



Numeracy Predicts Extreme Responding: An IR-Tree Approach

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Research Question

We asked whether one's **latent trait of numeracy**, influences the likelihood of relying on **response style** when asked to respond on a **Likert Scale**

H1: Individuals with lower numeracy will exhibit higher levels of mid-point and extreme responding.

Introduction

Numeracy is one's ability, knowledge, and usage of mathematical concepts and figures.²

Numeracy has been linked with highest education level, such that each year of education was related to a 3.6% increase in Numeracy¹

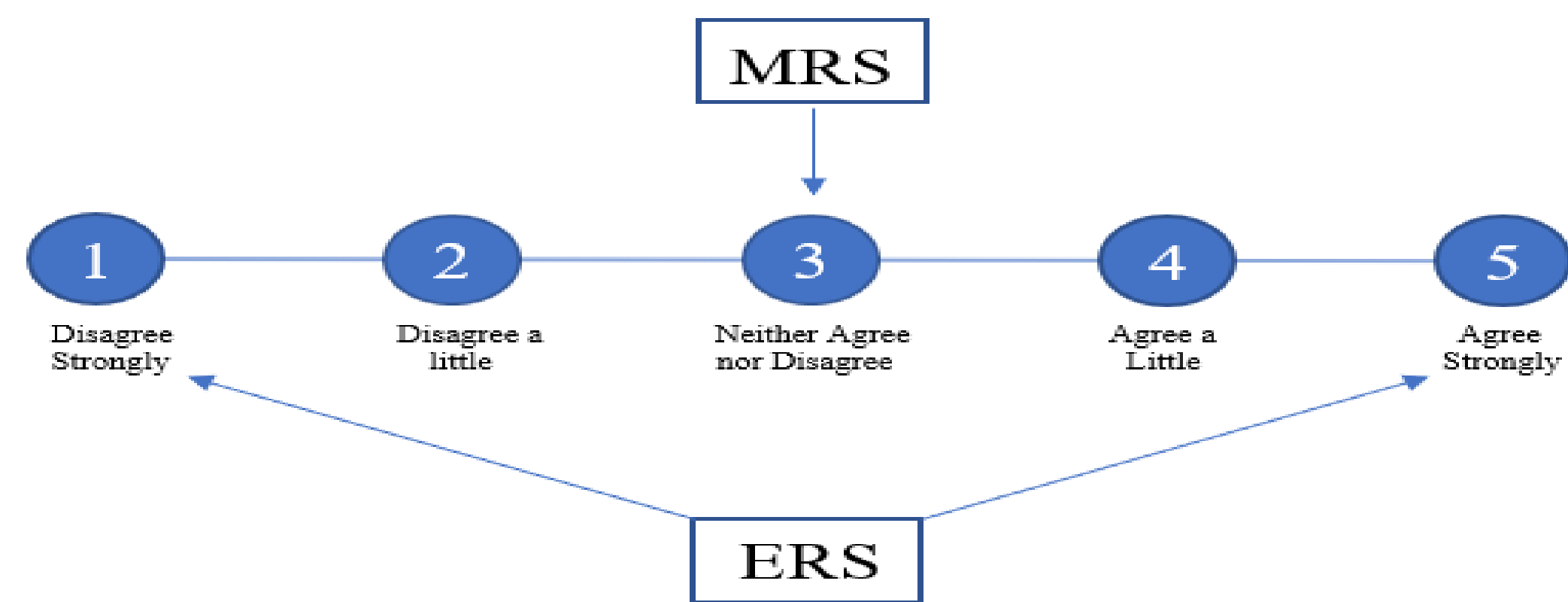
Imagine that we roll a fair, six-sided die, 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up as an even number?

Likert Scales are extremely prevalent in Psychological research to linearly transform attitudes.

Response Style patterns of responding that do not depend on question content.

Extreme Response Style a tendency to pick the endpoints of the scale

Midpoint Response Style a tendency to use the middle of the scale



OCEAN includes Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.

'I easily learn what I study at school'

The data was gathered from the **Understanding America Study N=7,157**.

Methods

Item Response Theory also known as latent trait theory is a set of models that defines a way of establishing the correspondence between latent variables and corresponding manifestations.³
- The models were run in the programming language R, and the Lavaan⁴ package.

IR-Tree models dichotomize polytomous items into multiple processes with each process having its own IRT model. This allows one to get information at multiple points within a single question by simultaneous estimation of the content variable and response style.

IR-Trees use the **probit** version of the 2PL

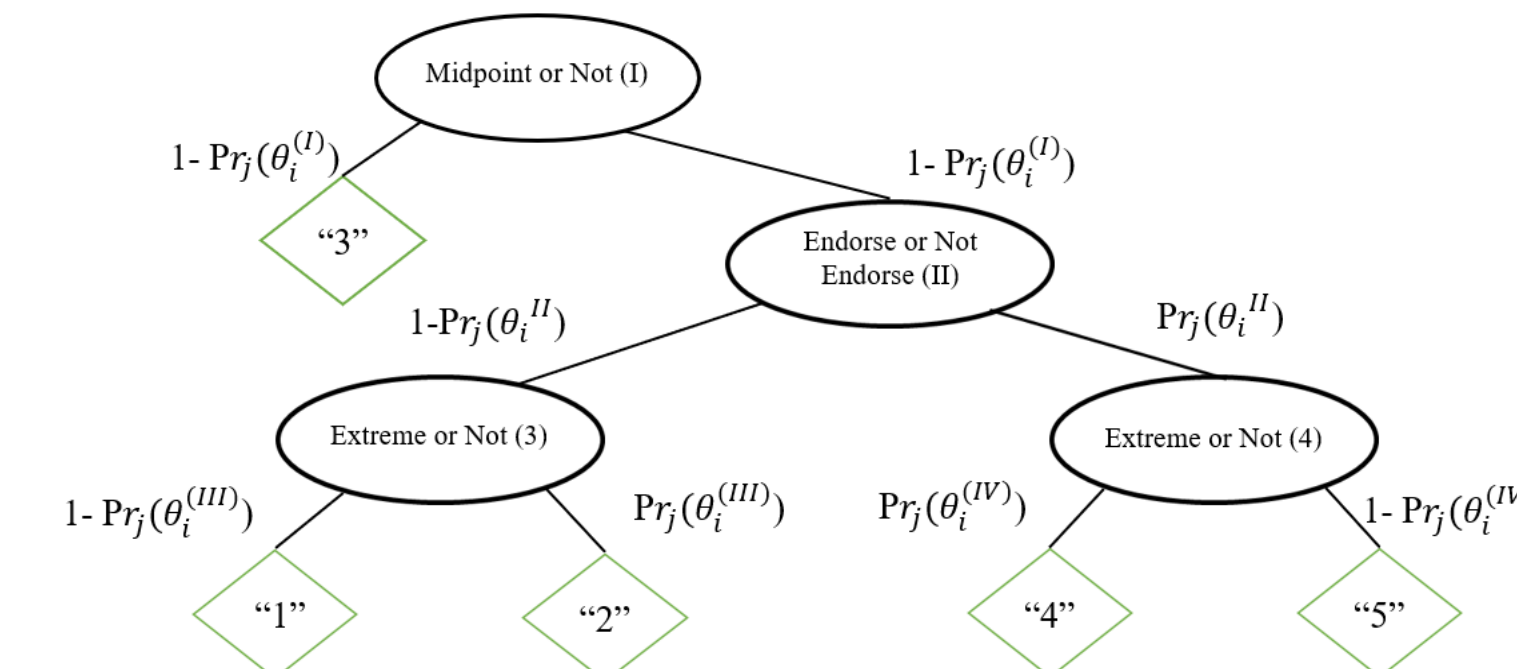
$$P(y_{ij} = "A") = 1 - \Phi(\theta_{ij} - \gamma_i)$$

Φ represents the normal cumulative distribution

γ represents difficulty – The point along the trait continuum where the probability of endorsement is .50

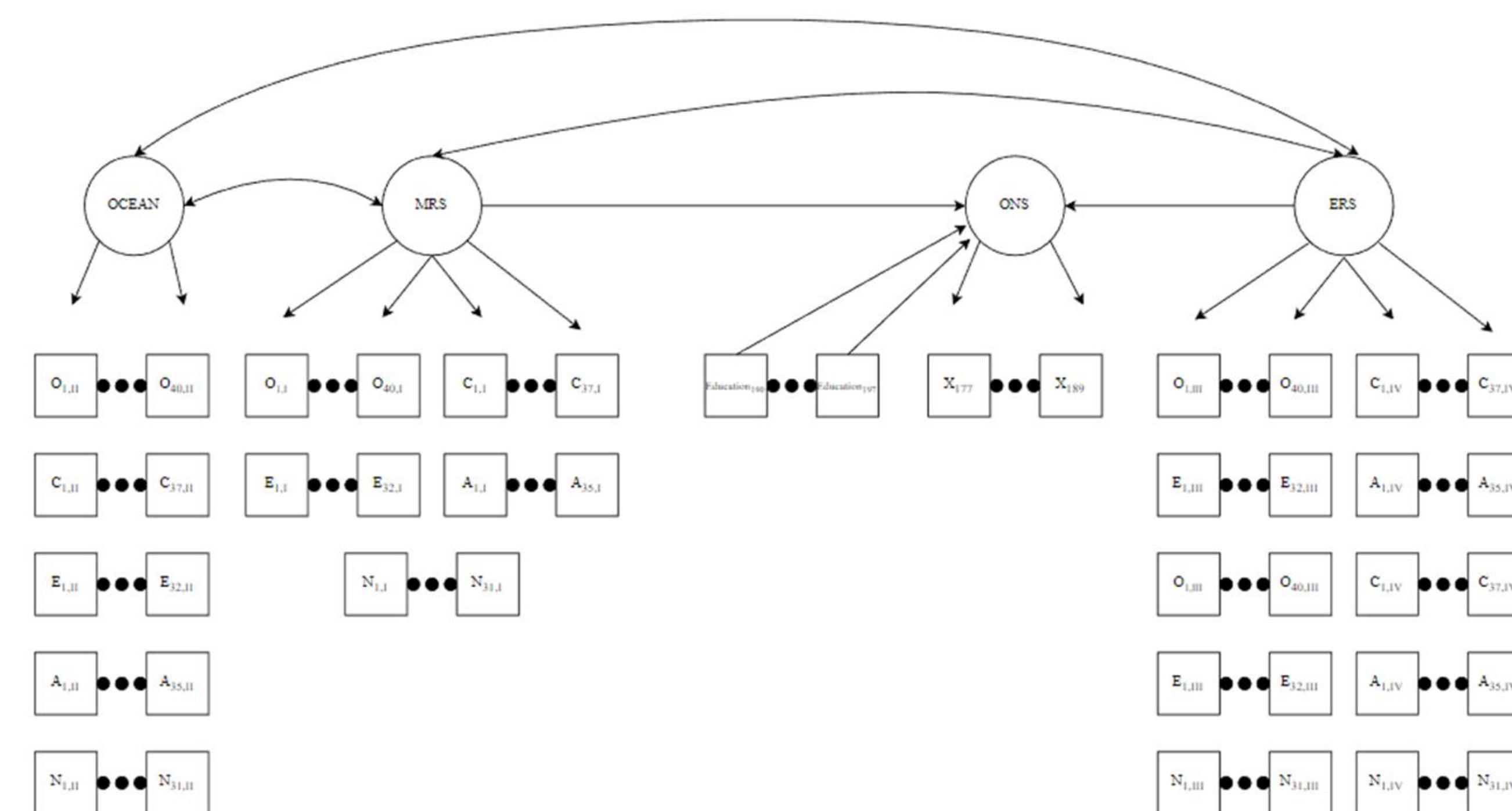
Response Categories	Pseudo Item Response			
	I	II	III	IV
1	0	0	0	-
2	0	0	1	-
3	1	-	-	-
4	0	1	-	1
5	0	1	-	0

Note: A dash (-) indicates a planned missing value



$$Y_{ONS} = \beta_0 + \beta_{education1}L_1 \dots + \beta_{education8}L_8 + \beta_{MRS}M_1 + \beta_{ERS}E_1$$

To separate **any potential confounding between numeracy, and education** we conducted a **regression**



Selected Results

After partialing out the effect of education the correlations are

Correlation Table	MRS	ONS	ERS
MRS	1		
ONS	-.105***	1	
ERS	-.458***	-.229***	1

*** Indicates $p < .001$

Discussion

Lower scores of **Numeracy** were correlated with higher levels of **Mid-point responding** ($r = -.055$)

Lower scores of **Numeracy** were correlated with higher levels of **Extreme responding** ($r = -.212$)

Higher rates of **Mid-point responding** were correlated with lower levels of **Extreme Responding** ($r = -.441$)

Even after accounting for the relationship between **Numeracy** and **Education**, lower numeracy was still significantly related to **higher levels of MRS and ERS**

Researchers may want to account for variabilities in response style to avoid misrepresentation of the variable of interest

Limitations: IR-Trees 'lose' information from each question about the primary focus (e.g., OCEAN)

Future Directions: Use Falk & Cai's Multidimensional Nominal Response Model to parse out response style

$$P(Y = k|x, a, S, c) = \frac{\exp([a \circ sk]'x + ck)}{\sum_{m=1}^K \exp([a \circ sm]'x + cm)}$$

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(Please ask me about code)

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