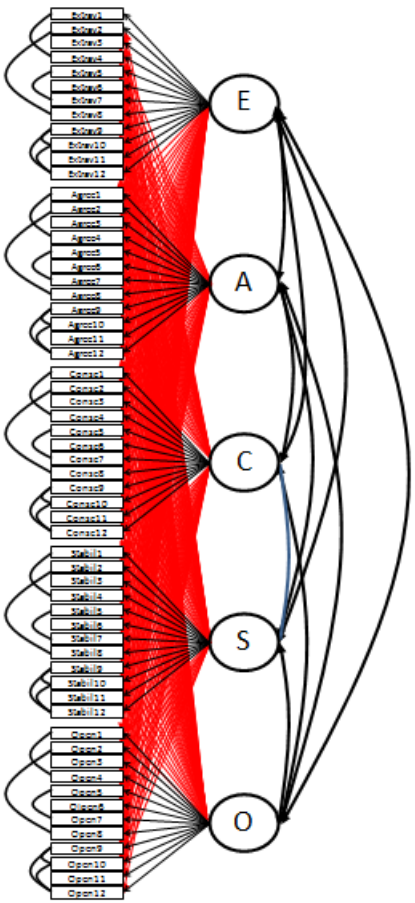
Note that all correlated residuals specified by Marsh et al. (2010) were within domains.

The path diagram shown here is schematic – not designed to depict the actual pairs of items whose residuals were correlated.

Bifactor EFA model with correlated residuals



Correlated residuals model comparison



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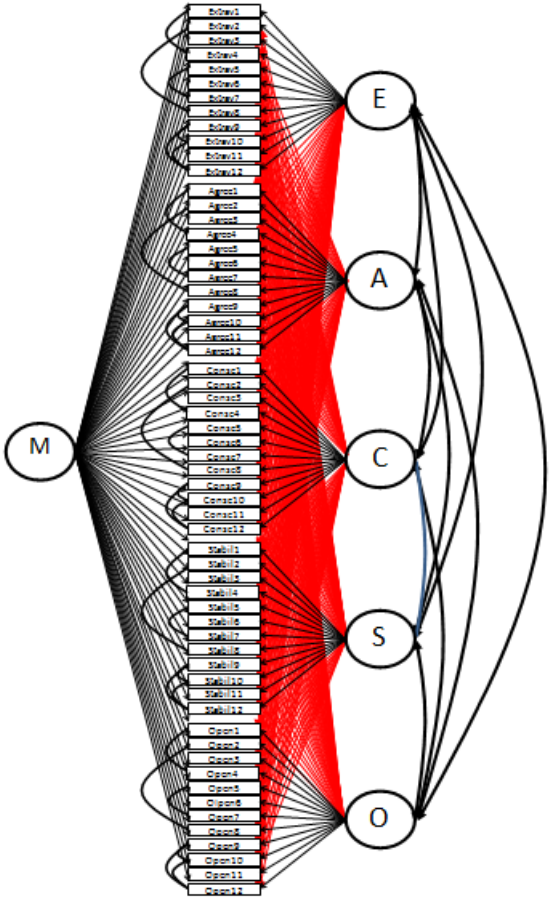


Correlated Residuals Models Comparison

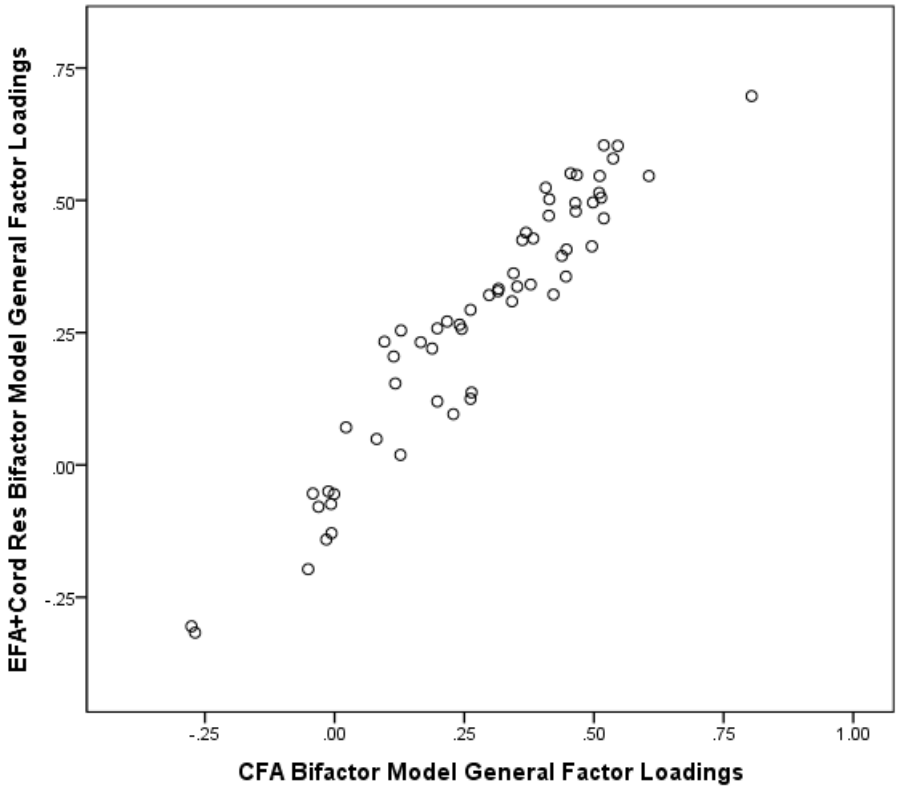
Model	χ^2	df	CFI	TLI	RMSEA	SRMR
Cor'd Res	2084.048	1423	0.843	0.805	0.049	0.047
Bifactor CR	1940.077	1368	0.865	0.825	0.046	0.044
Difference	143.971	55	0.022	0.020	0.003	0.003

N=196

Adding a general factor to a correlated residuals EFA of the NEO-FFI results in significant increase in goodness-of-fit.

Invariance of general factor loadings

Just to confirm that the CFA general factor and the EFA general factor are the same factor when the Marsh et al. (2010) residuals are allowed to be correlated. Pearson r = .955.



So What?

1. The general factor in Big Five models may represent a stable characteristic of personality.

It may represent a general expression of affective state.

Evidence: Correlations of general factor with measures of affect

Depression	NA	RSE	PA
-.486	-.249	+.461	+.622

Remember the general factor is orthogonal to the Big Five group factors, so these correlations cannot be attributed to Stability/Neuroticism.

So What - 2?

2. Regardless of what the general factor is, it's a contaminant and should be removed from Big Five measures

Unadjusted correlations of Big Five Scales with Depression

Ext	Agr	Con	Sta	Opn
-.581	-.290	-.219	-.441	-.063

Correlations after partialling the general factor

Ext	Agr	Con	Sta	Opn
-.404	-.165	-.005	-.420	.097

Conclusion

This presentation provided evidence for the utility of modeling Big Five items with a bifactor model.

The individual differences underlying the common variance may represent a personality characteristic worthy of study in its own right.

The removal of the effects of the general factor may yield useful results in characterizing the nomological net of Big Five factors.

References

Biderman, M. D., & Nguyen, N. T. (2004). Structural equation models of faking ability in repeated measures designs. Paper presented at the 19th Annual Society for Industrial and Organizational Psychology Conference, Chicago, IL.

Biderman, M. D. (2007). Method variance and big-five correlations. Paper presented at the 7th Annual Conference of the Association for Research in Personality, Memphis, TN, 2007, January 24, 2007.

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Marsh, H. W., Lüdtke, O., Muthén, B., Asparouhov, T., Morin, A. J. S., Trautwein, U., & Nagengast, B. (2010). A new look at the Big Five factor structure through exploratory structural equation modeling. *Psychological Assessment, 22,* 471-491.