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Sense of Direction and Spatial Strategies. A Bifactor Structure for the Spatial Strategies Questionnaire Fragebogen Räumliche Strategien

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GEO information

Introduction

- Global/Egocentric Frame of Reference (g/e): "comprises indicators of general ability and egocentric strategies which are based on knowledge of directions and knowledge of routes"
- Allocentric Frame of Reference (allo): "comprises indicators of mental map formation"
- Knowledge of Cardinal Directions (card): "comprises indicators of knowledge of cardinal directions" (p. 111)

- Sense of direction (SOD) can formally be defined as knowledge of the location and orientation of the body with respect to the large stationary objects, or landmarks, attached to the surface of the earth. (Sholl, 2000, p. 17)

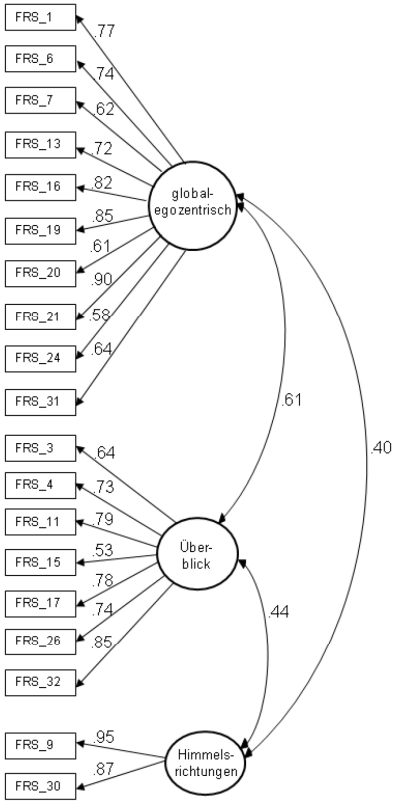

Abbildung 1. Ergebnis der konfirmatorischen Faktorenanalyse für die Modellierung räumlicher Strategien mit den Faktoren „Orientierung global/egozentrisch", „Überblick" und „Himmelsrichtungen". Die Wortlaute der Items können Tabelle 1 entnommen werden.

aus Münzer & Hölscher (2011). Entwicklung und Validierung eines Fragebogens zu räumlichen Strategien. Diagnostica, 57(3), 111-125

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Method

- GESIS panel (N = 4037)
- Checking measurement model fit: Bifactor analysis
- Bifactor or hierachical model: proportional constraint of the loadings
  Gignac (2016). The higher-order model imposes a proportionality constraint: That is why the bifactor model tends to fit better. Intelligence. 2016;55:57–68. doi:10.1016/j.intell.2016.01.006.

- Checking reliability, dimensionality and the use of scores
  - ω, ω_H, ω_{HS}
  - factor determinacy (FD)
  - construct reliability (H)
  - explained common variance (ECV)

  Rodriguez, Reise & Haviland (2016). Evaluating bifactor models: Calculating and interpreting statistical indices. Psychological Methods, 21(2), 137-150. doi:10.1037/met0000045

  - Proportional Reduction in MSE (PRMSE)
    Haberman (2008). When Can Subscores Have Value? Journal of Educational and Behavioral Statistics, 33(2), 204-229. doi:10.3102/1076998607302636.

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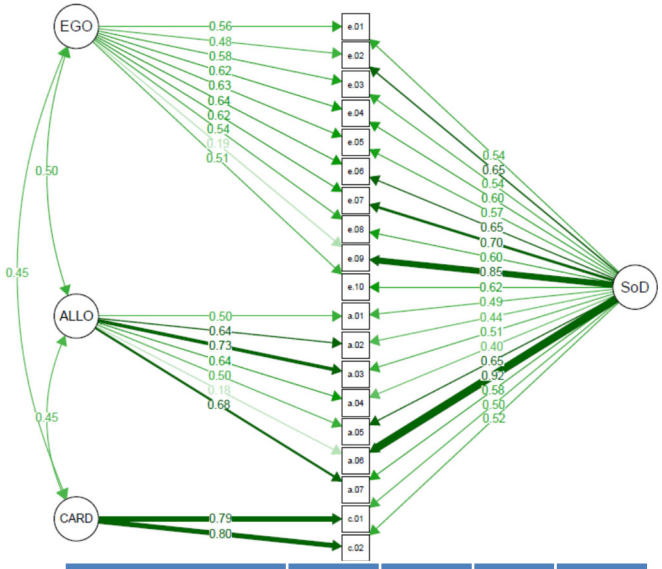
Results

$$CoV = 1.89$$

Model	X^2	df	p	RMSEA	90%-CI	SRMR	CFI	NNFI	TLI	aBIC
3-Factor	3932.98	149	.00	.10	[.09;.10]	.05	.92	.91	.91	238239
3-Factor (τ -equ.)	4975.00	165	.00	.10	[.10;.10]	.08	.91	.90	.90	239372
3-Factor (τ -par.)	6459.83	181	.00	.11	[.11;.11]	.08	.88	.88	.88	241331
2-Factor	7191.75	151	.00	.13	[.13;.13]	.07	.86	.84	.84	242903
1-Factor	11202.25	152	.00	.16	[.16;.17]	.08	.77	.74	.74	249195
Bi-Factor correl	1964.57	130	.00	.07	[.07;.07]	.03	.96	.95	.95	235425
Bi-Factor uncorrel	3534.44	133	.00	.08	[.08;.08]	.04	.95	.94	.94	236067

	SoD	ego	allo	card
ω	.98	.96	.93	.94
$\omega_{H(S)}$	.60	.40	.45	.67
FD	.95	.91	.91	.94
H	.94	.82	.80	.77
EVC	.51			



coefficient	ego	allo	card	SOD
# items	10	7	2	19
Mean	47.9	28.5	8.0	84.5
Var	196.3	115.8	14.9	665.1
SD	14.0	10.8	3.9	25.8
α	.96	.92	.94	.96
rX–SOD	.94	.90	.74	
rTX–TSOD	.96	.92	.77	
rTX–SOD	.94	.91	.76	
RMSE X	2.87	2.90	0.90	
RMSE SOD	4.66	4.36	2.45	
RMSE X+SOD	2.77	2.73	0.88	
PRMSE X	.96	.92	.94	
PRMSE SOD	.88	.82	.57	
PRMSE X+SOD	.96	.93	.94	

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Discussion

- Bifactor model with correlated subfactors with highest and at least the only proper fit
- High proportional constraint of the loadings (CoV): the bifactor solution is to preferred over a hierarchical model

- Two Items with high impact on SoD
  - Item ego.09: In my hometown, I can point quite accurately from any place towards prominent buildings and other points of interest.
  - Item allo.06: I have a very good mental representation of my hometown, as if it were shown on a map.

- High ω: definitely some reliable measurement of some kind of spatial strategies
- High FD and H: both, SoD and the subfactors give relevant information
- Low ECV and Haberman indices: just SoD let a lot information rest
- Mean ω_{H} and ω_{HS}: do not ignore the bifactor structure in using sumscores –

- use composite scores

With this digital poster presentation, we like to inform you about a reanalysis of the GESIS panel data of the Fragebogen Räumliche Strategien (FRS) with a bifactor tau congeneric measurement model.

As we start using the FRS we observed the high correlations of the three proposed spatial strategy factors “Allocentric Frame of Reference”, “Knowledge of Cardinal Directions” and “Egocentric Frame of Reference”, which is confounded with some kind of global score. As our original scope was the sense of direction we wanted to control these correlations in partial out the global variance by using a bifactor model.

We asked the GESIS for their panel data of 2014, and using 4037 questionnaire without missings. For the analysis and the assessment of the appropriateness we use the guidance of the paper of Rodriguez, Reise and Haviland as well as the idea of proportional reduction in the mean square error given by Haberman and the thoughts about proportional constraint of the loadings by Gignac. We do a lot more and deeper analysis which go beyond the scope of this two minute poster presentation but could read when we get the paper published.

Our reanalysis of the 3-factor tau congeneric model it shows a less proper fit as in the original analysis by Münzer and Hölscher for a correction of a bug in the lavaan algorithm after their publication. So, the standard bifactor model with uncorrelated subfactors fits the data better with acceptable indices but this restriction did not yield a positive definite variance-covariance matrix. With correlated subfactors the model fit become far better and all requirements were comply. We found high scores for omega total, factor determinacy and construct reliability H but mean scores for omegaH and HS as well as the explained common variance. There are high correlations of the subfactor sum scores with the general factor and just slightly differences in the proportional reduction in the mean square error using the subfactor or additional the general factor.

Model fit and proportional constrains argue for the bifactor model. We found two items which have a high impact on the general factor Sense of direction, and a lot of interesting effects for which here the space lacks. The high ω means you do with regards to reliability of each scale less wrong when using the summed score. But the high factor determinacy and construct reliability H give us the hint, that both, the general factor and the subfactors contain relevant information and the low explained common variance and the Haberman indices are to interpreted that using just the general score as sense of direction would let rest a lot information. The mean omega_H and omega_HS warns us not to ignore the bifactor structure in using just sumscores but – and that’s our main conclusion use the composite scores when consider all relevant information the FRS can give. Thanks.