DUE-2013392

Students' Motivational Attitudes about Statistics: Results from the S-SOMAS Pilot

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S-SOMAS: Overview

- Student Survey of Motivational Attitudes toward Statistics (S-SOMAS)
  - For more information see Unfried et al. (2018) and Whitaker et al. (2019)
  - Based on Expectancy-Value Theory (Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2020)

	Student Instrument	**Instructor Instrument**	**Environment Inventory**
Statistics	S-SOMAS	I-SOMAS	E-SOMAS
Data Science	S-SOMADS	I-SOMADS	E-SOMADS

PI: Unfried; Co-PIs: Posner, Bond, Whitaker, and Kerby-Helm

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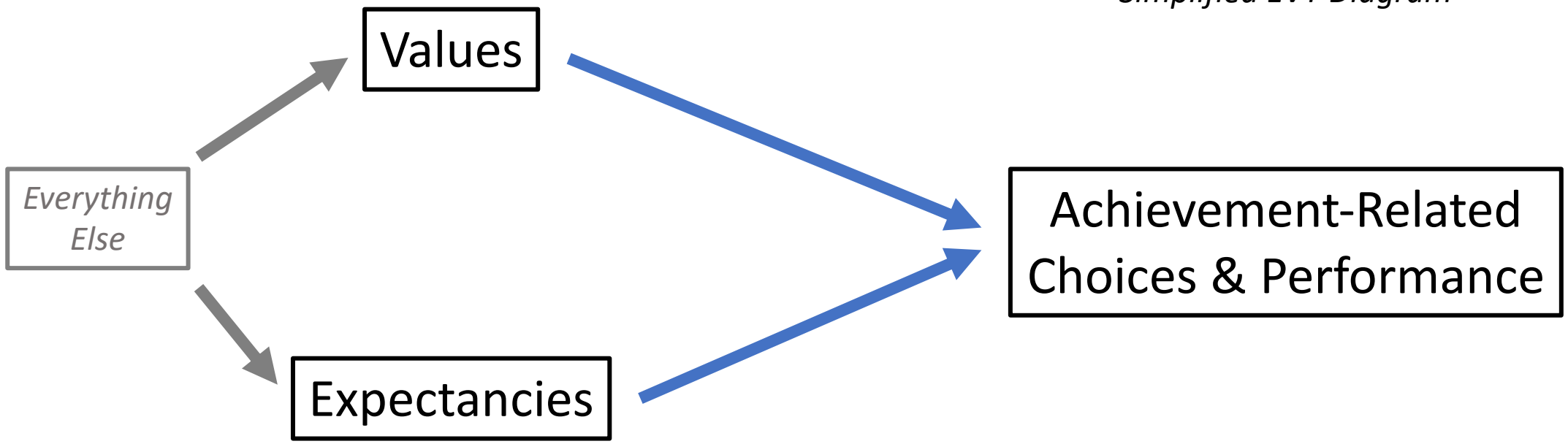
MASDER Team

The *Motivational Attitudes in Statistics and Data Science Education Research* (MASDER) team:

- Leyla Batakci *Elizabethtown College*
- Wendi Bolon *Monmouth College*
- Marjorie Bond *Monmouth College*
- April Kerby-Helm *Winona State University*
- Michael Posner *Villanova University*
- Alana Unfried *California State University, Monterey Bay*
- Douglas Whitaker *Mount Saint Vincent University*

Also: numerous undergraduate and graduate student assistants (including Matt Dunham); Research On Statistics Attitudes (ROSA) Working Group; USCOTS 2015 and 2017 Workshop participants; *many more!*

Simplified EVT Diagram



Expectancy-Value Theory (EVT)

- Originally developed to explain motivation for learning mathematics among students in grades 5-12 (Eccles (Parsons) et al., 1983) and is actively developed (Eccles & Wigfield, 2020)
- Widely used across disciplines and age (Eccles & Wigfield, 2002)
- Has been applied with university students (Eccles & Wigfield, 2020)

Scales on Pilot 0

Form 1	Form 2
Beliefs & Stereotypes about Statistics	Academic Self-Concept
Intrinsic Goal Orientation	Statistics Self-Concept
Extrinsic Goal Orientation	Expectancies
Interest/Enjoyment Value	Perception of Difficulty
Utility Value	Costs & Benefits
Attainment Value (on both forms)	Attainment Value (on both forms)
49 items	50 items
N = 1155 intro. stats. students	N = 1159 intro. stats. students

Challenges to using EVT for S-SOMAS

- *How should the EVT constructs be operationalized as scales?*
  - Want the S-SOMAS to be useful longitudinally… and not require enrolment in a statistics course
  - Some EVT constructs have been researched less than others
    - Especially *Costs & Benefits* (e.g., Flake et al., 2015; Wigfield et al., 2017)

- We will briefly examine EFA, PCA, and IRT results for one scale (Extrinsic Goal Orientation).

Extrinsic Goal Orientation

1. I need to know statistics.
2. I need to know statistics because it is required of me.
3. I need to know statistics to obtain a degree/certification.
4. I need to know statistics to satisfy employers.
5. I need to know statistics because it will be expected of me in the future.
6. I need to know statistics so that I appear intelligent to my peers.
7. I need to know statistics because someone important to me wants me to.
8. I need to know statistics because my family wants me to.

Definitions

"Extrinsically motivated behavior is defined as engaging in an activity to obtain an outcome that is separable from the activity itself (deCharms, 1968; Lepper & Greene, 1978)" (Vansteenkiste et al., 2006, p. 20)

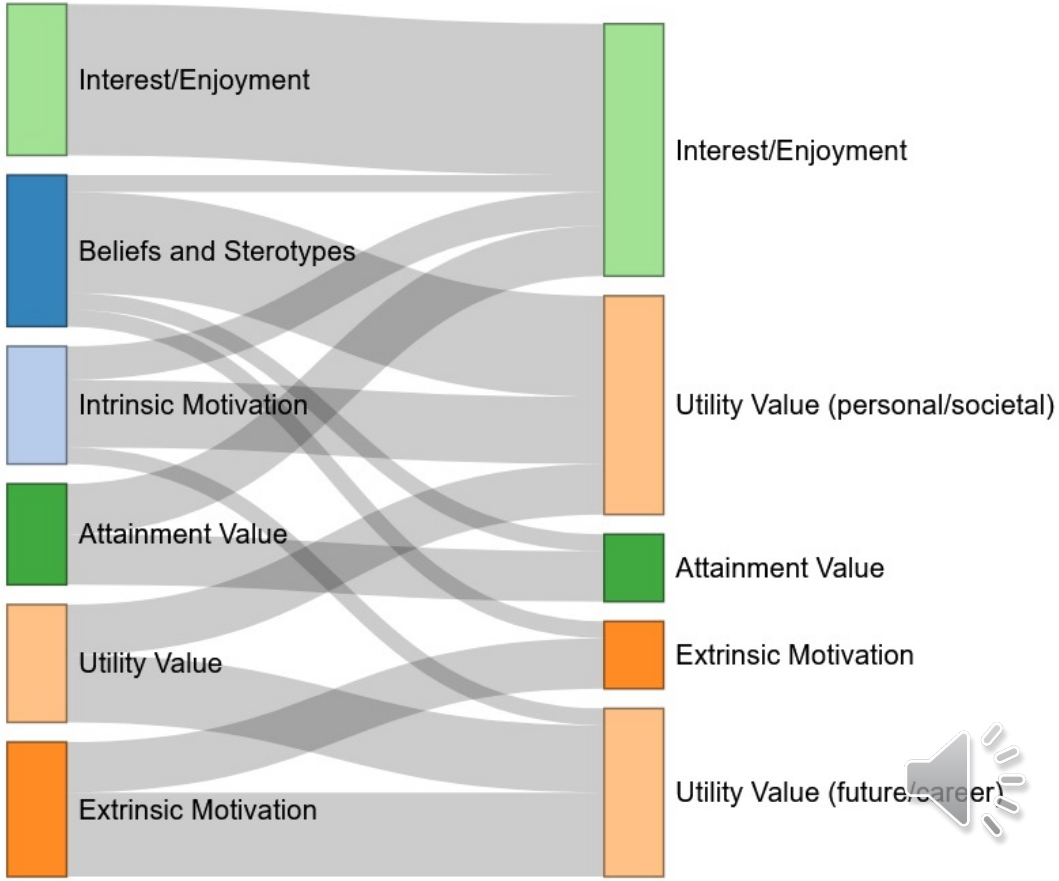
"Individuals with ego-involved [extrinsic] goals seek to maximize favorable evaluations of their competence and minimize negative evaluations of competence." (Eccles & Wigfield, 2002, p. 115)

Note: The term Extrinsic Motivation *is sometimes used instead.*

Exploratory Factor Analysis

- Extension of work by Unfried et al. (2018); a lot of credit to Matthew Dunham (2020)
- Exploratory Factor Analysis (EFA) with:
  - Polychoric correlations
  - Promax rotation
  - ƒa function in R

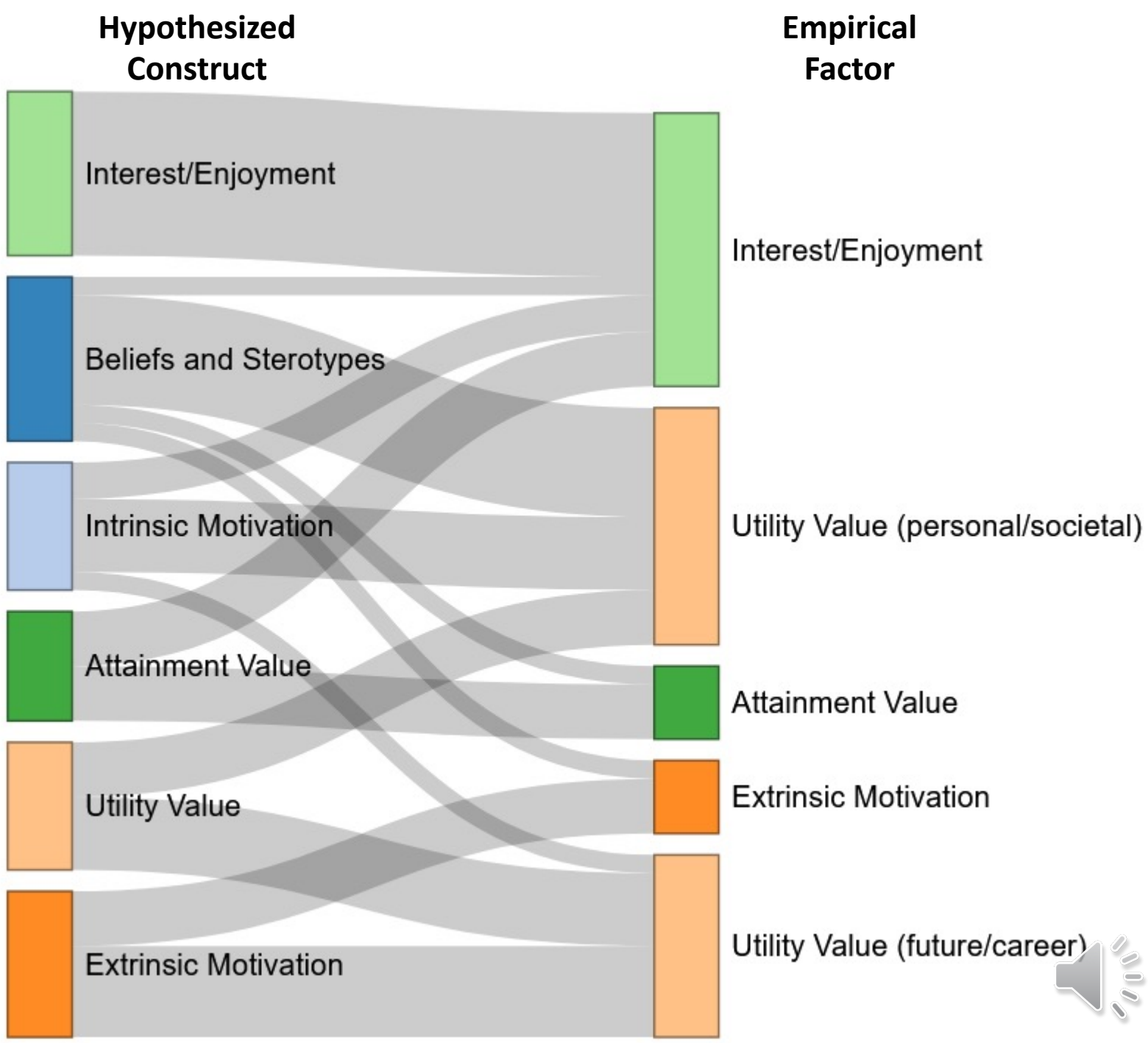
	PA2	PA1	PA4	PA3	PA5
Belief_1		0.726			
Belief_2					
Belief_3		-0.607			
Belief_4					
Belief_5					
Belief_6		0.693			
Belief_7		0.616			
Belief_8		0.624			
Belief_9		0.745			
Belief_10	0.746				0.441
Intrinsic_1	-0.579				
Intrinsic_2			0.414		
Intrinsic_3		0.684			
Intrinsic_4		0.432			
Intrinsic_5		0.652			
Intrinsic_6	-0.535				
Intrinsic_7		0.740			
Exstrinsic_1			0.509		
Exstrinsic_2			0.556		



EFA Results

Sankey Diagram from networkD3 R package

(Allaire et al., 2017)



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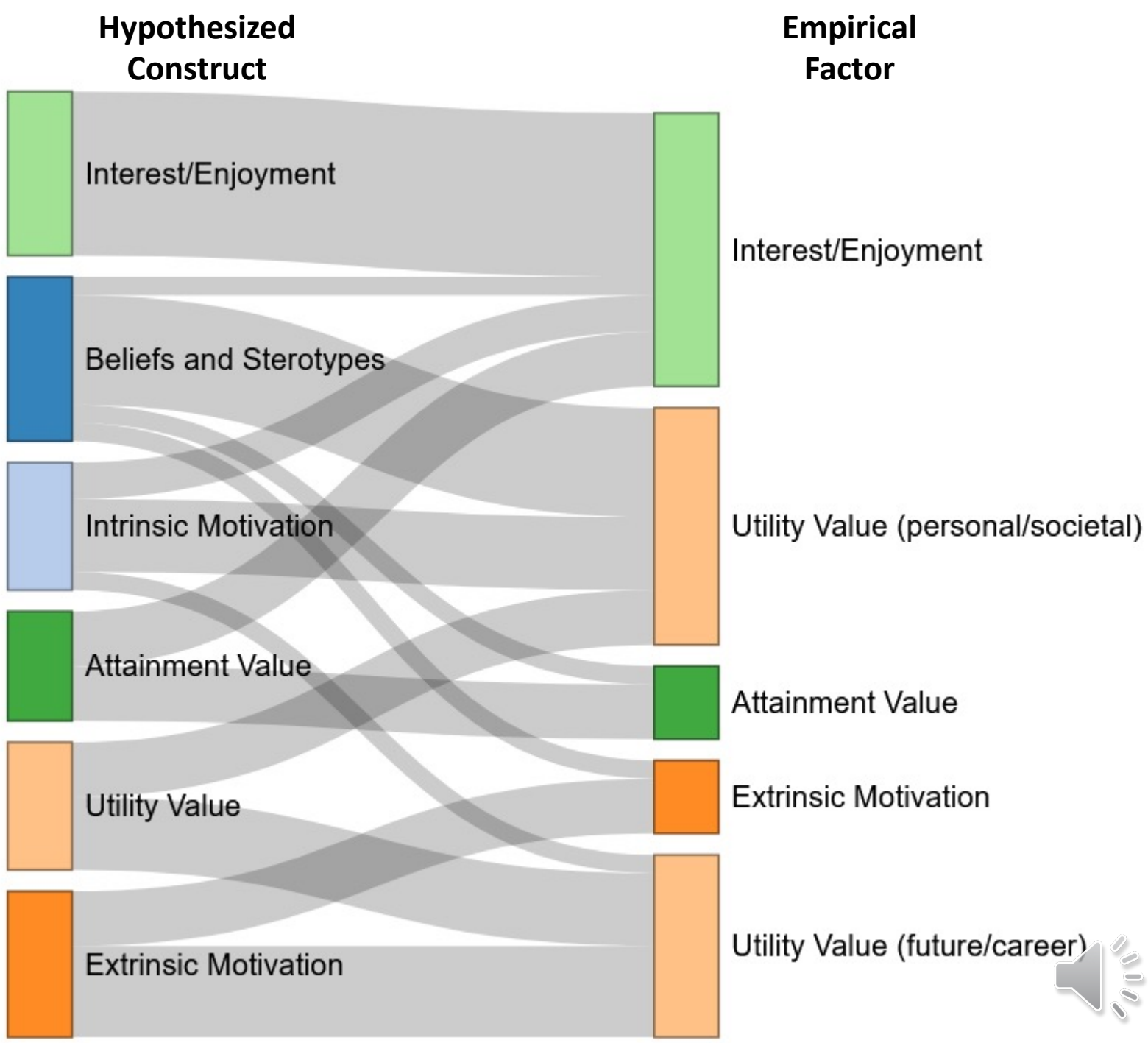

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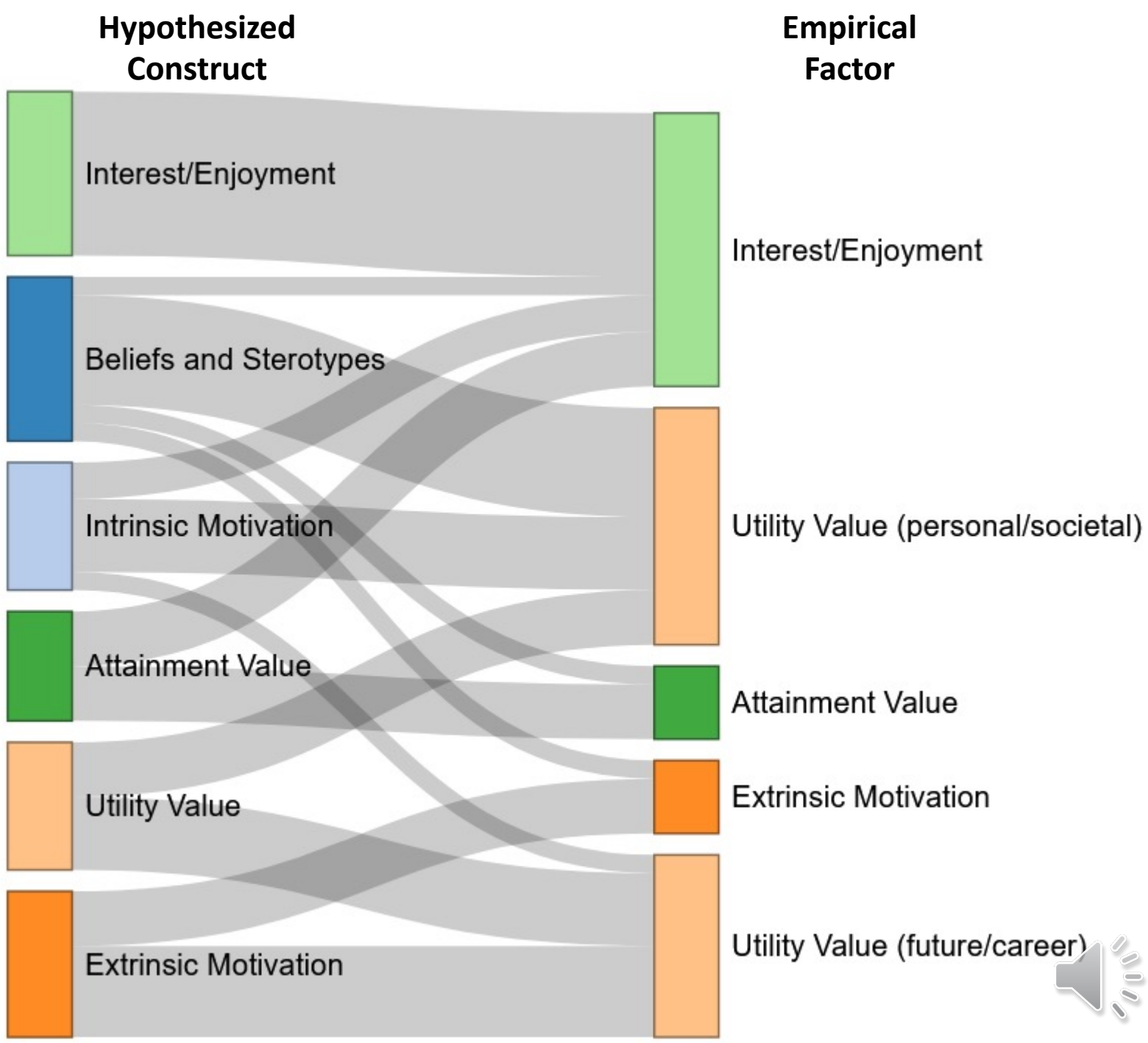
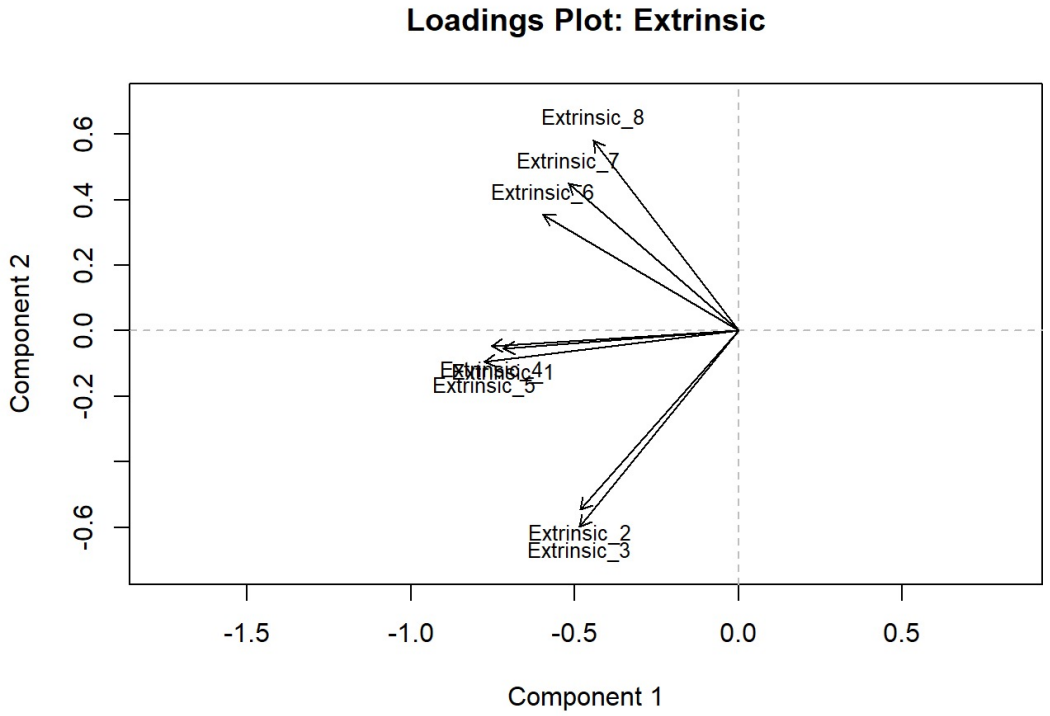


Dimensionality

- PCA used to assess unidimensionality assumption for IRT
  - `Gifi` package in R (Mair & De Leeuw, 2019)

- Roughly homogenous loadings on the first two components suggests items are measuring the same construct (Mair, 2018)



Extrinsic Goal Orientation

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7. I need to know statistics because someone important to me wants me to.
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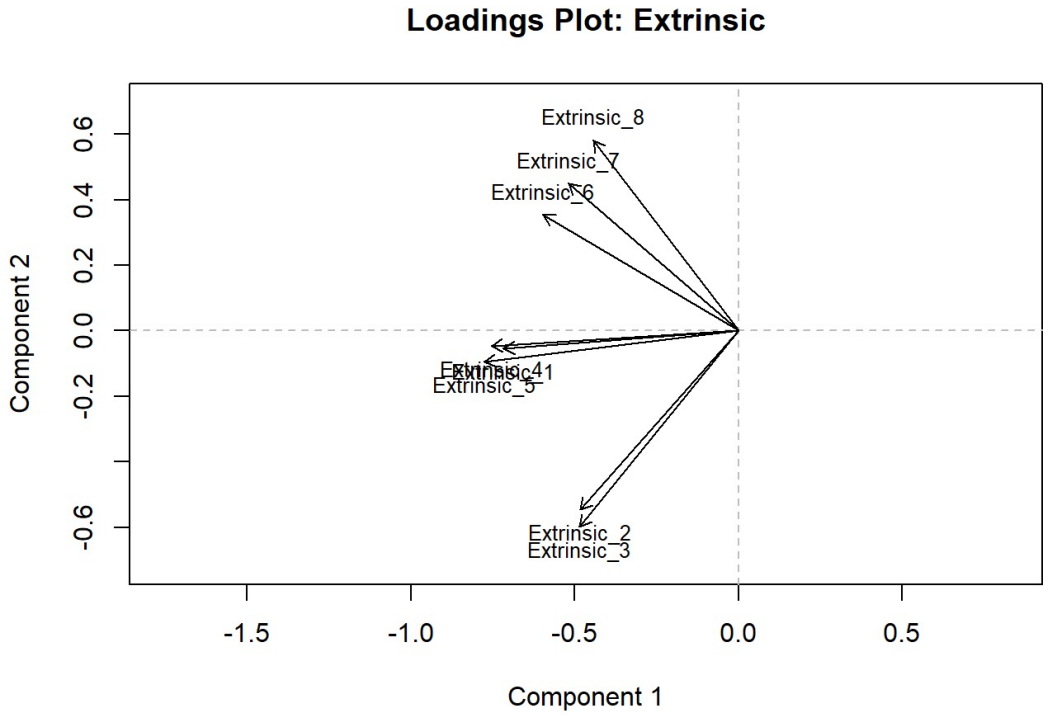

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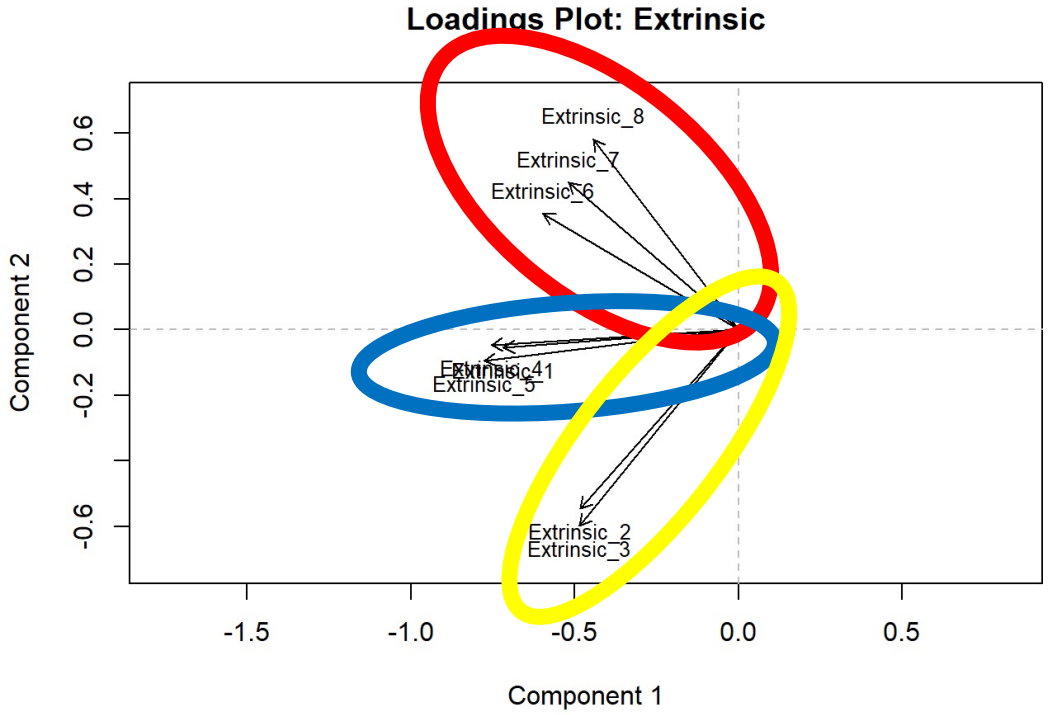

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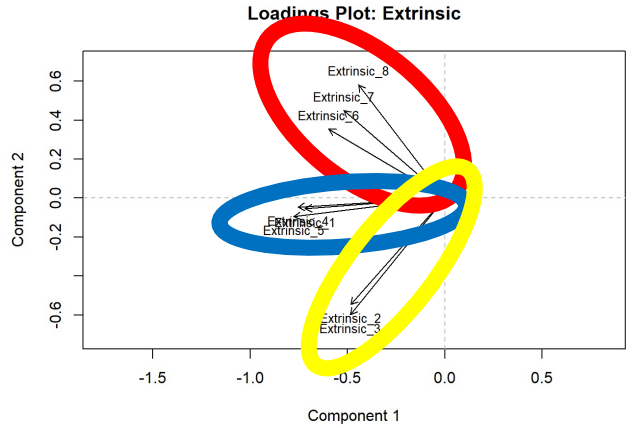

	PA2	PA1	PA4	PA3	PA5
Belief_10	0.746				0.441
Intrinsic_2			0.414		
Exstrinsic_1			0.509		
Exstrinsic_2			0.556		
Exstrinsic_3			0.512		
Exstrinsic_4			0.661		
Exstrinsic_5			0.732		
Exstrinsic_6					0.487
Exstrinsic_7					0.500
Exstrinsic_8					0.585
Utility_1			0.634		
Utility_2			0.476		
Utility_3			-0.422		
Utility_8			-0.553		
Attain_5					0.467
Attain_6					0.614
Attain_7					0.458

Partial EFA loadings table from previous slide

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Partial EFA loadings table from previous slide

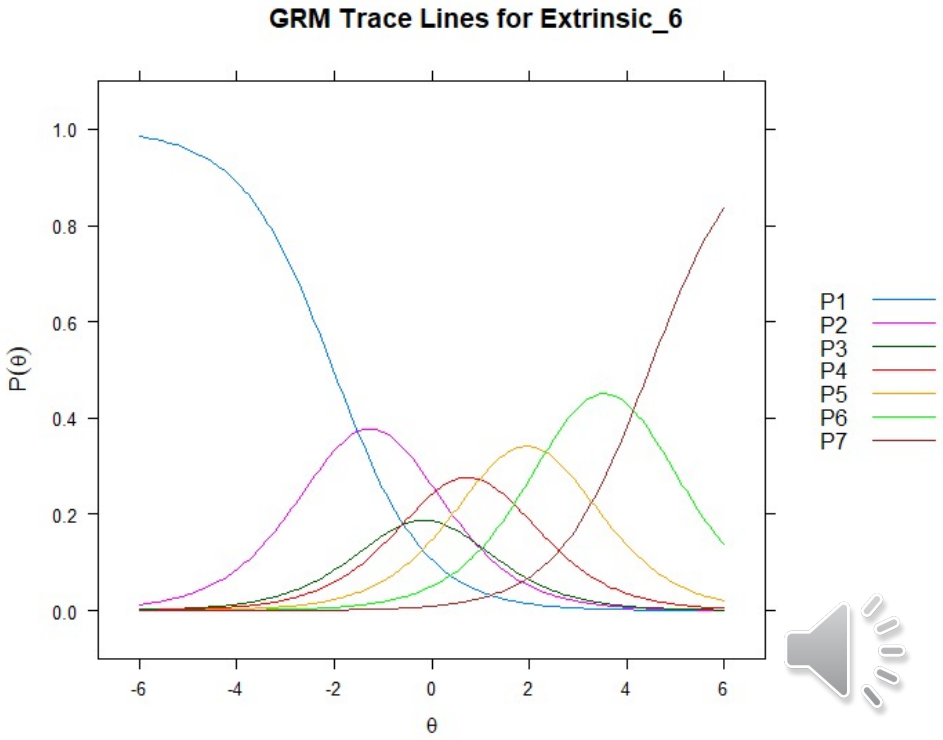
Item Response Theory

- Graded Response Model (GRM; Samejima, 1969)
  - Under the GRM, the probability that person n responds in category j or higher is given as

$$P_{nij}^{*} = \frac{\exp\left[\alpha_i\left(\theta_n - \delta_{ij}\right)\right]}{1 + \exp\left[\alpha_i\left(\theta_n - \delta_{ij}\right)\right]}$$

  - where θ_n represents the ability of person n,
  - α_i is the discrimination parameter for item i, and
  - δ_{ij} represents the point at which endorsing category j or higher is 0.50. (The δ_{ij} values are the locations of the boundaries between categories.)
- `mirt` R package (Chalmers, 2012)

item	outfit	z.outfit	infit	z.infit
Extrinsic_1	0.812331	-3.647524	0.839815	-3.407616
Extrinsic_2	0.917320	-1.634018	0.945811	-1.130446
Extrinsic_3	0.916533	-1.512248	0.956632	-0.846541
Extrinsic_4	0.814624	-3.776179	0.795204	-4.561520
Extrinsic_5	0.698351	-5.946859	0.703567	-6.550707
Extrinsic_6	0.934298	-1.718547	0.940876	-1.627520
Extrinsic_7	0.940678	-1.485473	0.958320	-1.122843
Extrinsic_8	0.913790	-1.580124	0.956166	-0.825954



Conclusions, Limitations, and Next Steps

- Lots of information for the MASDER team to review when revising the S-SOMAS instrument
  - EFA, PCA, IRT
  - Improved definitions
- Decision to split constructs into two forms limits interpretations
  - Pilot 1 includes all constructs on one form
- Next steps:
  - Revise items, remove items, write new items
  - Change number of response points (e.g., go from 7 to 5)
  - (Change response options? Rewrite items? [Drop Agree/Disagree?])
  - Use lessons when developing I-SOMAS, S-SOMADS

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Questions?

Live Q&A Wednesday, June 30th
2:45pm-3:30pm ET

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