

Literacy Skill Use Among Working Prisoners & Household Adults: Measurement Validation Using the Rasch Model

Emily Buehler
Criminology PhD
School of Law

Outline

- Background – Literacy & PIAAC Survey of Adult Skills
- Research questions
- Method – Rasch measurement modelling
- Workplace Reading Skill Use – construction and validation
- Differential Item Functioning – inmates vs general population
- Skill Use Scores – Comparing General Inmates & Household Adults
- Next Steps

PIAAC Definition of Literacy

- "Literacy is **understanding**, **evaluating**, **using** and **engaging** with written text to participate in the society, to achieve one's goals and to develop one's knowledge and potential."
- Evaluating engage in literacy practices in the workplace
- Consideration of the unique prison work environment context

2012/2014 PIAAC Survey of Adult Skills

- Given to nationally representative samples of US Household (n=8670) and US Incarcerated Adults (n=1319)
- Assessment - tests of four cognitive domains
 - Literacy
 - Numeracy
 - Problem-solving in technology rich environments
 - Reading components
- Background questionnaires - education & training, work experiences, health, political efficacy, skill use at work and at home, etc

Research Questions

- Do the PIAAC Survey of Adult Skills items produce a good measure of workplace reading skill use?
- Is the measure potentially biased for inmates compared to US household adults?

Self-Report Workplace Reading Skill Use Items

- Only relevant currently employed inmates (n=797) & household adults (n=6191)
- Frequency of activity response options – never, less than once a month, less than once a week but at least once a month, at least once a week but not every day, every day
- Reading
 - Directions or instructions
 - Letters or memos
 - Newspapers or magazines
 - Professional journals or publications
 - Books
 - Manuals or reference materials
 - Financial statements
 - Diagrams, maps, or schematics

Rasch Measurement - RSM

- Rating Scale Model (Andrich, 1978)
 - Polytomous ordinal responses that have a consistent structure for all items
 - Outcome estimates based on a continuous measure of skill use

$$\Pr\{X_{ni} = x\} = \frac{\exp \sum_{k=0}^x (\beta_n - (\delta_i - \tau_k))}{\sum_{j=0}^m \exp \sum_{k=0}^j (\beta_n - (\delta_i - \tau_k))}$$

Person ability

Item difficulty

Threshold

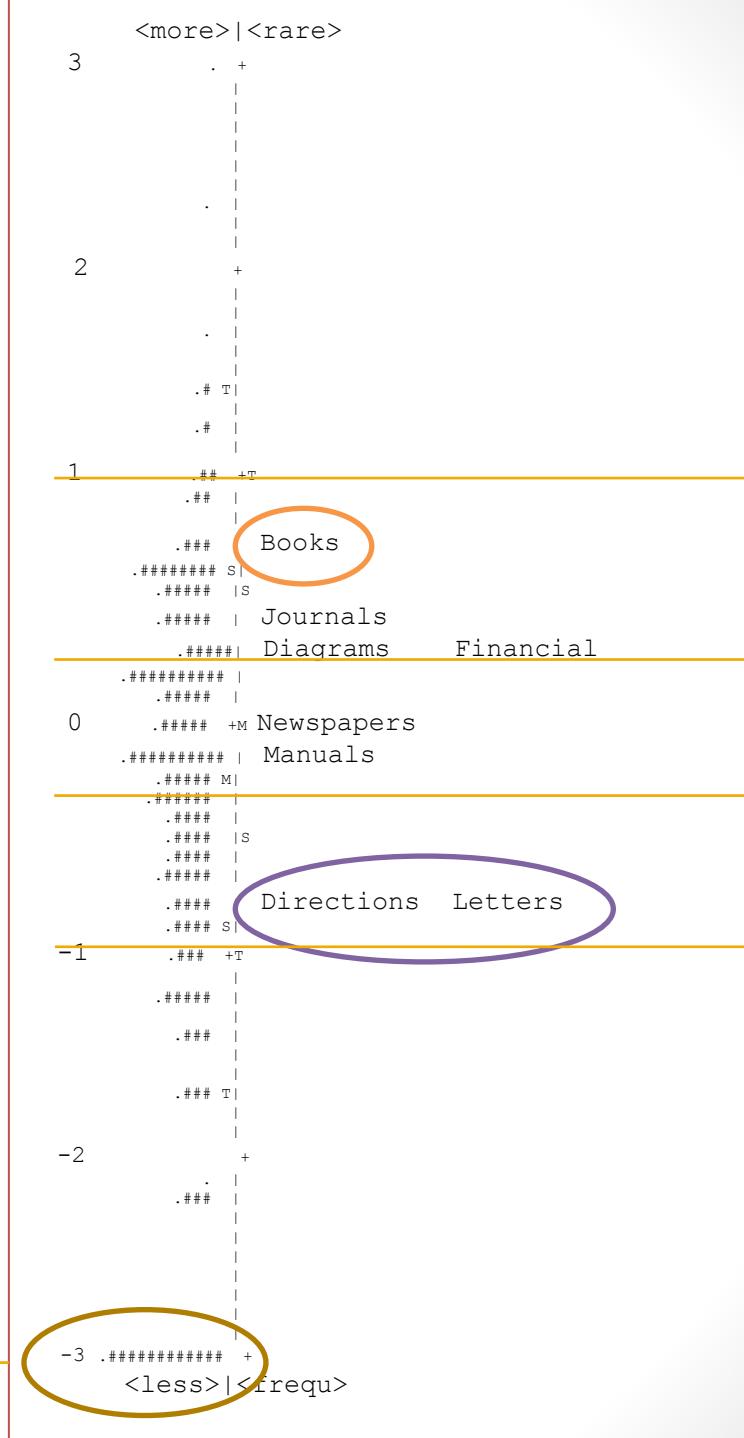
Measure Construction and Validation – Reading Skills

- Unidimensional – only one latent construct
 - Unexplained variance 11.4%, eigenvalue 1.9
- Monotonicity – probabilities move in expected directions
 - Middle three response categories under-endorsed
- Person separation (1.45) and reliability (0.68) X
- Item separation (42.68) and reliability (1)
- Infit and Outfit Mean Square Errors – items are productive, do not degrade instrument
 - Seven good items = values between 0.6 and 1.4
 - Financial statements item = infit 1.41, outfit 1.53 X

Person – Item Map

- One continuum of latent workplace reading skill use
- Reading books at work the most difficult item to endorse
- Reading letters/memos and directions the easiest
- Large number of respondents' with lowest reading skill use ability level → who are they?

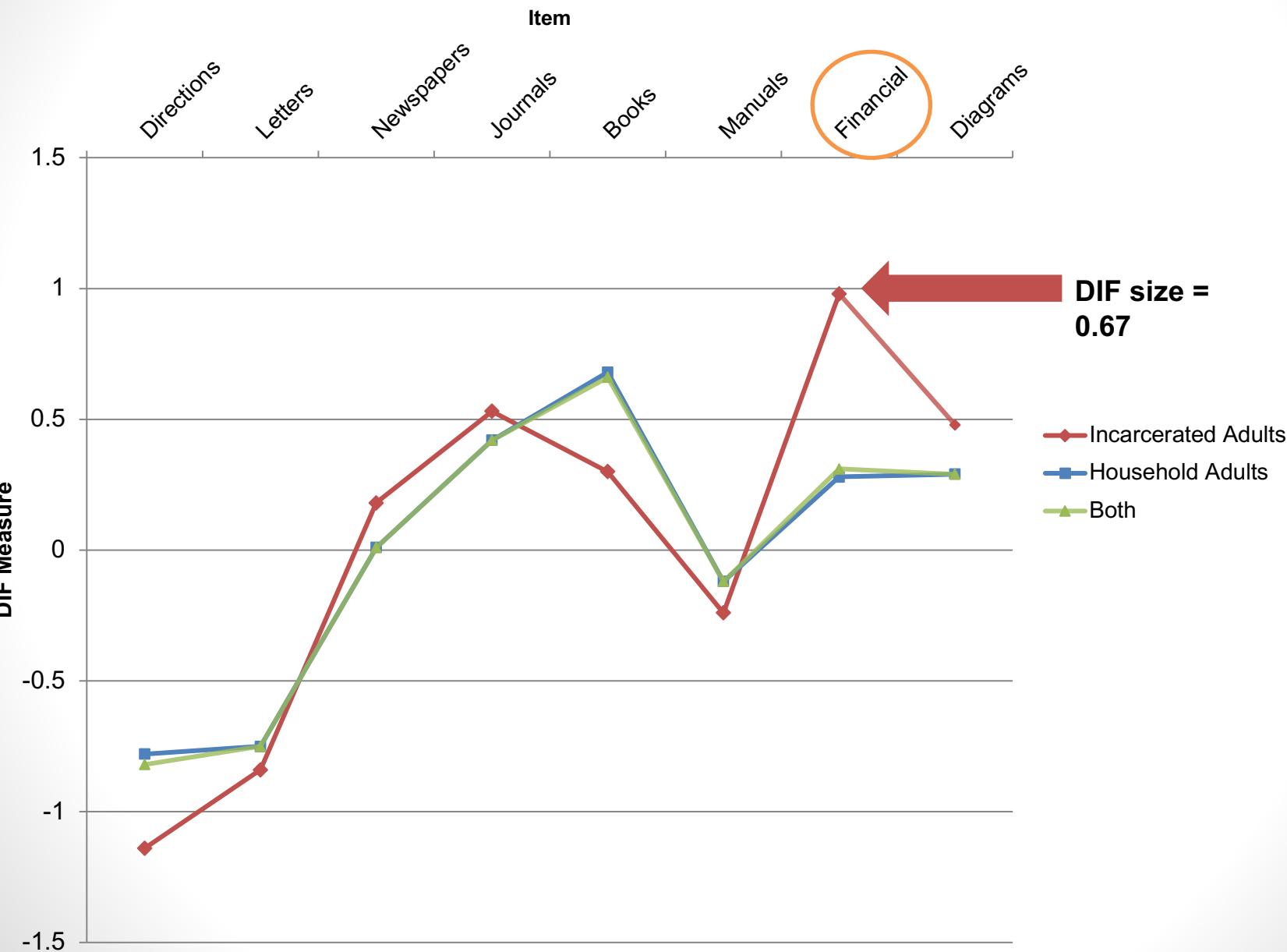
Bottom effects



Test of Measurement Invariance – Differential Item Functioning (DIF)

- Items should behave the same way regardless of group membership – individuals with same latent ability should answer similarly to items
- Mantel-Haeszel (MH) chi-square for statistically significant DIF
- Significant substantive DIF size in logits (Educational Testing Service guidelines)
 - Slight to moderate – 0.43 to 0.63
 - Moderate to large – greater than 0.64

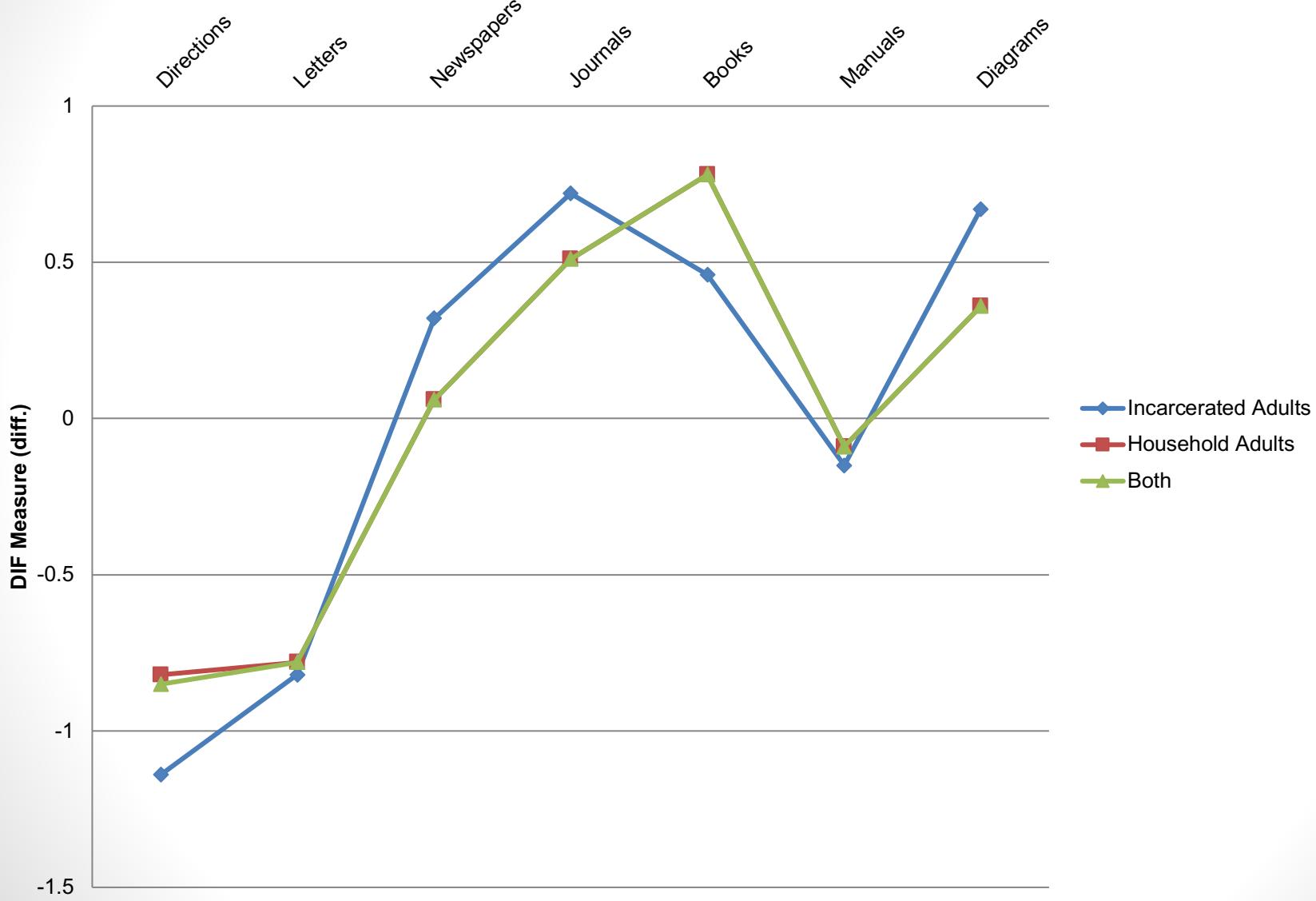
Differential Item Functioning of Workplace Reading Skill Use Items



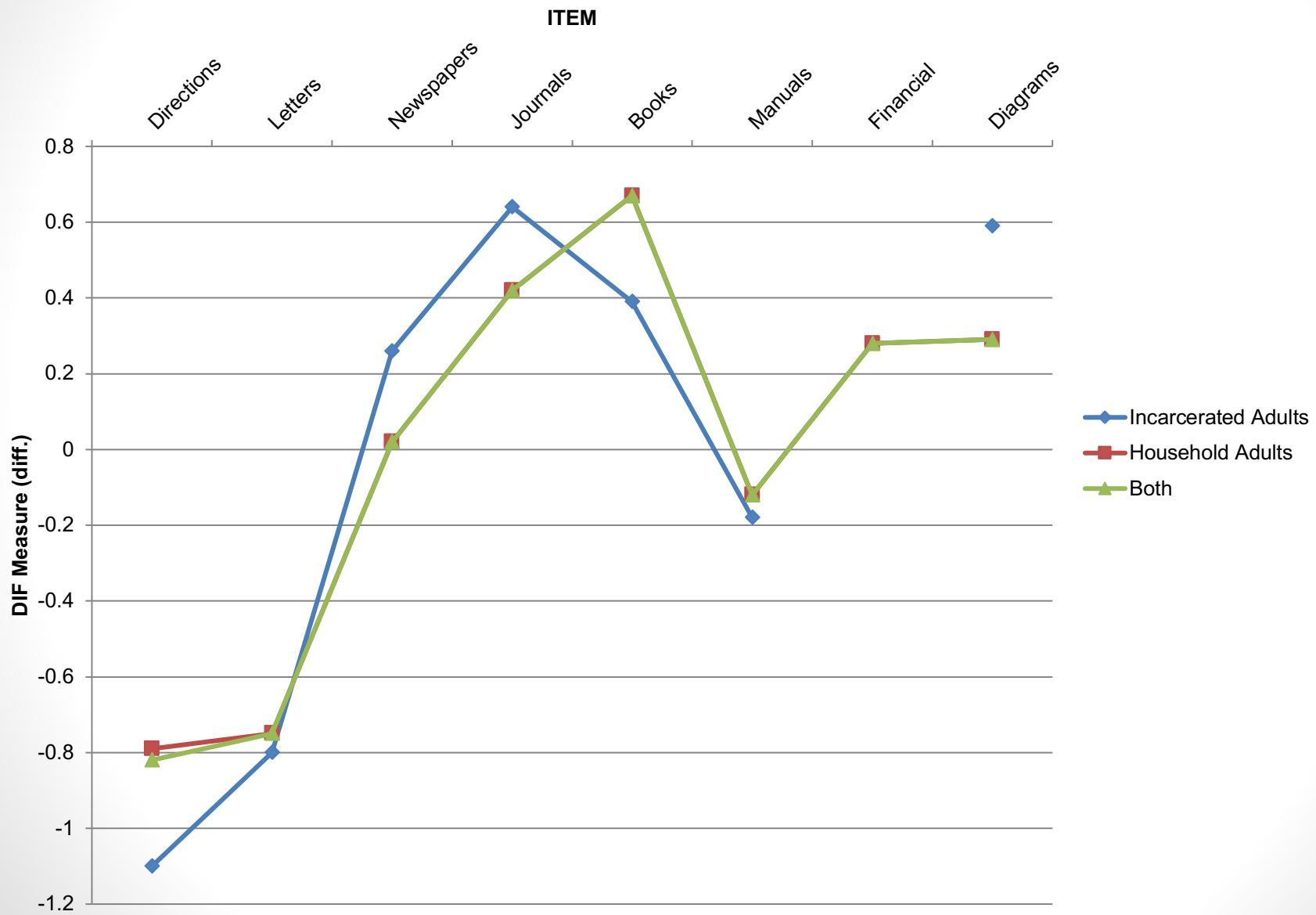
Options to address DIF

- Reading financial documents the most difficult item for inmate group to endorse yet overall has a difficulty in the middle of the measure
- Remove item, resulting in a new seven item measure
 - No significant changes in other fit elements of the measure or DIF findings of other items
- Recode as missing for members of the focal group of inmates
 - Financial documents item high infit & outfit remains (1.41, 1.55 respectively)
 - No significant changes in other fit elements of the measure or DIF findings of other items

DIF of Workplace Reading Skill Use with Financial Documents Item Removed

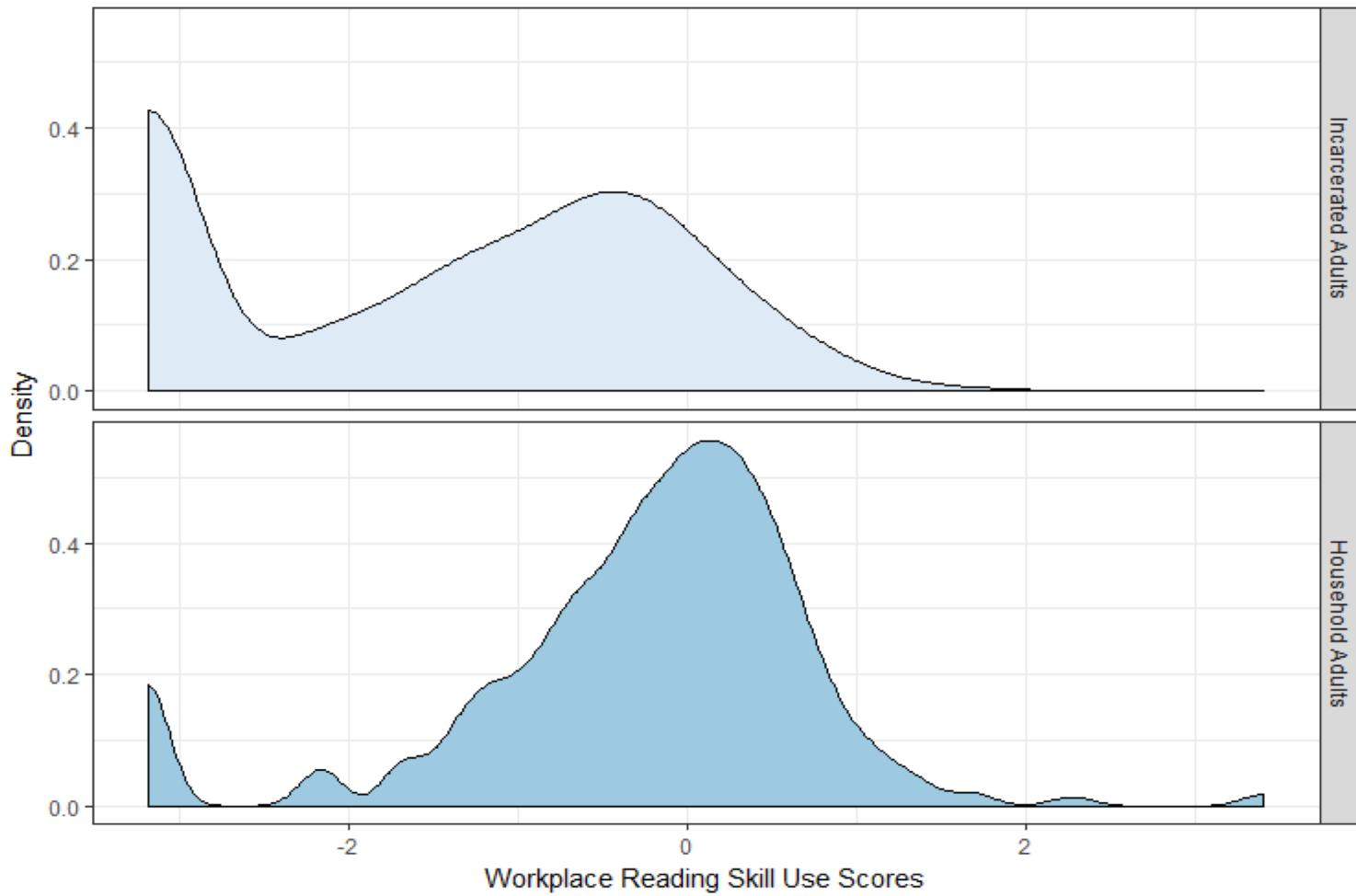


DIF of Workplace Reading Skill Use Measure with Financial Documents Item as Missing for Incarcerated Adults

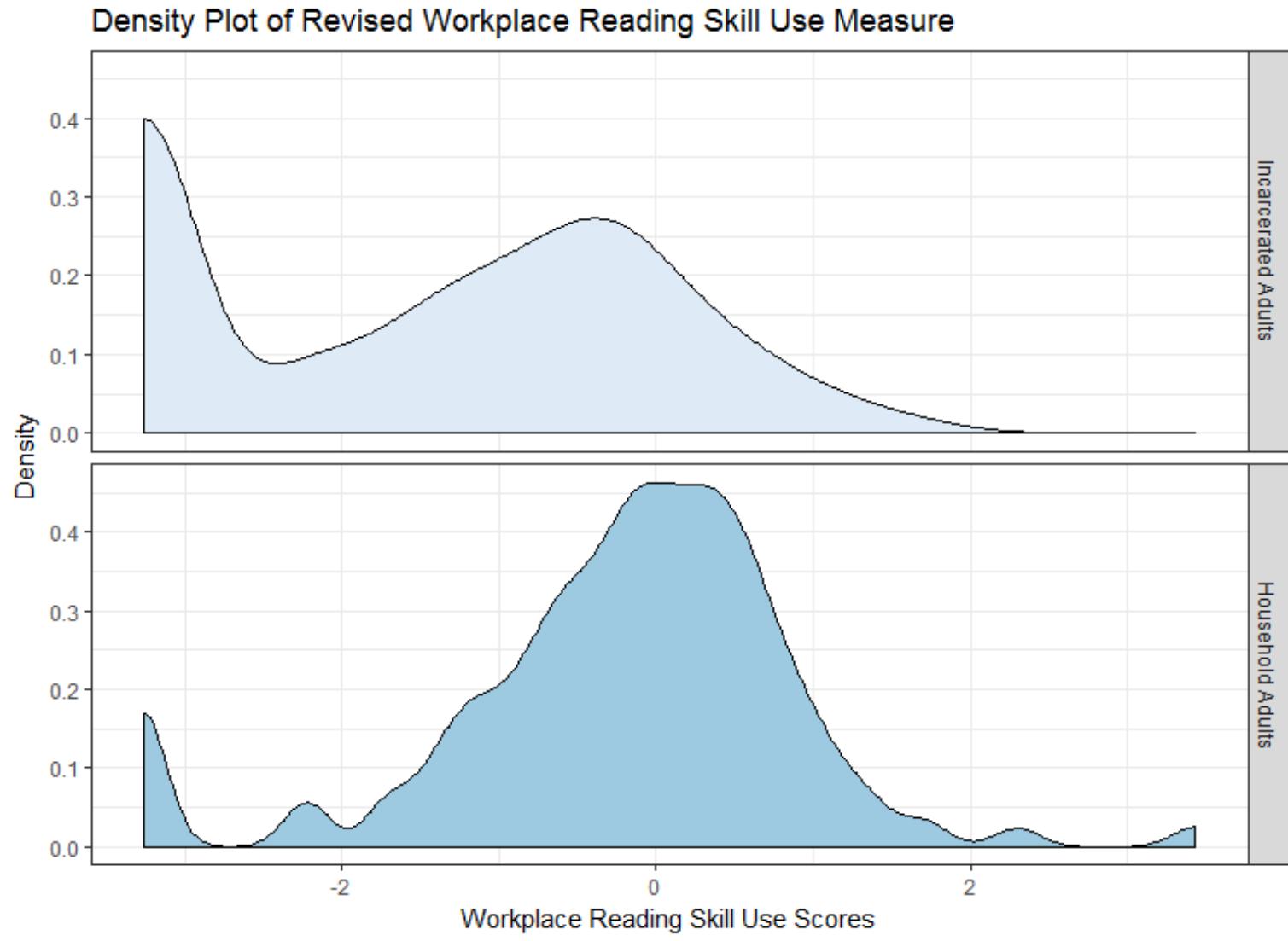


Reading Skill Use Person Estimates – Original Measure

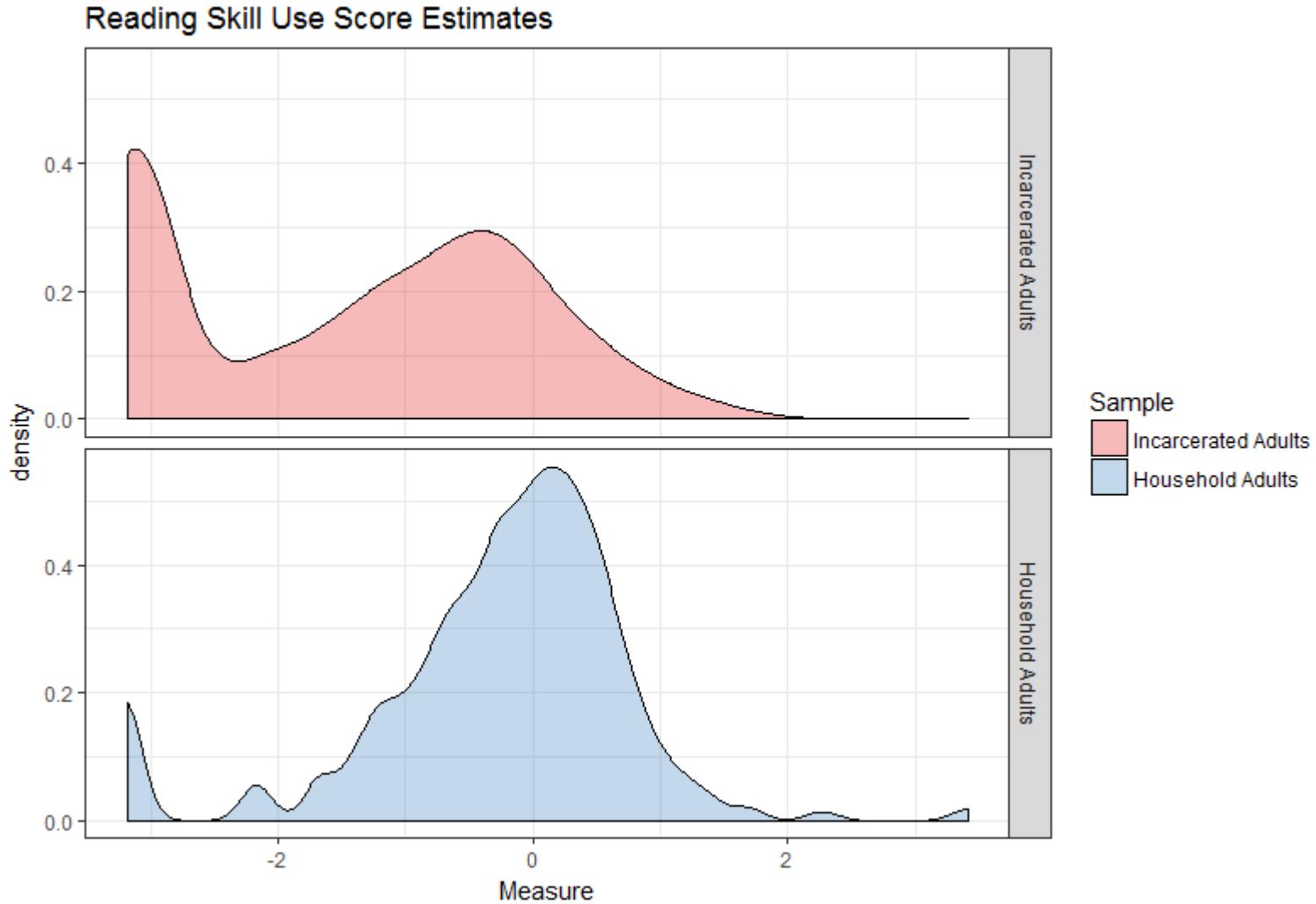
Density Plot of Workplace Reading Skill Use Measure



Reading Skill Use Person Estimates – Financial Documents Item Removed



Reading Skill Use Person Estimates – Financial Documents Item as Missing



What to do about it?

- Investigate DIF using propensity score matching
 - Create synthetic control (household) and treatment (inmate) groups accounting for potential confounding covariates to evaluate potential bias effect of prison work environment on self-reported reading skill use
 - Run conditional logistic regression (considers matched pairs nature of data) with outcome of item displaying DIF modelled by group membership
 - PROBLEM
 - My items from this research are polytomous...

Questions?
Comments?

References

- Andrich, D. (1978). Application of a Psychometric Rating Model to Ordered Categories which are Scored with Successive Integers. *Applied Psychological Measurement*, 2(4), pp. 581-594.
- Andrich, D. & Hagquist, C. (2015). Real and Artificial Differential Item Functioning in Polytomous Items. *Educational and Psychological Measurement*, 75(2), pp 185-207.
- Bonta, J. & Andrews, D.A. (2017). *The Psychology of Criminal Conduct*, 6th edition. Routledge: London.
- Davis, L.M. , Bozick, B. , Steele, J.L., Saunders, J. & Miles, J.M.V. (2013). Evaluating the Effectiveness of Correctional Education: A Meta-analysis of Programs that Provide Education to Incarcerated Adults.
- Liu, Y., Zumbo, B.D., Gustafson, P., Huang, Y., Kroc, E. , and Wu, A.D. (2016). Investigating Causal DIF via Propensity Score Methods. *Practical Assessment, Research & Evaluation*, 21(13), pp 1-24.
- Mackenzie, D. (2006). *What Works in Corrections: Reducing the Criminal Activities of Offenders and Delinquents*. Cambridge University Press.
- Potenza, M.T. & Dorans, N.J. (1995). DIF Assessment for Polytomously Scored Items: A Framework for Classification and Evaluation. *Applied Psychological Measurement*, 19(1), pp 23-37.
- Ward, T. & Maruna, S. (2007). *Rehabilitation*. Routledge: London.
- Wilson, D. B., Gallagher, C. A., & MacKenzie, D. L. (2000). A Meta-Analysis of Corrections-Based Education, Vocation, and Work Programs for Adult Offenders. *Journal of Research in Crime and Delinquency*, 37(4), 347-368.
- Wu, A.D., Liu, Y., Stone, J.E., Zou, D., & Zumbo, B.D. (2017). Is Difference in Measurement Outcome between Groups Differential Responding, Bias or Disparity? A Methodology for Detecting Bias and Impact from an Attributional Stance. *Frontiers in Education*, 2(39), pp.1-12.
- Zieky, M. (1993). *Practical Questions in the Use of DIF Statistics in Test Development. Differential Item Functioning*. Lawrence Erlbaum Associates: London.