Integrative data analysis: Realizing the potential of dataset pooling for developmental science research

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Why am I telling you about this?

- I'm not a methodologist (Chris is!), I just like using advanced methods!
- Especially when they help me get publications, funding…and do better science!

- Why do I think IDA has such potential for developmental science?

- Here is my life:

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Daniël Lakens 
@lakens

Following

The field of Developmental Psychology is entering the Replication Crisis. The small sample sizes typical in this field pose a real challenge. Developmental psycholoy will probably have to switch 100% to multi-site collaborative research projects to gain reliable knowledge.

RESEARCH ARTICLE

Estimating th
science

Open Science Collaboration

+ Author Affiliations

†Corresponding author. E-mail: r

Science 28 Aug 2015:
Vol. 349, Issue 6251,
DOI: 10.1126/science.aac4716

Mark Sabbagh @MarkSabbagh1
Special issue of Cognitive Development featuring peer-reviewed replication attempts of infant and toddler false belief work (and commentary from original authors) is now complete and online! sciencedirect.com/journal/cognit...

10:50 PM - 18 Sep 2018

71 Retweets **206** Likes

19 71 206

S

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- Even for simple correlation, need n = 250!

Journal of Research in Personality 47 (2013) 609–612

Contents lists available at SciVerse ScienceDirect

Journal of Research in Personality

journal homepage: www.elsevier.com/locate/jrp

Brief Report

At what sample size do correlations stabilize?

Felix D. Schönbrodt [a,*], Marco Perugini [b]

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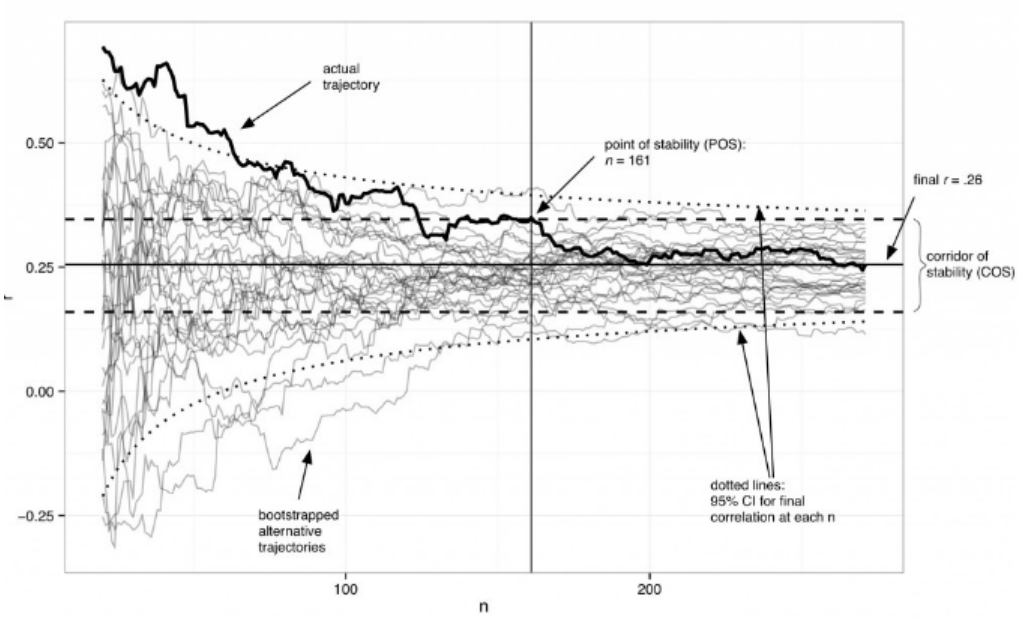

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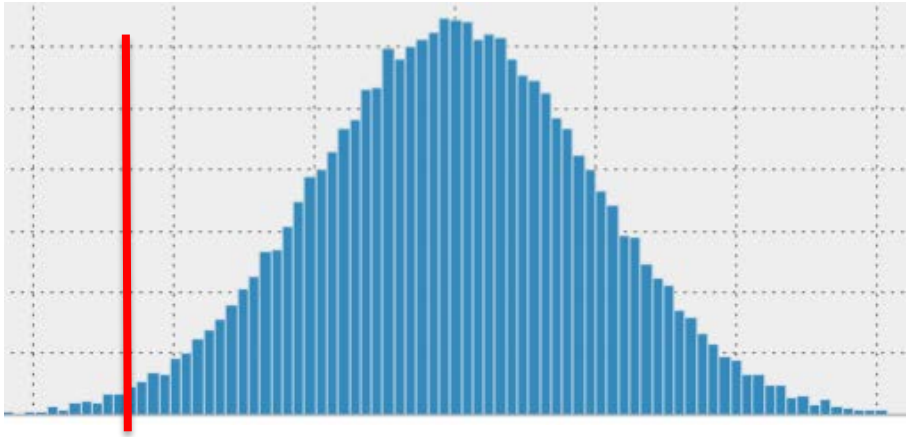
- Sample = 500!
  - Awesome!
  - Interested in tail?
    - Oops
    - N=small (e.g., 15%tile, n = 75)

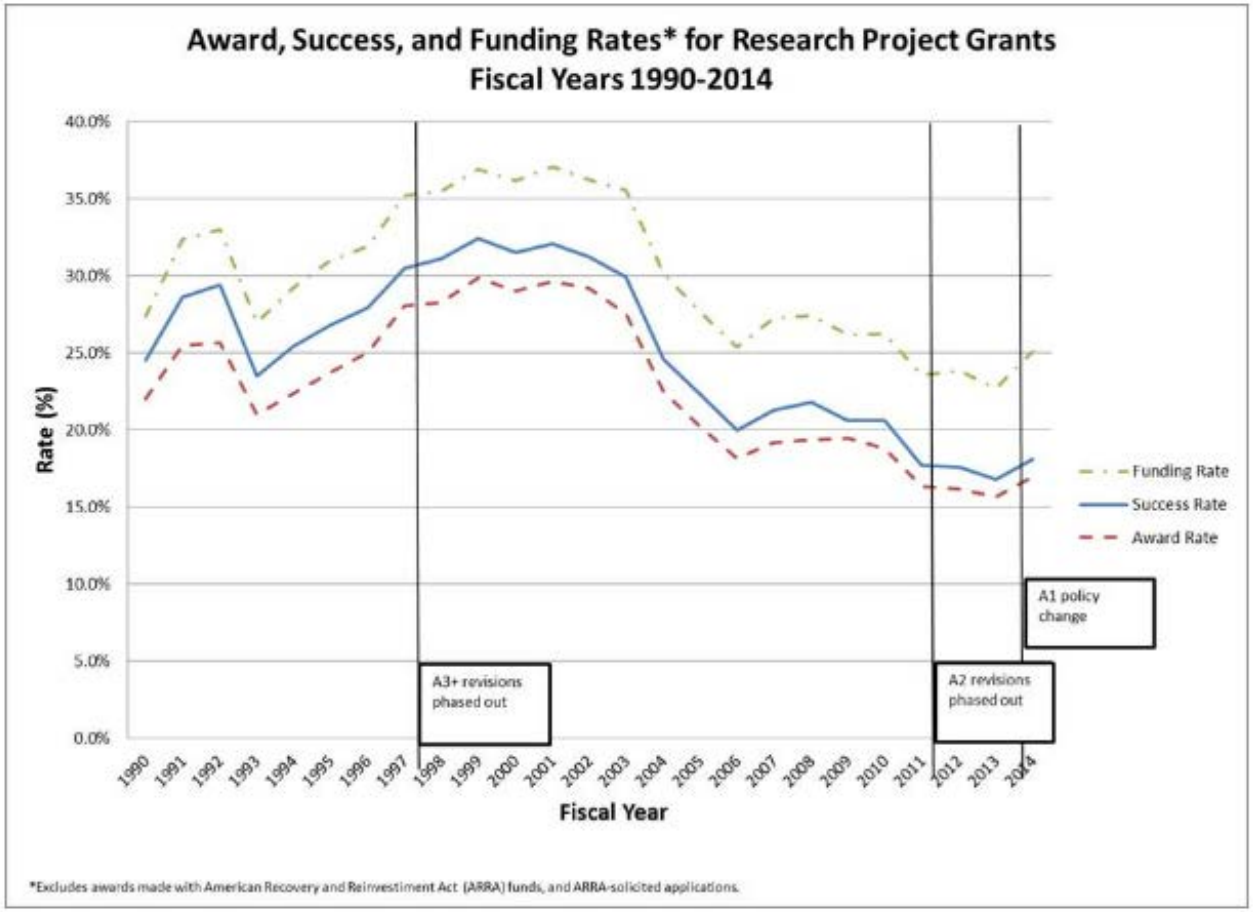


Rock Talk

Helping connect you with the NIH perspective

Posted on June 29, 2015 by Sally Rockey

What are the Chances of Getting Funded?



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INFANCY

THE OFFICIAL JOURNAL OF THE INTERNATIONAL CONGRESS OF INFANT STUDIES

Target Article | Free Access

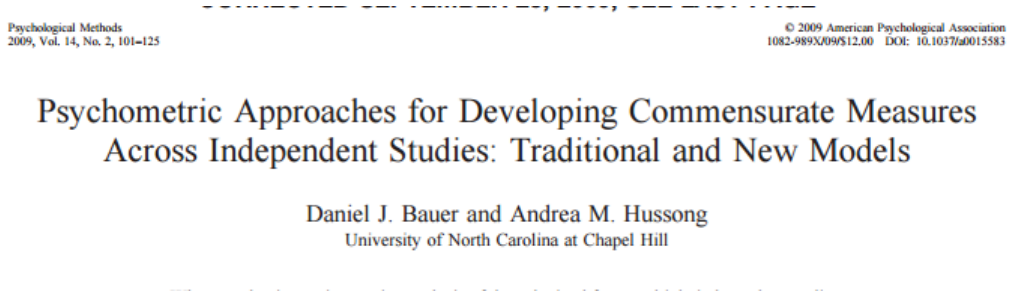
A Collaborative Approach to Infant Research: Promoting Reproducibility, Best Practices, and Theory-Building

Michael C. Frank, Elika Bergelson, Christina Bergmann, Alejandrina Cristia, Caroline Floccia, Judit Gervain, J. Kiley Hamlin, Erin E. Hannon, Melissa Kline, Claartje Levelt ... See all authors

First published: 09 March 2017 | https://doi.org/10.1111/infa.12182 | Cited by: 20

Integrative Data Analysis (IDA)

- Capitalizes on cumulative knowledge
  - Increased statistical power
  - Increased demographic representativeness
  - Increased absolute numbers in tails
  - More generalizable findings
  - Longer developmental time span
  - Broader assessment potential
  - Increased modeling potential
  - Cheaper



Psychological Methods
2009, Vol. 14, No. 2, 101–125

1082-989X/09/$12.00 DOI: 10.1037/a0015583

Psychometric Approaches for Developing Commensurate Measures Across Independent Studies: Traditional and New Models

Daniel J. Bauer and Andrea M. Hussong
University of North Carolina at Chapel Hill

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Integrative Data Analysis (IDA)

- Only need squintably close data
  - Can use harmonization techniques to bring together closely related items
  - Only need some common items (really, one as the minimum), and then can deal with missing data across uncommon items
- Controls for heterogeneity
  - Sampling, age/grade, cohort, geographical, design, measurement, etc
    - Can be on any/mixed scale
- You can't just slam data together!


Psychological Methods
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1082-989X/09/$12.00 DOI: 10.1037/a0015583

Psychometric Approaches for Developing Commensurate Measures Across Independent Studies: Traditional and New Models

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IDA in practice

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Integrative Data Analysis

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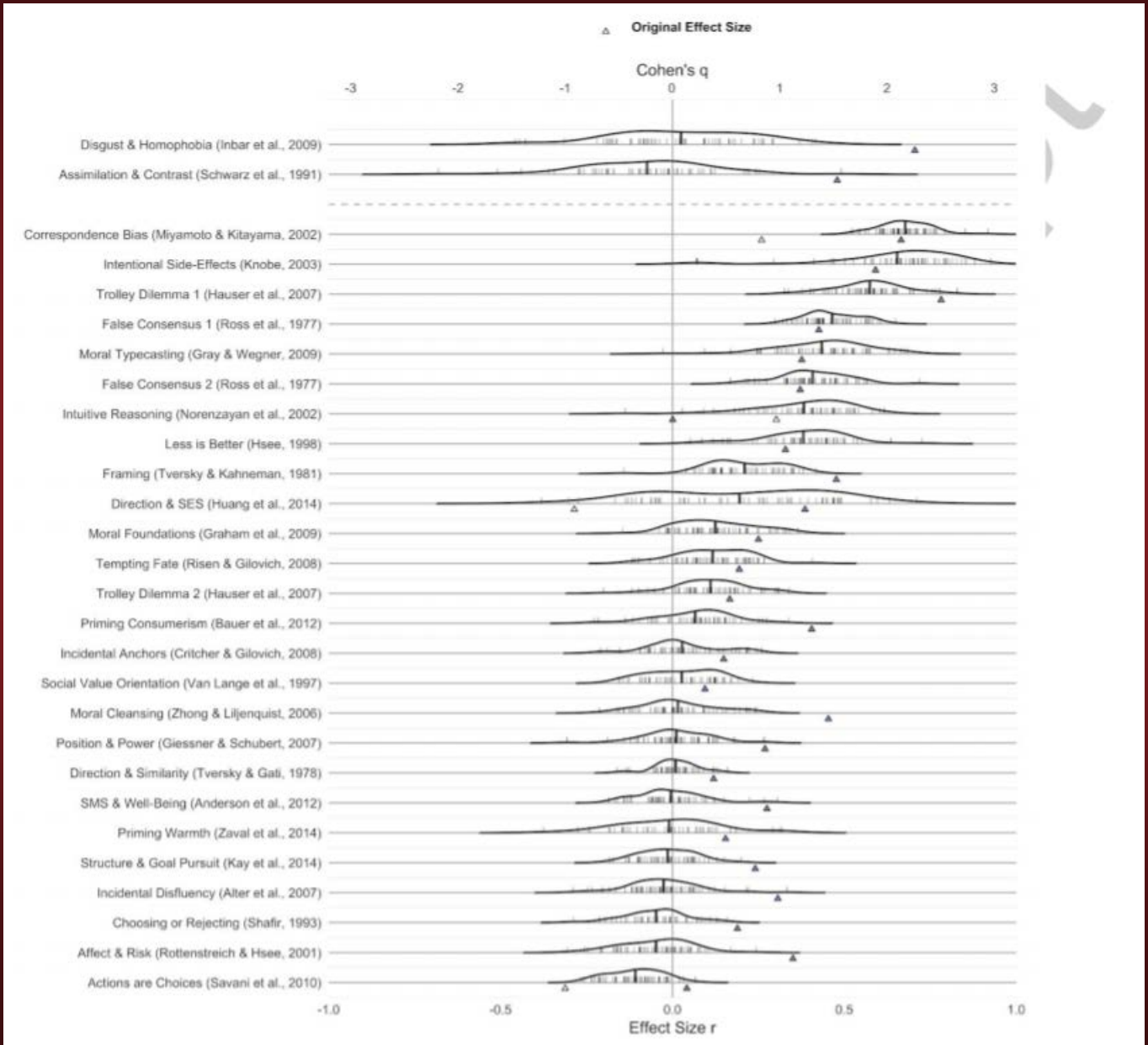
Cumulative Nature of Science

- Growing acknowledgement that science needs to move from just single sample studies to a synthesis of findings from drawn from multiple studies (Curran, 2007).
- No single study should decide an issue.
- Typically more confident in research findings if it is replicated across settings, measures, and conditions.

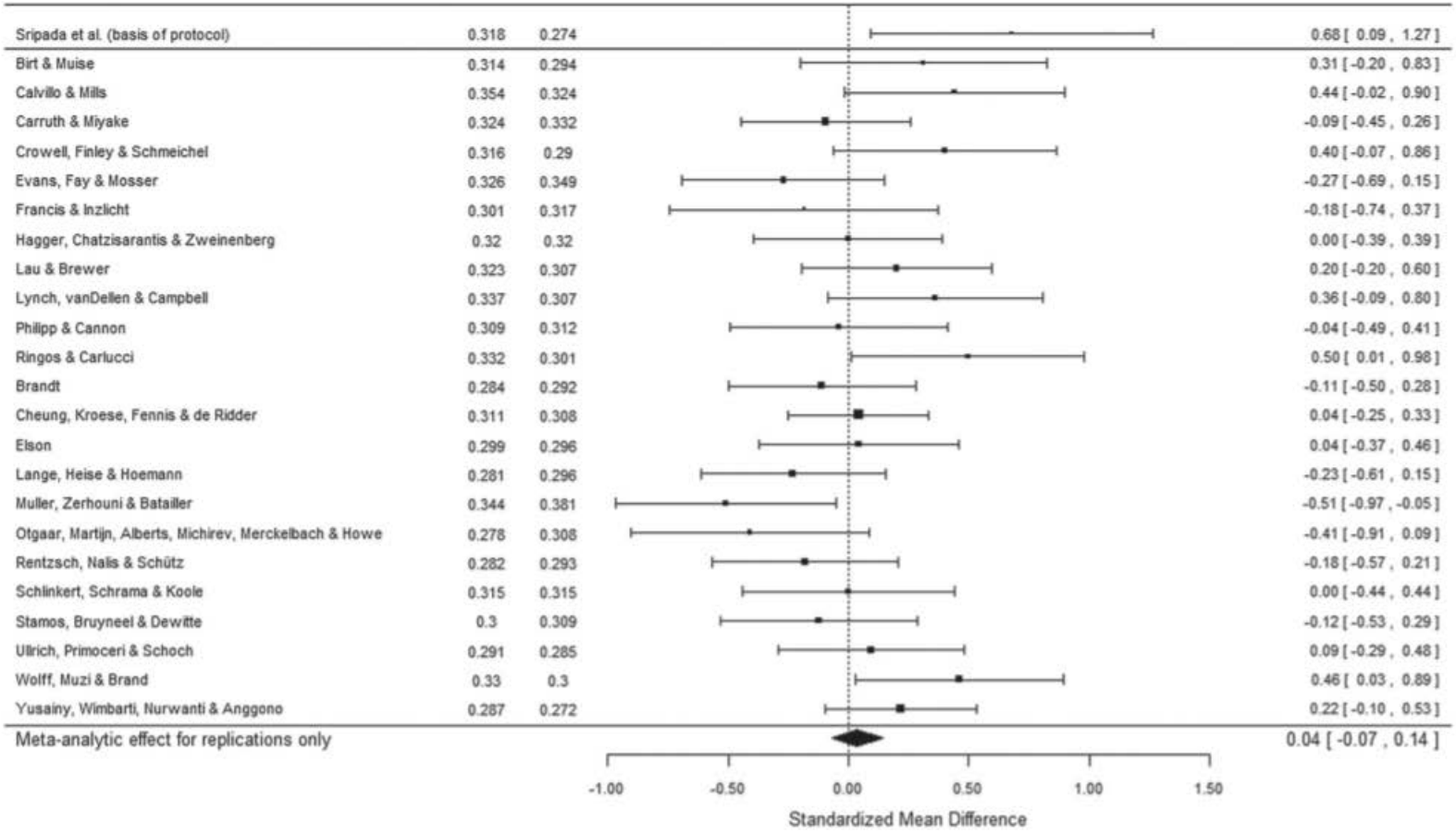
Replication

- Ionedis (2005) Why Most Published Research Findings Are False.
  - Low power
  - Small effects
  - Publication bias
  - P-hacking
  - HARKing

Replication



Replication



What's the solution?

- The problem is multifaceted, and the solution will also be multifaceted
  - Preregistration
  - Lower the incentive to only publish significant results
  - Replication
  - Aggregation of data

Meta-Analysis

- Combines the results of other published (or unpublished) studies all focused on a particular topic.
- Effect size estimates are computed per study – and these estimates become the "participants" in the analyses.

Integrative Data Analysis (IDA)

- Integrative Data Analysis (IDA), or individual participant data meta-analysis (IDP meta-analysis) uses the original "source data" from multiple studies to answer research questions.

Aggregating Results – Meta Analysis versus IDA (Cooper and Patall, 2009)

- Benefits of IDA
  - Can perform subgroup analyses that were not conducted by original investigators
  - Can check data and results from original studies
  - Can perform more complex analyses more easily
  - Can add new information into the datasets
  - Tests of moderation are more powerful than used in meta-analysis (Lambert et al, 2002)
  - Can test for both between studies and within studies moderators.

Aggregating Results – Meta Analysis versus IDA (Cooper and Patall, 2009)

- More benefits of IDA
  - Can combine datasets together to answer longitudinal growth questions
  - Can create latent variables even if not all studies have the same observed variables

Aggregating Results – Meta Analysis versus IDA (Cooper and Patall, 2009)

- Benefits of meta-analysis
  - Can be conducted at less cost (in both money and time)
  - Can be carried out faster
  - Can include group level statistics when individual data is not available
    - May diminish bias by included all available studies (even studies where original data is unavailable)
    - May increase power (by including studies where original data are not available)

Not necessarily one of the other

- The Cocharan Collaboration (Stewart & Clarke, 1995) recommend that as a first step, one would want to do a regular meta-analysis before doing an IDA.
- One benefit of doing both would be to see if the studies with available data for IDA were systematically different from those studies where only the published results were available.

Issues

- The same issues that are important in meta-analysis also apply to IDA.
  - Identifying sources of between-study heterogeneity due to:.
    - Sampling (fixed or random effects)
    - Geography
    - History
    - Other design features

Measurement Issues

- Measurements
  - In meta-analysis, the measures used are converted to standardized effect sizes
  - In IDA, more attention can be to be paid to measurement
    - Even if all the studies pooled together use the same measures, its still possible that the measures will not be invariant across studies.
    - If the same measures are not used, then the issue gets even murkier.

Attention, Hyperactivity and Reading Ability: An example of IDA

- To provide a demonstration of IDA, we pooled together 7 studies that collected data on attention, hyperactivity, and reading.
- All 7 datasets used the SWAN as a measure of attention/hyperactivity and 6 of the 7 have Woodcock Word ID.
- In these datasets, we coded the SWAN such that higher scores mean you have better attention and are less hyperactive/impulsive.

Samples

	Ages											
	6	7	8	9	10	11	12	13	14	15	16	total
Site 1	359	119	1	0	0	0	0	0	0	0	0	479
Site 2	0	459	0	0	0	0	0	0	0	0	0	459
Site 3	299	39	1	0	0	0	0	0	0	0	0	339
Site 4	0	0	0	1274	0	0	0	0	0	0	0	1274
Site 5	0	1	7	47	35	32	5	0	0	0	0	127
Site 6	0	0	0	1	175	510	551	447	75	12	0	1771
Site 7	0	0	938	0	0	0	0	0	0	0	0	938
												5387

Steps in the Measurement Model for Attention and Hyperactivity

1) Test for dimensionality
2) Calibration - fit an unconditional IRT model to pooled data
3) Test for DIF by site (and other potential predictors)
4) Create IRT based scores for all participants.

Dimensionality

- Conducted an exploratory factor analysis for ordered categories in R for each dataset.
- Inspected eigenvalues and percent variance accounted for in the covariance matrices by factor.

Eigenvalues

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7	
Items	Value	Percent	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Eigenvalue 1	12.64	70.22%	13.88	77.10%	12.64	70.2%	11.44	63.5%	14.36	79.7%	10.56	58.6%	8.66	48.1%
Eigenvalue 2	1.21	6.71%	1.35	7.48%	1.21	6.71%	1.49	8.27%	1.36	7.56%	1.33	7.40%	0.71	3.92%
Eigenvalue 3	0.23	1.27%	0.14	0.79%	0.23	1.27%	0.11	0.59%	0.09	0.48%	0.35	1.95%	0.17	0.96%
Eigenvalue 4	0.04	0.21%	0.04	0.23%	0.04	0.21%	0.03	0.14%	0.05	0.26%	0.17	0.95%	0.13	0.70%
Correlations	.75		.78		.73		.70		.78		.70		.72	

Factor Loadings across Datasets

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7	
Items	Hyp	Att	Hyp	Att	Hyp	Att	Hyp	Att	Hyp	Att	Hyp	Att	Hyp	Att
Close attention detail		.98		.93		.94		.93		.95		.81		.89
Sustain attention		.92		.88		.84		.88		.85		.78		.62
Listen		.72		.66		.67		.73		.70		.62		.51
Follow-through		.99		.95		.95		.95		.99		.81		.75
Organize tasks		.90		.97		.94		.95		.99		.94		.96
Sustained mental effort		.96		1.00		1.00		.96		.97		.77		.71
Keeps track of things		.87		.88		.88		.85		.92		.86		.87
Ignore stimuli	.40	.56	.34	.63	.36	.57	.44	.52	.47	.48	.27	.69	.39	.42
Daily activities		.83		.81		.72		.77		.81		.82		.85
Sit still	.84		.83		.71		.89		.93		.71		.59	
Stay seated	.78		.81		.67		.83		.86		.78		.61	
Modulate motor activity	.91		.97		.98		.99		1.00		.94		.47	
Play quietly	.94		.94		.90		.90		1.00		.88		.84	
Settle down	.96		.96		.95		.97		.96		.86		.86	
Modulate verbal activity	.97		.94		.93		.83		.86		.48		1.00	
Reflect on questions	.93		.95		.95		.92		.94		.83		.94	
Await turn	.93		.90		.81		.88		.85		.74		.87	
Controls interrupting	.84		.83		.71		.89		.93		.71		.84	

Interesting patterns

- Item 3 – “Listen when spoken to directly” consistently has the lowest loading on attention (for the items that are supposed to tap attention)
- Item 8 – “Ignore extraneous stimuli” consistently crossloads on hyperactivity

Calibration

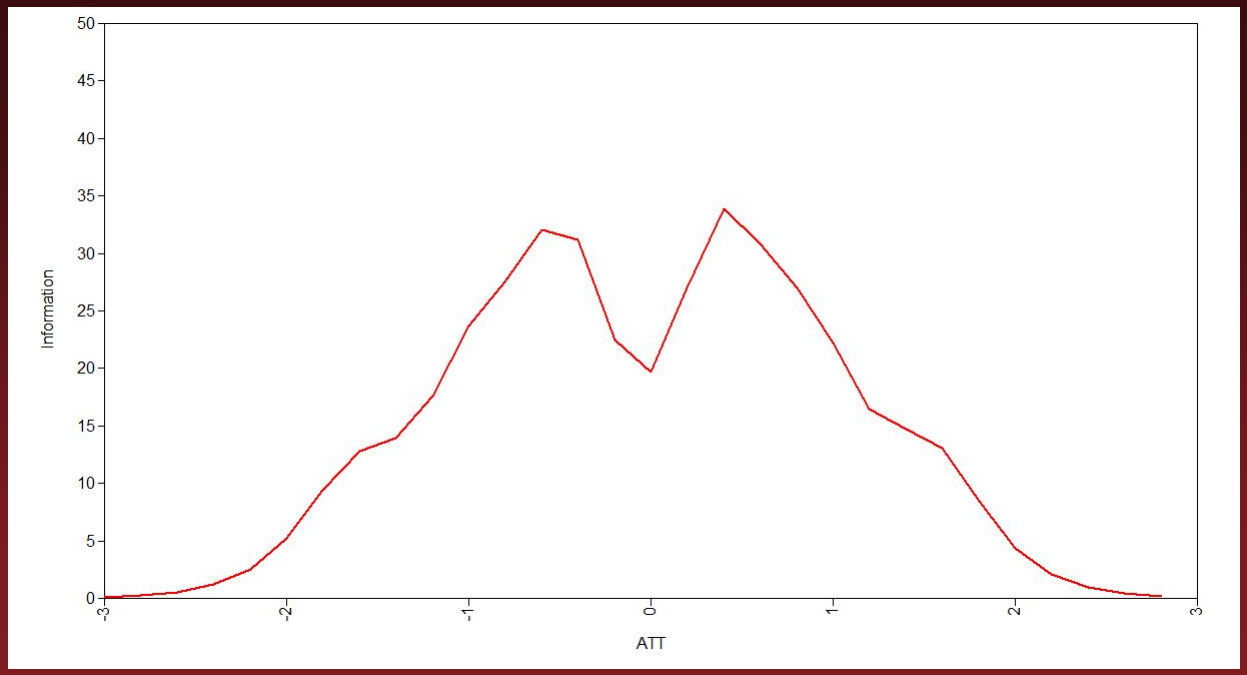
- I fit a unconditional graded response model to the pooled dataset.
  - Gives us an idea about how the item discrimination and threshold parameters will look on average before we look for potential differences across sites.

Proportion Endorsed by Category

Item	Far Below	Below	S. Below	Ave	S. Above	Above	Far Above
Close attention detail	.05	.11	.16	.31	.16	.16	.06
Sustain attention	.04	.10	.13	.34	.16	.16	.06
Listen	.03	.08	.12	.42	.16	.13	.06
Follow-through instructions	.05	.10	.15	.33	.17	.14	.08
Organize tasks	.05	.09	.14	.36	.16	.13	.07
Sustained mental effort	.05	.10	.15	.32	.17	.14	.08
Keeps track of things	.04	.08	.14	.38	.16	.12	.07
Ignore stimuli	.05	.10	.15	.36	.15	.12	.07
Daily activities	.03	.07	.12	.43	.16	.12	.06
Sit still	.05	.09	.14	.37	.14	.13	.08
Stay seated	.05	.08	.13	.38	.14	.13	.09
Modulate motor activity	.04	.07	.11	.45	.13	.12	.08
Play quietly	.04	.08	.13	.41	.14	.13	.07
Settle down	.05	.08	.13	.41	.14	.13	.07
Modulate verbal activity	.05	.08	.15	.37	.16	.13	.08
Relfect on questions	.05	.08	.13	.39	.16	.12	.08
Await turn	.05	.07	.11	.43	.15	.13	.08
Controls interrupting	.04	.08	.13	.43	.14	.11	.07

IRT Discrimination and Thresholds

		Thresholds					
Item Content Summary	Discrim	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7
Close attention to detail	2.32	-1.80	-1.06	-0.49	0.33	0.85	1.74
Sustain attention on tasks	3.15	-1.82	-1.09	-0.59	0.30	0.79	1.59
Listen	2.17	-2.02	-1.30	-0.76	0.41	0.96	1.74
Follow-through on Instruction	3.28	-1.71	-1.08	-0.53	0.30	0.80	1.49
Organize tasks	3.35	-1.76	-1.11	-0.56	0.35	0.86	1.55
Sustained mental effort	2.71	-1.76	-1.09	-0.54	0.29	0.83	1.49
Keeps track of things	3.00	-1.84	-1.19	-0.62	0.38	0.91	1.58
Ignore extraneous stimuli	1.82	-1.93	-1.16	-0.55	0.45	1.00	1.72
Remember daily activities	2.38	-2.04	-1.32	-0.77	0.42	0.96	1.66
Sit still	3.00	-1.73	-1.11	-0.58	0.36	0.82	1.50
Stay seated	3.37	-1.73	-1.12	-0.61	0.33	0.77	1.43
Modulate motor activity	2.48	-1.86	-1.24	-0.74	0.43	0.88	1.55
Play quietly	3.52	-1.80	-1.18	-0.66	0.37	0.84	1.52
Settle down	4.56	-1.74	-1.14	-0.62	0.36	0.81	1.48
Modulate verbal activity	2.45	-1.81	-1.15	-0.59	0.35	0.87	1.56
Relfect on questions	2.31	-1.83	-1.18	-0.65	0.35	0.87	1.55
Await turn	2.88	-1.79	-1.20	-0.74	0.36	0.83	1.49
Controls interrupting conversations	2.46	-1.87	-1.20	-0.67	0.45	0.94	1.58


Information
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-2
-1
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1
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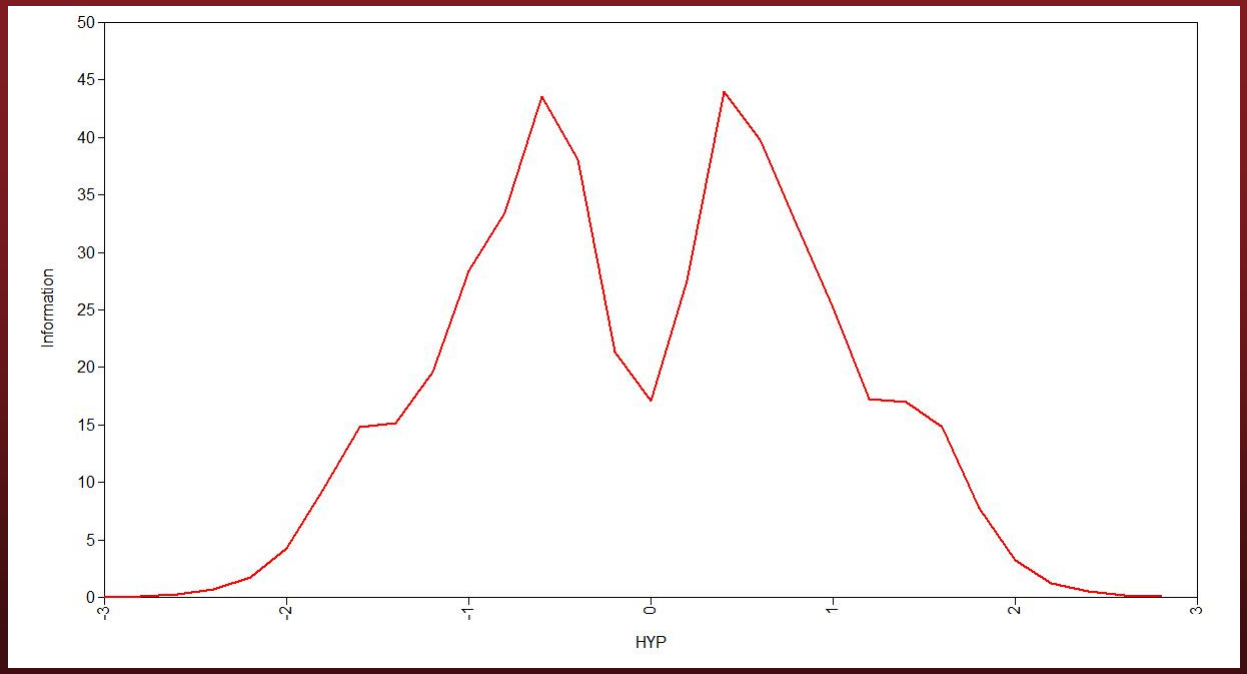
3
ATT


Information
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HYP

DIF Analyses?

- Some type of DIF analysis needs to be conducted to see of these parameters are consistent across site.
- Initially I wanted to model a multi-group multi-dimensional IRT – but I was unable to fit this model due to some projects missing some levels to some items
- So I shifted gears and moved to multi-group CFA and used measurement invariance modeling.

Measurement Invariance Modeling

- Configural invariance. This implies that the groups have the same number of latent factors and the same items/subscales load on the same factors.
- Weak/metric invariance. This states that the factor loadings are the same across groups
- Strong/scalar invariance. This states that the loadings and intercepts are the the same across groups
- Strict invariance. This implies that the loadings, intercepts, and error variances are the same across groups. There is some argument as to whether this is even meaningful or not because it can be considered odd to expect the same amount of error from sample to sample.

Configural Invariance

- Configural Invariance – this is your base model. It's a multigroup CFA where the same model is fit across all projects, but none of the parameters are constrained to be equal.

R

- R has a number of different packages that will help in measurement invariance modelling
  - lavaan
  - measurementInvariance
  - partialInvariance
- I will show you how the “sausage is made” after the powerpoint presentation.

Measurement Invariance Results

```
Measurement invariance models:

Model 1 : fit.configural
Model 2 : fit.loadings
Model 3 : fit.intercepts
Model 4 : fit.means

Chi Square Difference Test

                Df    AIC    BIC Chisq Chisq diff Df diff Pr(>Chisq)
fit.configural  938 207568 210095 11827
fit.loadings   1034 207813 209710 12264      436.7      96  < 2.2e-16 ***
fit.intercepts 1130 211393 212660 16036     3772.0      96  < 2.2e-16 ***
fit.means      1142 211769 212957 16436      400.2      12  < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Fit measures:

                cfi rmsea cfi.delta rmsea.delta
fit.configural 0.922 0.125        NA          NA
fit.loadings   0.919 0.120     0.002       0.004
fit.intercepts 0.893 0.133     0.026       0.012
fit.means      0.890 0.134     0.003       0.001
```

Partial Weak invariance?

- We do not have full weak invariance
- We can try and establish partial weak invariance.
  - We can do this in one of two ways.
    - Build up – we leave all loadings unconstrained and start constraining one at a time
    - Tear down – we constrain all loadings and then unconstrain one at a time.

Build Up

```
> round(weakpartial$results,4)
         free.chi free.df free.p free.cfi fix.chi fix.df  fix.p fix.cfi wald.chi wald.df wald.p
ATT=~a1    8.1811       6 0.2251    0e+00  4.9257      6 0.5534    0e+00   4.7382       6 0.5778
ATT=~a2   11.9598       6 0.0629    0e+00  4.9257      6 0.5534    0e+00   5.0792       6 0.5337
ATT=~a3   35.6874       6 0.0000   -2e-04 20.7127      6 0.0021   -1e-04  21.9223       6 0.0013
ATT=~a4   22.8192       6 0.0009   -1e-04 10.3324      6 0.1113    0e+00  11.0756       6 0.0861
ATT=~a5    9.6085       6 0.1421    0e+00  3.9264      6 0.6866    0e+00   3.7869       6 0.7055
ATT=~a6    6.5509       6 0.3644    0e+00  5.3957      6 0.4942    0e+00   5.4620       6 0.4861
ATT=~a7   23.2852       6 0.0007   -1e-04 19.0069      6 0.0042   -1e-04  19.4814       6 0.0034
ATT=~a8   25.4930       6 0.0003   -1e-04 21.4735      6 0.0015   -1e-04  22.4388       6 0.0010
ATT=~a9   38.2887       6 0.0000   -2e-04 30.1789      6 0.0000   -2e-04  32.9777       6 0.0000
HYP=~a10  46.1955       6 0.0000   -3e-04  0.9400      6 0.9878    0e+00   0.9247       6 0.9883
HYP=~a11  46.5279       6 0.0000   -3e-04  0.9400      6 0.9878    0e+00   0.9246       6 0.9883
HYP=~a12  23.1289       6 0.0008   -1e-04 19.9035      6 0.0029   -1e-04  20.7653       6 0.0020
HYP=~a13  33.2635       6 0.0000   -2e-04 62.1612      6 0.0000   -4e-04  67.4634       6 0.0000
HYP=~a14  13.0239       6 0.0427   -1e-04 28.1301      6 0.0001   -2e-04  28.7232       6 0.0001
HYP=~a15  27.4275       6 0.0001   -2e-04 59.6200      6 0.0000   -4e-04  66.6400       6 0.0000
HYP=~a16  68.1034       6 0.0000   -4e-04 90.1196      6 0.0000   -6e-04 105.3880       6 0.0000
HYP=~a17   4.9608       6 0.5488    0e+00 29.2128      6 0.0001   -2e-04  30.5444       6 0.0000
HYP=~a18  33.3493       6 0.0000   -2e-04 67.0591      6 0.0000   -4e-04  72.8190       6 0.0000
```

Iterative Build Up – Round 2

```
> round(weakpartial1$results,4)
          free.chi free.df free.p free.cfi fix.chi fix.df  fix.p fix.cfi wald.chi wald.df wald.p
HYP=~a11   46.5279       6 0.0000   -3e-04  0.9400      6 0.9878   0e+00   0.9246       6 0.9883
HYP=~a12   23.1289       6 0.0008   -1e-04 19.9035      6 0.0029   -1e-04  20.7653       6 0.0020
HYP=~a13   33.2635       6 0.0000   -2e-04 62.1612      6 0.0000   -4e-04  67.4634       6 0.0000
HYP=~a14   13.0239       6 0.0427   -1e-04 28.1301      6 0.0001   -2e-04  28.7232       6 0.0001
HYP=~a15   27.4275       6 0.0001   -2e-04 59.6200      6 0.0000   -4e-04  66.6400       6 0.0000
HYP=~a16   68.1034       6 0.0000   -4e-04 90.1196      6 0.0000   -6e-04 105.3880       6 0.0000
HYP=~a17    4.9608       6 0.5488    0e+00 29.2128      6 0.0001   -2e-04  30.5444       6 0.0000
HYP=~a18   33.3493       6 0.0000   -2e-04 67.0591      6 0.0000   -4e-04  72.8190       6 0.0000
ATT=~a1     8.1811       6 0.2251    0e+00  4.9257      6 0.5534    0e+00   4.7382       6 0.5778
ATT=~a2    11.9598       6 0.0629    0e+00  4.9257      6 0.5534    0e+00   5.0792       6 0.5337
ATT=~a3    35.6874       6 0.0000   -2e-04 20.7127      6 0.0021   -1e-04  21.9223       6 0.0013
ATT=~a4    22.8192       6 0.0009   -1e-04 10.3324      6 0.1113    0e+00  11.0756       6 0.0861
ATT=~a5     9.6085       6 0.1421    0e+00  3.9264      6 0.6866    0e+00   3.7869       6 0.7055
ATT=~a6     6.5509       6 0.3644    0e+00  5.3957      6 0.4942    0e+00   5.4620       6 0.4861
ATT=~a7    23.2852       6 0.0007   -1e-04 19.0069      6 0.0042   -1e-04  19.4814       6 0.0034
ATT=~a8    25.4930       6 0.0003   -1e-04 21.4735      6 0.0015   -1e-04  22.4388       6 0.0010
ATT=~a9    38.2887       6 0.0000   -2e-04 30.1789      6 0.0000   -2e-04  32.9777       6 0.0000
```

Iterative Build Up – Round 6

```
> round(weakpartial6$results,4)
         free.chi free.df free.p free.cfi  fix.chi fix.df  fix.p fix.cfi wald.chi wald.df wald.p
ATT=~a3   35.6874       6 0.0000   -2e-04  36.4533      6 0.0000  -2e-04  36.9387       6 0.0000
ATT=~a4   22.8192       6 0.0009   -1e-04  14.0486      6 0.0291  -1e-04  14.1801       6 0.0277
ATT=~a7   23.2852       6 0.0007   -1e-04  28.6420      6 0.0001  -2e-04  28.8412       6 0.0001
ATT=~a8   25.4930       6 0.0003   -1e-04  21.6850      6 0.0014  -1e-04  22.1045       6 0.0012
ATT=~a9   38.2887       6 0.0000   -2e-04  41.7850      6 0.0000  -3e-04  42.9411       6 0.0000
HYP=~a12  23.1289       6 0.0008   -1e-04  23.7914      6 0.0006  -1e-04  24.3200       6 0.0005
HYP=~a13  33.2635       6 0.0000   -2e-04  83.5080      6 0.0000  -6e-04  89.8841       6 0.0000
HYP=~a14  13.0239       6 0.0427   -1e-04  39.2514      6 0.0000  -2e-04  40.3534       6 0.0000
HYP=~a15  27.4275       6 0.0001   -2e-04  72.5012      6 0.0000  -5e-04  78.8777       6 0.0000
HYP=~a16  68.1034       6 0.0000   -4e-04 109.0372      6 0.0000  -7e-04 121.2958       6 0.0000
HYP=~a17   4.9608       6 0.5488    0e+00  35.7105      6 0.0000  -2e-04  37.0876       6 0.0000
HYP=~a18  33.3493       6 0.0000   -2e-04  81.7574      6 0.0000  -5e-04  87.0753       6 0.0000
```

We are able to constrain 7 of the 18 loadings across 7 projects

Partial Strict Invariance?

```
> round(scalarpartial$results,4)
      free.chi free.df free.p free.cfi  fix.chi fix.df fix.p fix.cfi wald.chi wald.df wald.p
a1~1  331.1852       6      0  -0.0023 225.8281      6      0 -0.0016 232.8797       6       0
a2~1  143.7741       6      0  -0.0010 269.8604      6      0 -0.0019 284.4036       6       0
a3~1  707.7727       6      0  -0.0051 343.0269      6      0 -0.0024 359.2997       6       0
a4~1   64.3561       6      0  -0.0004  76.7043      6      0 -0.0005  79.0753       6       0
a5~1   60.1769       6      0  -0.0004 120.8849      6      0 -0.0008 123.6404       6       0
a6~1  119.8899       6      0  -0.0008 243.3275      6      0 -0.0017 255.2341       6       0
a7~1   39.1603       6      0  -0.0002  75.8946      6      0 -0.0005  77.1084       6       0
a8~1  717.7670       6      0  -0.0051 147.0200      6      0 -0.0010 149.8650       6       0
a9~1  369.6119       6      0  -0.0026 167.8806      6      0 -0.0012 172.7409       6       0
a10~1 136.5662       6      0  -0.0009 150.6131      6      0 -0.0010 154.1948       6       0
a11~1  60.6789       6      0  -0.0004 330.5642      6      0 -0.0023 349.3131       6       0
a12~1 220.9432       6      0  -0.0015 442.3653      6      0 -0.0031 469.6476       6       0
a13~1  38.1900       6      0  -0.0002 239.6532      6      0 -0.0017 247.9248       6       0
a14~1  41.5168       6      0  -0.0003 255.6907      6      0 -0.0018 265.4519       6       0
a15~1 577.7716       6      0  -0.0041  95.5770      6      0 -0.0006  97.8299       6       0
a16~1  31.4562       6      0  -0.0002 224.9594      6      0 -0.0016 233.8804       6       0
a17~1 308.9974       6      0  -0.0022 464.9302      6      0 -0.0033 496.4208       6       0
a18~1 147.2112       6      0  -0.0010 118.7793      6      0 -0.0008 120.9481       6       0
>
```

Ouch

What could you do next?

- Explore why none of the items have scalar invariance
  - These are tests with 6 degrees of freedom
  - Is this being driven by one project? A small subset?
- Maybe take an effect size approach?

Nothing obvious

$estimates

	poolest	int:1	int:2	int:3	int:4	int:5	int:6	int:7
a1~1	3.976873	3.794641	3.722642	3.826530	4.289134	4.112652	4.103868	3.904909
a2~1	4.033474	3.959706	4.007377	3.990641	4.040998	4.015417	4.294709	4.186733
a3~1	4.101281	4.305791	4.326628	4.286977	3.821346	3.721800	4.137752	4.232850
a4~1	4.013787	4.055781	4.029332	4.058041	3.970359	4.027917	3.840128	3.966311
a5~1	4.003583	3.970982	3.931032	3.975050	4.033745	4.084866	3.998225	3.901786
a6~1	4.009733	4.000031	4.047437	4.054700	4.000815	3.911384	4.217475	4.272120
a7~1	4.024041	4.055829	4.038248	3.959773	4.001255	4.056116	3.915431	3.874708
a8~1	3.909620	3.653996	3.796221	3.674596	4.340858	4.354567	3.694786	3.512434
a9~1	4.078211	4.357178	4.217141	4.250904	3.655209	3.928975	3.987282	4.119274
a10~1	4.121127	4.058073	4.022187	4.022587	4.279572	4.227324	4.053746	3.941099
a11~1	4.142502	4.136214	4.102373	4.116079	4.165974	4.121198	4.293743	4.351168
a12~1	4.156351	4.263384	4.236933	4.254886	4.014789	3.944662	4.275805	4.341029
a13~1	4.148409	4.187489	4.142772	4.222952	3.986943	4.152500	4.117424	4.060982
a14~1	4.143267	4.171892	4.195138	4.116183	4.066906	4.113306	4.096482	4.057274
a15~1	4.105194	3.892914	3.927275	3.983981	4.455614	4.410821	3.980751	4.018394
a16~1	4.133740	4.058024	4.106854	4.106569	4.317017	4.149234	4.177398	4.229990
a17~1	4.163663	4.276823	4.276075	4.244946	3.975686	3.985922	4.335019	4.321847
a18~1	4.116214	4.147378	4.178645	4.157431	4.164402	4.155450	3.839307	3.938866

Effect Size

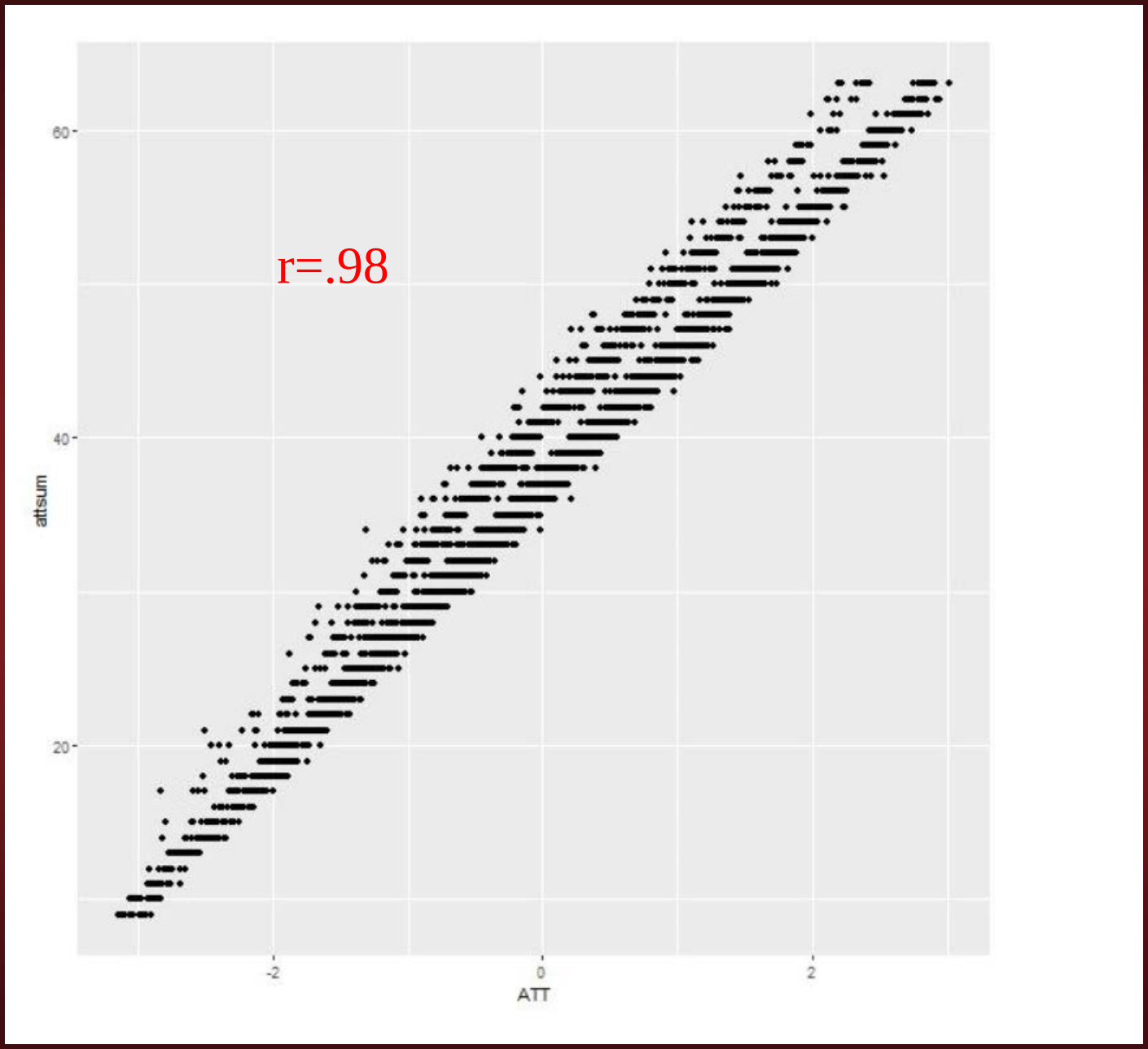
- It’s possible that because we have over 5,000 students in this analyses, that we are sensitive to detecting small differences in loadings and intercepts
- Researchers have proposed some effect size metrics for loadings and slopes (Pornprasertmanit, 2018) but I don’t believe these metrics have been tested out.

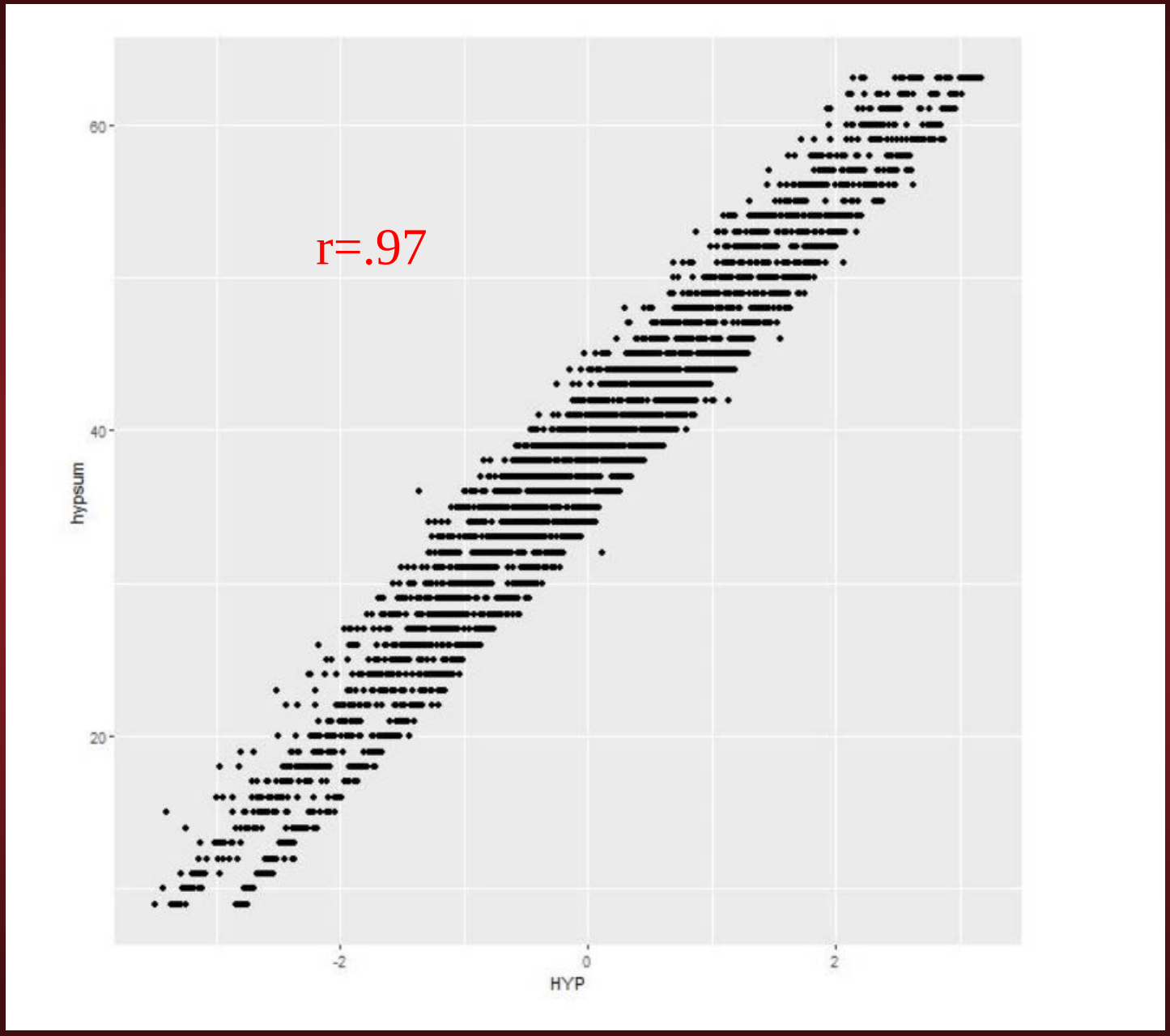
Practicalities

- For this presentation, I am just going to stay with partial weak invariance.
- This is good enough for correlational questions, but it would be unwise to inspect mean differences.

Create Factor Scores

- Factor-based estimates of inattention and hyperactivity were created based upon the final model that constrained some of the item parameters across all sites.


r=.98
60
40
20
attsum
-2
0
2
ATT


r=.97
60
40
20
hypsum
-2
0
2
HYP

Relationship between Attention and Reading

- We fit a series of HLM models nesting subjects within study to predict reading using the IRT based attention and hyperactivity/impulsivity scores.
- We allowed study to be a random factor.
- We found something interesting.

HLM Models

Model	Unc	Att only	NonHyp only	Att+NonHyp
Intercept	102.2	102	101.8	102.1
Att		5.3		6.5
Non - Hyp			3.8	-1.5
L2 variance	32.1	38.9	37.3	38.4
Residual	147.8	125.76	138.3	125.1

All fixed effects significantly different from zero

Both Attention and Non-Hyperactivity are related to better word reading skills separately

Jointly, there is a slight suppressor effect. Students Who are attentive and slightly overactive performed better At reading (and conversely, students will low attention and lower Hyperactivity did the worst)

Other Analyses

- One could look at between site characteristics as well to look for moderators (akin to what is done in a meta-analysis)
- Could potentially look for effects across a wider age range or across varied site characterstics

Practical Issues

- Establishing relationships across other sites
- Obtaining the data
- Authorship

So now you know how to do IDA.
Where do you find data?

LDbase

Data Repositories

- NICHD DASH
  - https://dash.nichd.nih.gov/
- ICPSR at Michigan
  - https://www.icpsr.umich.edu/icpsrweb/
- OSF
  - https://osf.io/
- Wondering what this is??

LDbase

- Ldbase.org: Domain specific data repository for behavioral data related to student achievement/learning disabilities
  - Free
  - Will fulfill federal data availability requirements
  - Backed by FSU Libraries, so 10 year commitment to storage and management, using FAIR principles
  - Investigator chosen data security levels

LDbase

LD
base

- Seeded with raw data from 6 major NICHD- & IES-funded projects, representing ~175 million dollars in investment
- ~20,000 children tested longitudinally
- Verbal commitment from many more

LDbase

LD base

- 2020: LDbase will be open to data users
- 2021: will be open for data deposits
- 2022: an integrated database of all children stored in LDbase will available

LD base

- Training and consulting on IDA, meta-analysis & data management
- Openly available data management and IRB documents will be created
- A constantly updating combined dataset of “typical” variables will be available


LDbase