# How Tenable are Modeling Assumptions Around Rapid Guessing Behavior?

## Results from a Large Corpus of Low-Stakes Assessments

**Alfonso J. Martinez** (Presenter), University of Iowa

**Joseph A. Rios**, University of Minnesota

# RG is Prevalent & Distorts Psychometric Inferences

**28% of examinees engage in RG**

- Rios et al. (2022)

**RG biases item & ability parameter estimates**

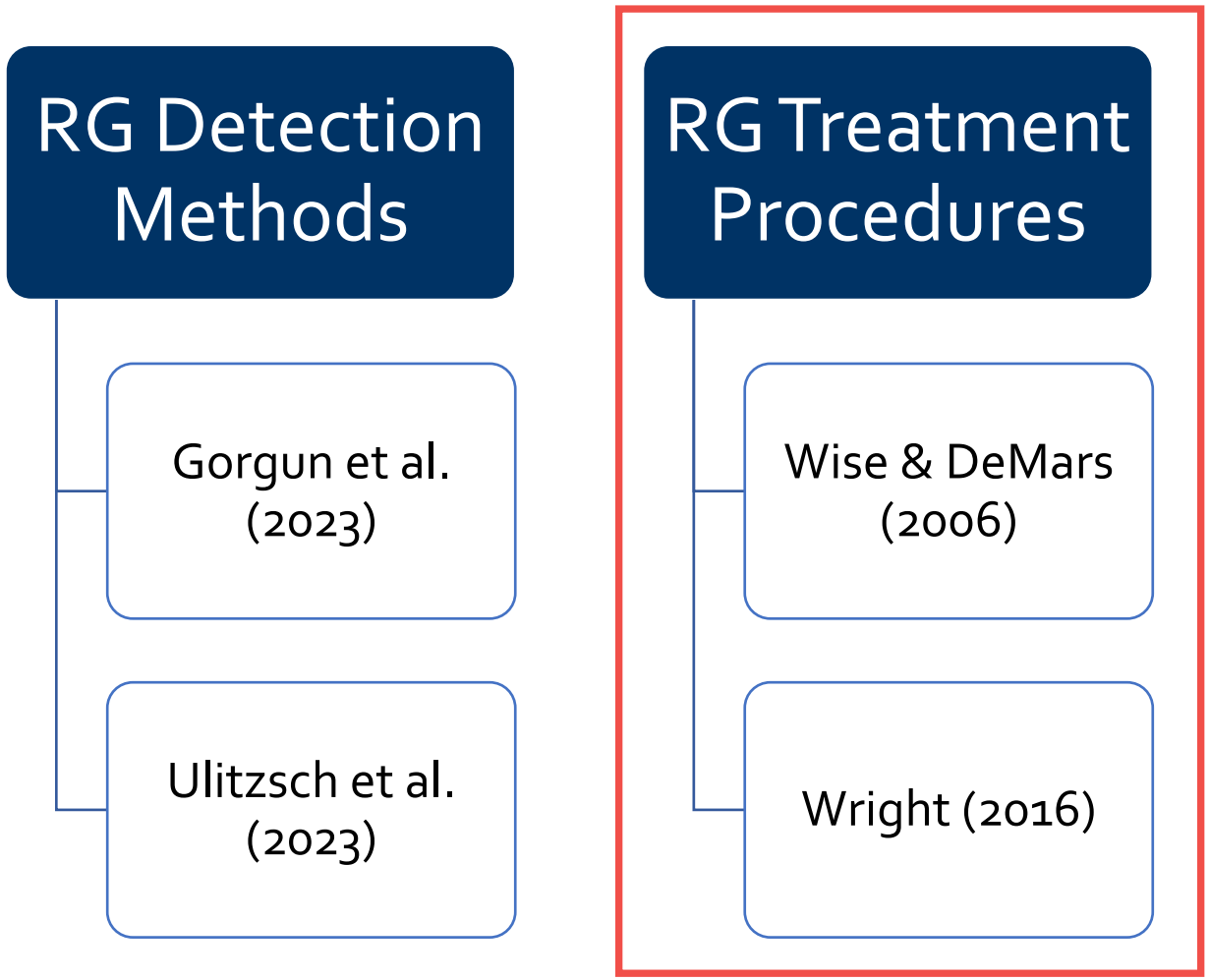
- Rios et al. (2017)
- Rios & Soland (2021)

**RG distorts item/test information**

- van Barneveld (2007)

Note: list is not exhaustive

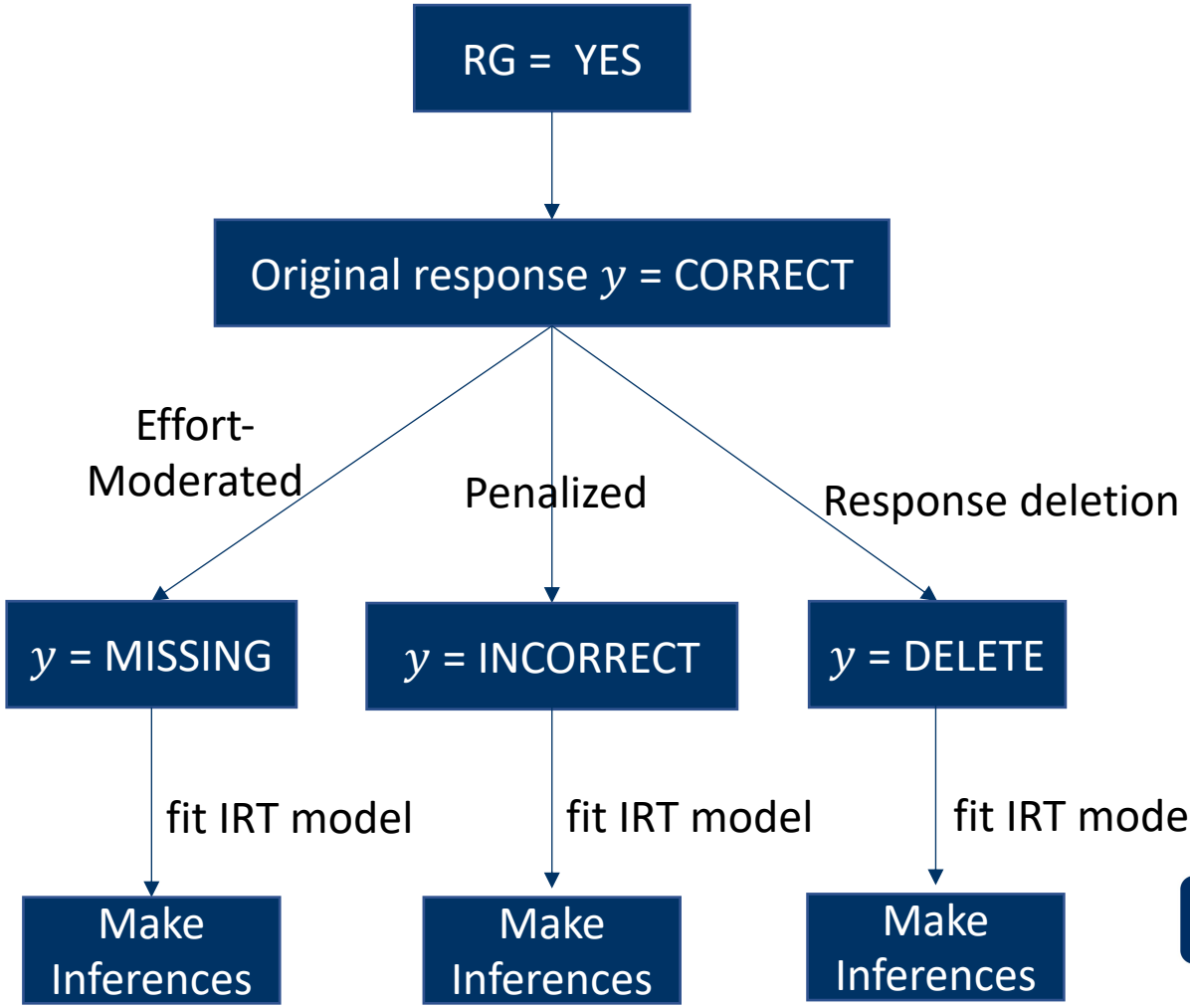
# We can Mitigate the Effects of RG!




Note: list is not exhaustive

# Limitations of RG Treatment Procedures

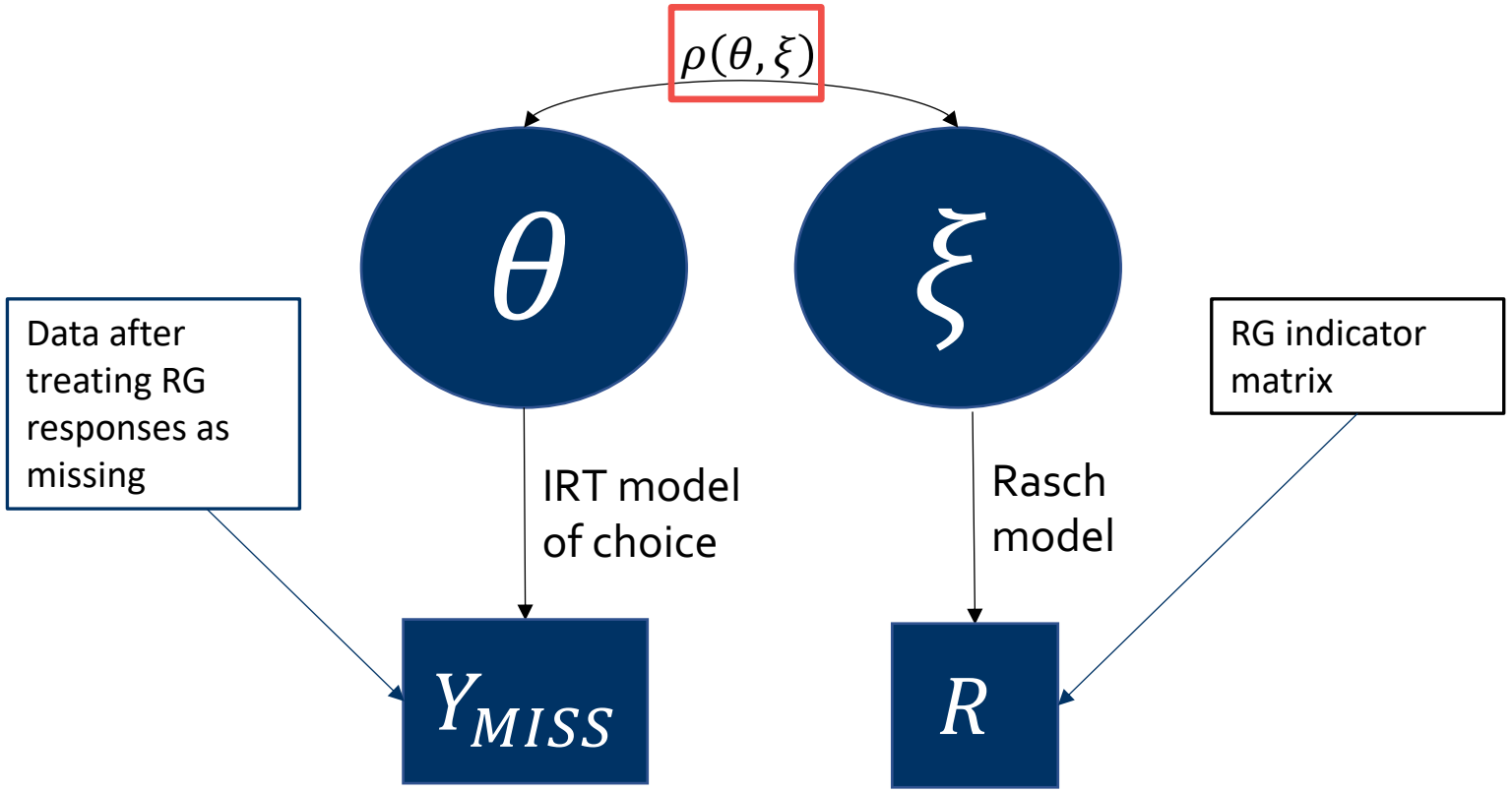
- Many popular methods to **treating** RG responses **do not directly model RG**
  - ➢'Model free' scoring
- **Empirical evidence that RG is related to ability** (e.g., Deribo et al., 2021)



# Model-based Scoring: the HG Missing Data Model

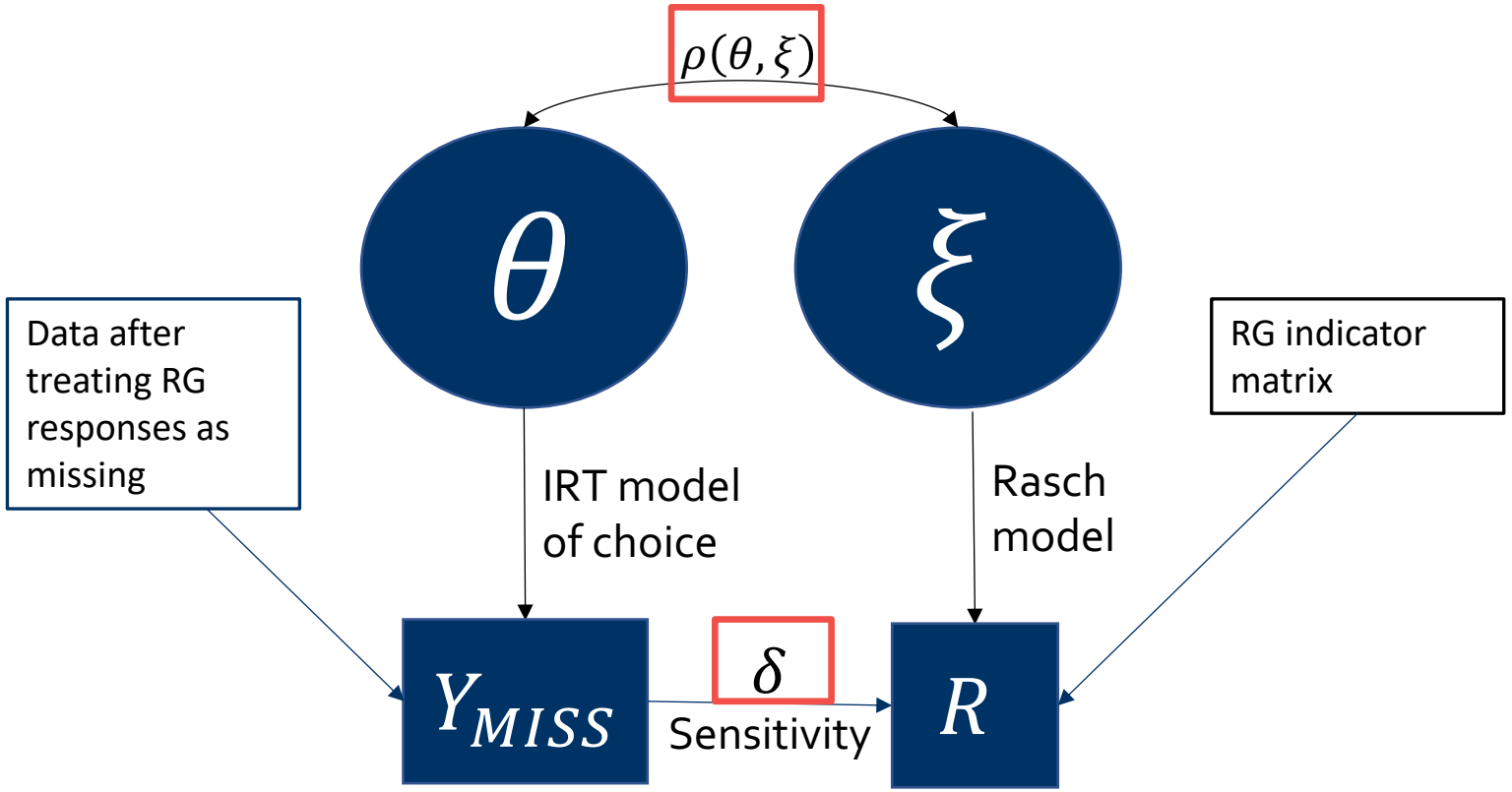
**Holman-Glas (HG) MIRT Scoring**

Model $Y_{MISS}$ and $R$ matrices simultaneously with MIRT model

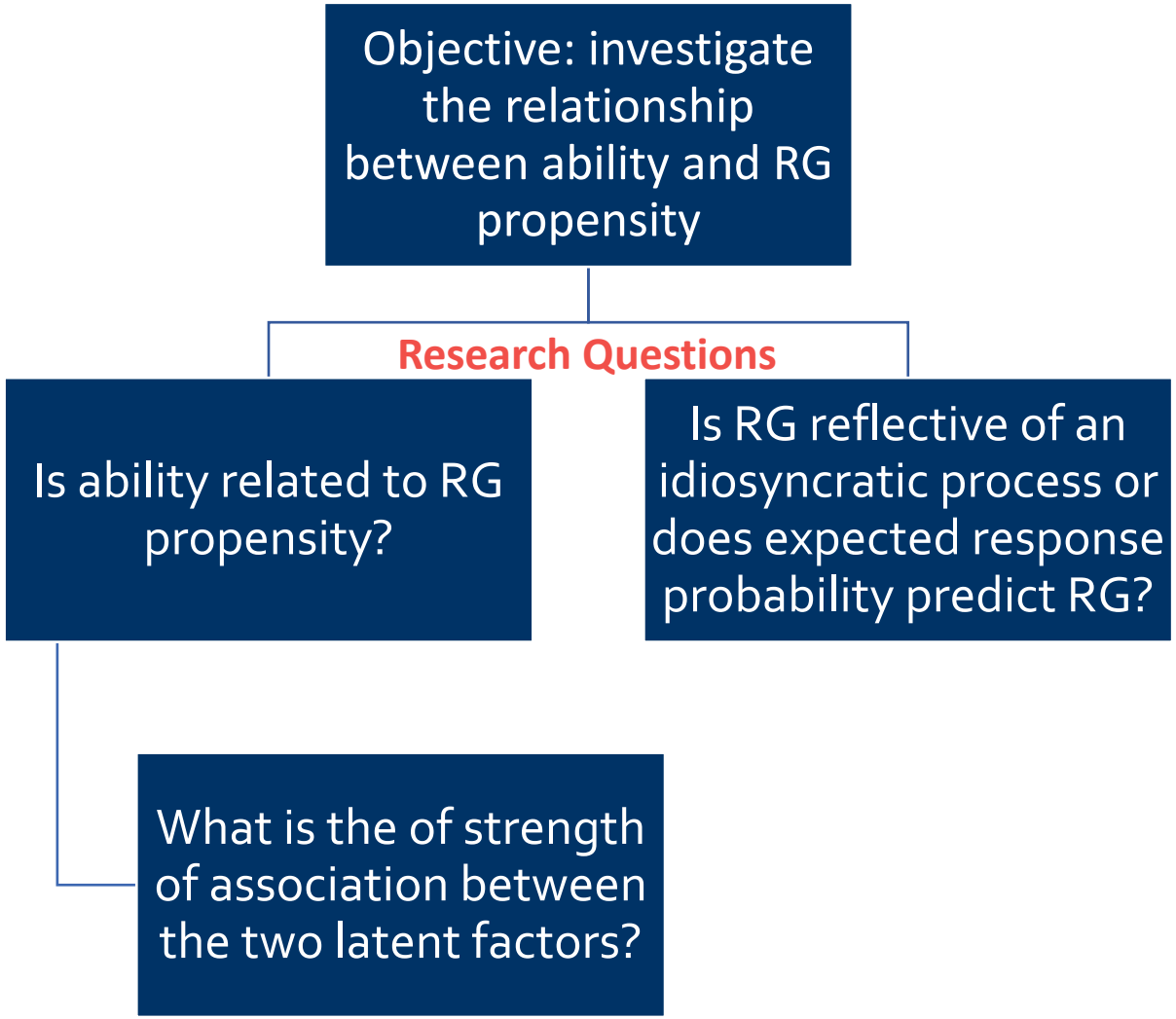


# Model-based Scoring: the MW Missing Data Model

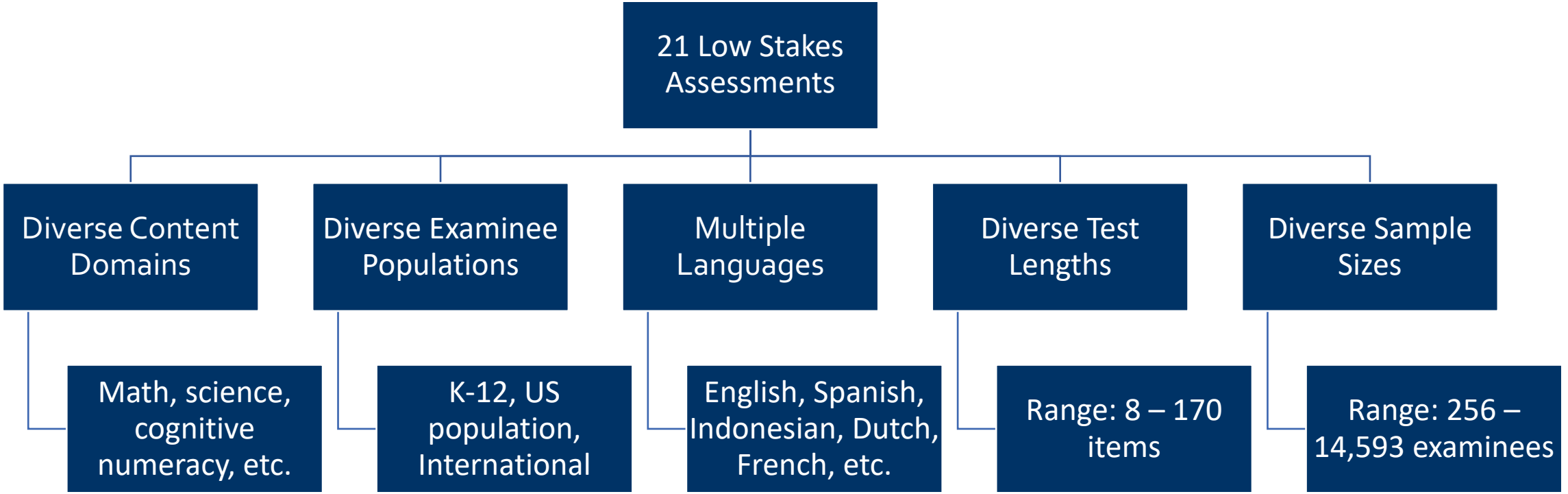
**Mislevy-Wu (MW) MIRT Scoring**
Model $Y_{MISS}$ and $R$ matrices simultaneously with **mediated** MIRT model



# Present Study

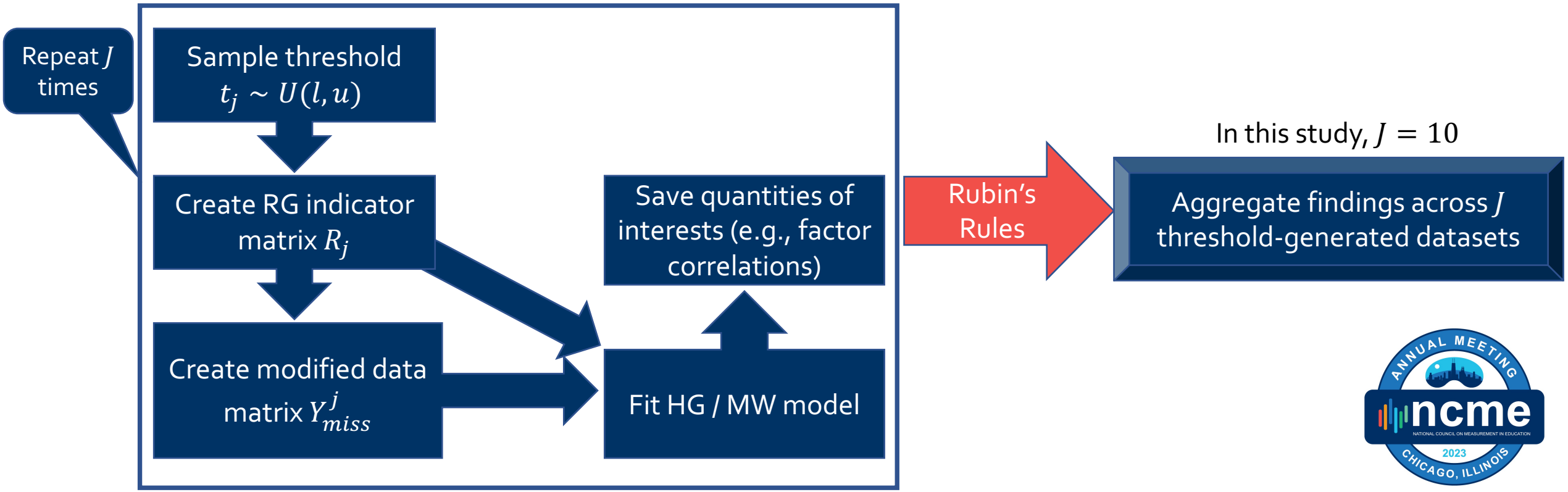


# Assessment Corpus

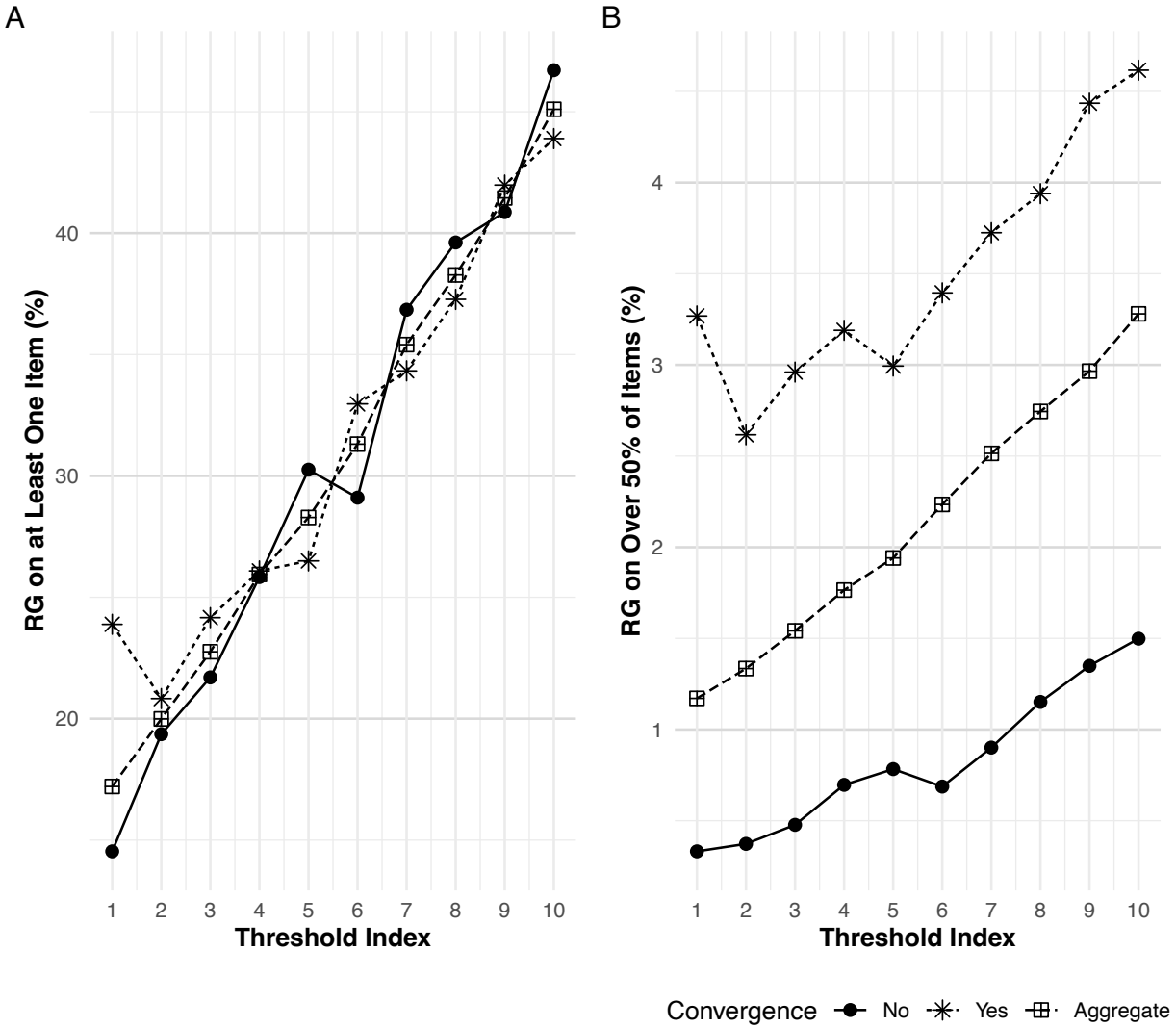


# Random Thresholds

- We used the **response time threshold procedure** to identify RG responses
- To **quantify error arising from the use of a single threshold**, we propose a **random thresholds** procedure

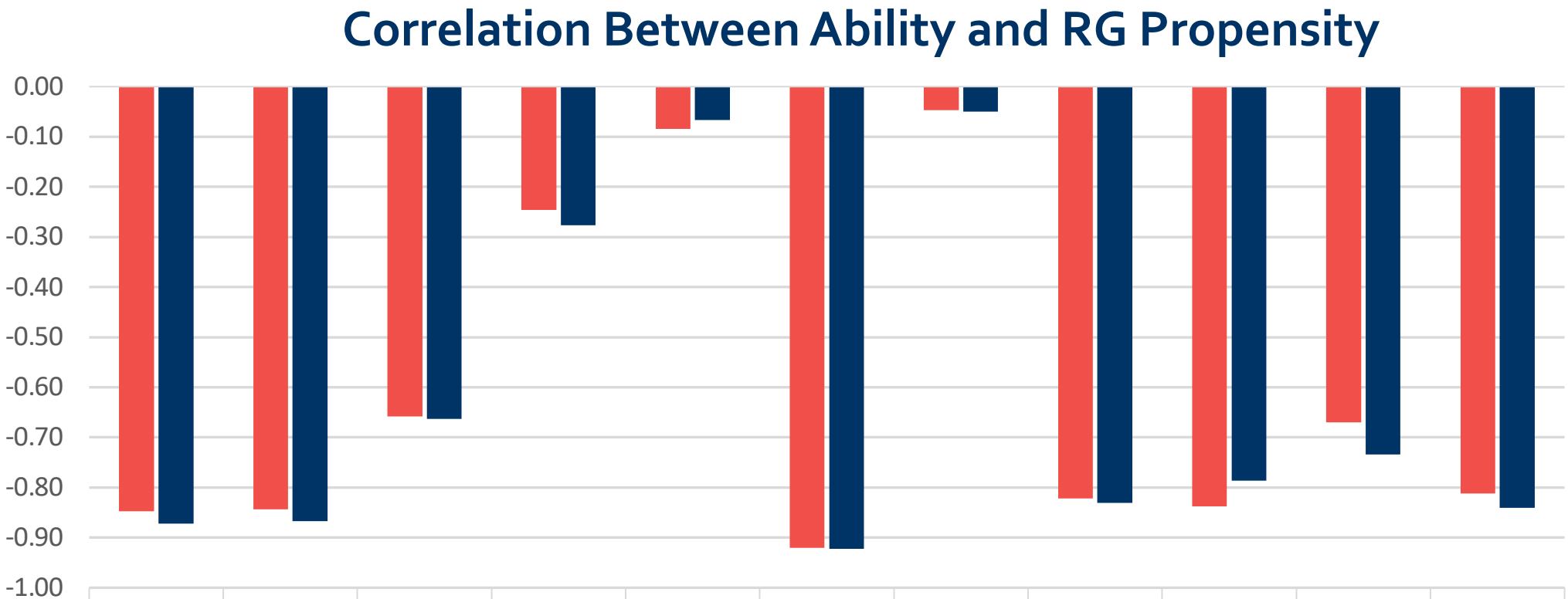


# Results: Issues with Model Convergence




- **38% of datasets that reached convergence when estimated with HG model did not converge when estimated with MW model**
- Of models that converged, MW required an **average of 432.25 more iterations** than HG
- Nonconvergence issue most prevalent when **RG rates were low**

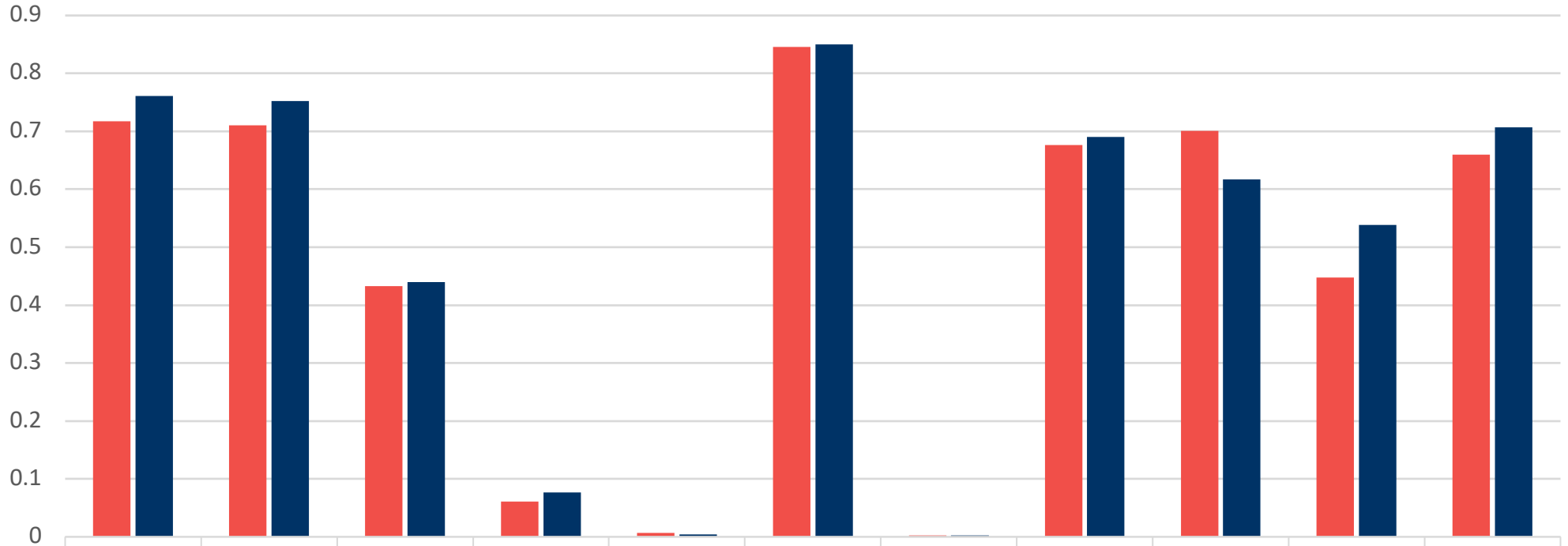
# Results: Relationship Between Ability and RG Propensity




| | PISA Math | PISA Global Comp. | PISA Fin. Lit. | UA Numeracy | UA Verbal Analogies | PIAAC PSTRE | PIAAC Num | PIAAC Lit. | eTIMSS Math | Higher Ed ELA 1 | Soc-emotion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HG Model | -0.85 | -0.84 | -0.66 | -0.25 | -0.08 | -0.92 | -0.05 | -0.82 | -0.84 | -0.67 | -0.81 |
| MW Model | -0.87 | -0.87 | -0.66 | -0.28 | -0.07 | -0.92 | -0.05 | -0.83 | -0.79 | -0.73 | -0.84 |

# Results: Relationship Between Ability and RG Propensity

## Amount of Variation in Ability Accounted for by RG Propensity (R2)

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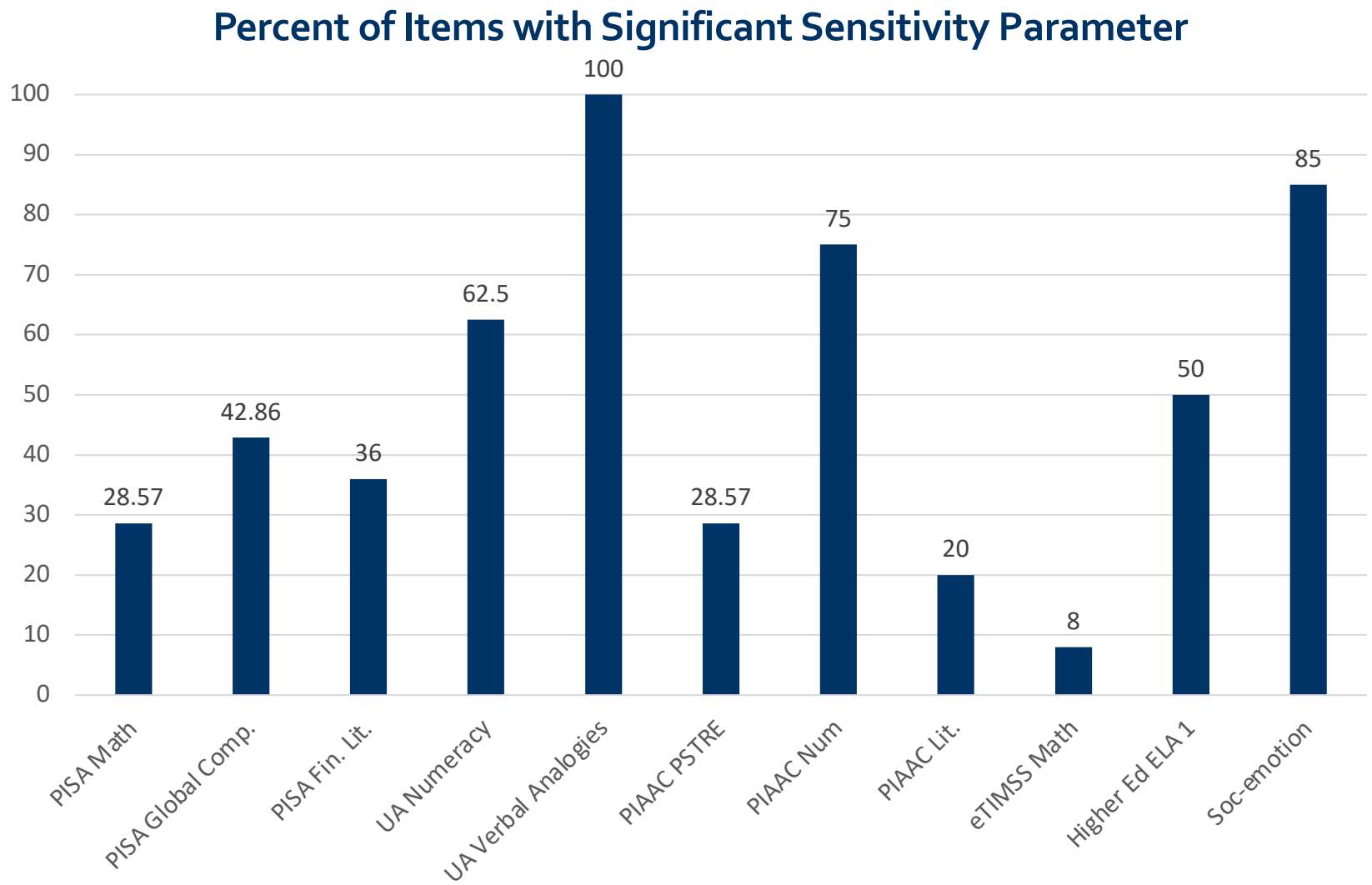
|---|---|---|---|---|---|---|---|---|---|---|---|
| HG Model | 0.717 | 0.71 | 0.433 | 0.061 | 0.007 | 0.846 | 0.002 | 0.676 | 0.701 | 0.448 | 0.66 |
| MW Model | 0.761 | 0.752 | 0.44 | 0.077 | 0.004 | 0.85 | 0.002 | 0.69 | 0.617 | 0.538 | 0.707 |

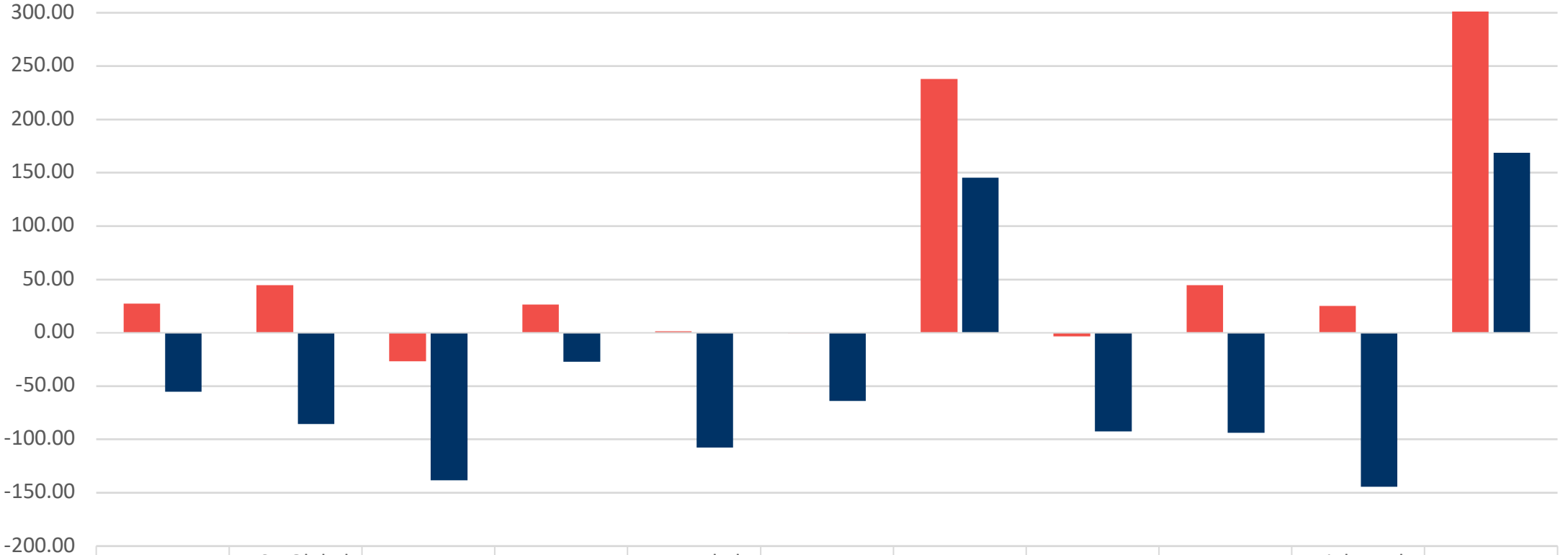
# Results: Is RG Idiosyncratic or Reflective of an Underlying Response Strategy?




- Sensitivity parameter averages ranged from **0.70 to 6.98**
- Results suggest that the **assumption of an idiosyncratic response process may be untenable** (i.e., results favor MW model)

# Results: Model Fit

## Difference in Average AIC/BIC between HG & MW Models

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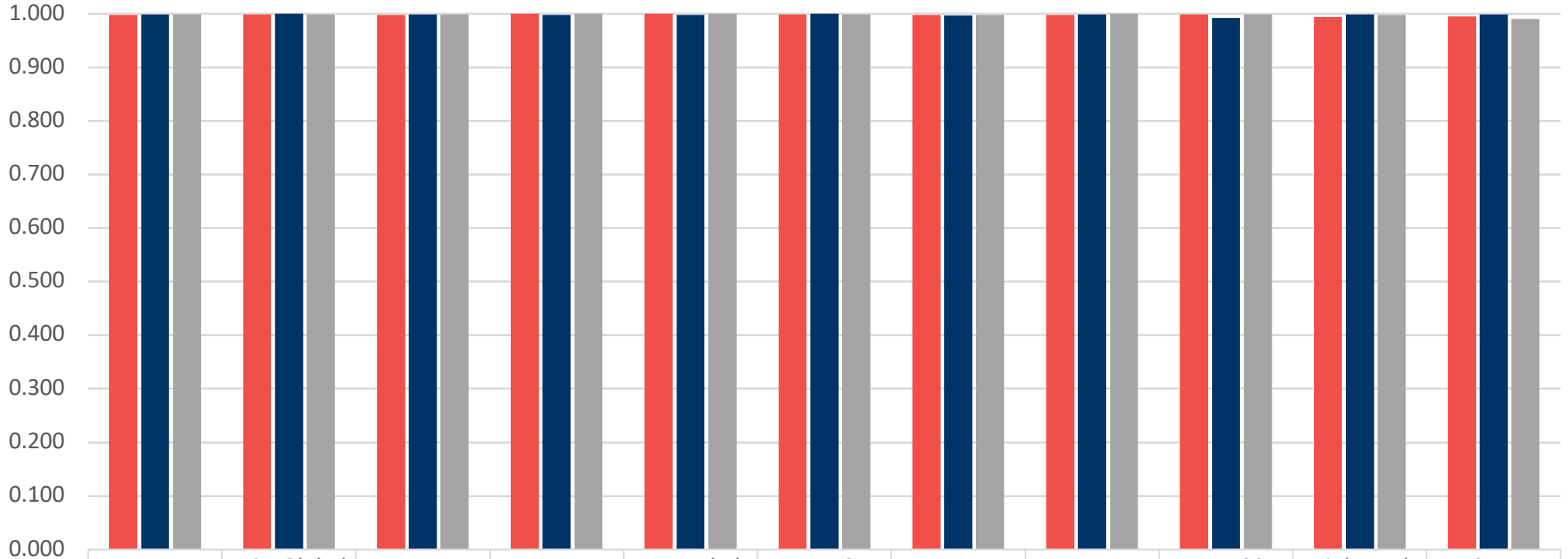
|---|---|---|---|---|---|---|---|---|---|---|---|
| AIC | 27.46 | 44.86 | -26.77 | 26.44 | 1.57 | -0.22 | 237.89 | -3.26 | 44.61 | 25.24 | 385.59 |
| BIC | -55.17 | -85.70 | -138.43 | -27.08 | -107.57 | -63.73 | 145.41 | -92.40 | -93.65 | -144.51 | 168.91 |

Note: + (-) values favor HG (MW)

# Results: Parameter Correlations

## Parameter Correlations Between HG and MW Models

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Ability | 0.998 | 0.999 | 0.998 | 1.000 | 1.000 | 0.999 | 0.998 | 0.998 | 0.999 | 0.994 | 0.995 |
| RG Propensity | 0.999 | 1.000 | 0.999 | 0.998 | 0.998 | 1.000 | 0.997 | 0.999 | 0.992 | 0.999 | 0.999 |
| Item difficulty | 0.999 | 0.999 | 0.999 | 1.000 | 1.000 | 0.999 | 0.998 | 1.000 | 0.999 | 0.998 | 0.990 |

**Takeaway: Parameter estimates were essentially identical**

# Recap & Conclusions

- We found evidence of a **strong linear inverse relationship** between ability and RG propensity across several assessments in the corpus
  - Corroborates previous research that has found that **low ability examinees** are **more likely to engage in RG** (Deribo et al., 2021; Rios et al., 2017)
- Found evidence that **RG is not idiosyncratic but predicted by ERP**
  - Caveat: no effect size measures for evaluating strength of the effect Model fit results were mixed but **parameter correlations between models were nearly identical**
  - Q for future research: is HG model is good enough for practical purposes?

# Future Directions

- Further examination of the MW model in an RG context
  - Model originally developed in the missing data literature for model non-ignorable missing data
  - Simulation-based research

- More research investigating relationship between ability and RG propensity
  - Using **different RG identification procedures**
  - **Compare to penalized and EM scoring**
    - Both approaches are very easy to implement
    - **Do we obtain similar inferences from these as we would with HG/MW model?**

# Implications

- **Our finding** that ability was strongly linearly and inversely related to RG propensity provisionally **suggests that the relationship between the two latent variables is robust**

- **We recommend** using **HG over MW** to jointly model RG propensity and ability
  - Less likely to run into convergence issues
  - Provides **nearly identical** item and ability **parameter estimates**
  - **Recommendations tentative** until further research into MW model can be conducted

# Thank you!

## Contact Information

**Alfonso J. Martinez**
University of Iowa
alfonso-martinez@uiowa.edu
Academic website:
https://alfonso-martinez.netlify.app/

**Joseph A. Rios**
University of Minnesota
jrios@umn.edu
Personal website:
https://josephriosphd.com/