

UTTyler™

THE UNIVERSITY OF TEXAS AT TYLER

UTTyler
THE UNIVERSITY OF TEXAS AT TYLER

Is latent factor analysis right for you?

Brandon L. Bretl, PhD
Assistant Professor
School of Education
University of Texas at Tyler

Outline

- Introductions
- What is a latent factor?
- What is latent factor analysis?
- Moral Development Example
- Key Takeaways

Introductions



Dr. Brandon Bretl

Assistant Professor, School of Education

PhD in Human Development and Learning

University of Kansas

- Math and science teacher
- Researcher on state standardized science tests
- Cognitive and social psych research



Introductions

Why attending?

What assessments/surveys are you using, creating, or plan on creating?

Have you used EFA or CFA?

Why do you think latent factor analysis might be a good fit?

The question of factor analysis…

You have 30 survey items.

Do they measure 1 thing?

5 things?

30 things?

What is a latent construct?

Real measurements



Latent Constructs



Latent Factor Analysis



PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

NAME:_____ **DATE:**_____

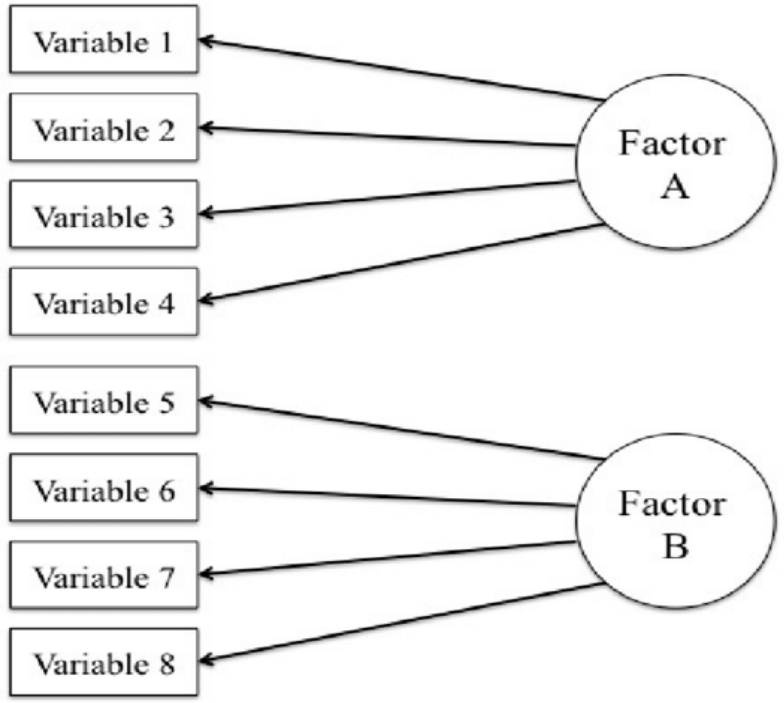
Over the last *2 weeks*, how often have you been bothered by any of the following problems?
(use "✓" to indicate your answer)

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3

Latent Factor Analysis

- The latent factor is **causing** some variation in ratings of items (measurements)

Latent Factor Analysis



Latent Constructs

- Cognitive
  - General intelligence
  - Working memory
  - Processing speed
  - Executive function
- Personality
  - Openness
  - Neuroticism
- Self-efficacy
- Social Psych
  - Empathy
  - Right-wing Authoritarianism
- Clinical
  - Depression
  - Impulsivity

Example: Moral Development

Social Domain Theory

Empathy for harm/injustice



Rules



Moral Foundations Theory

Care



Justice



Loyalty



Authority



Sanctity



Autonomy



Research Questions

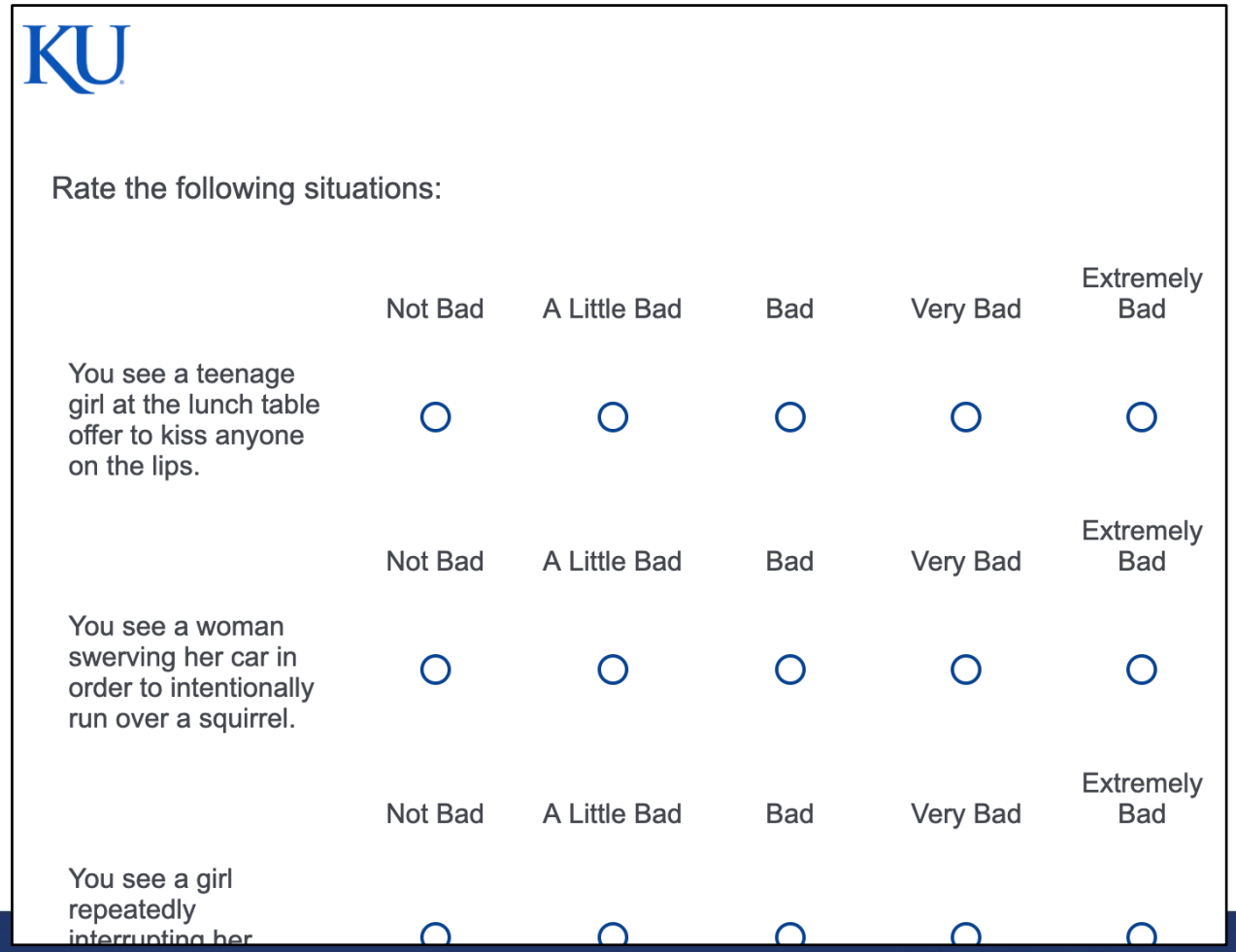
- Under the MFT paradigm, is the structure of moral intuitions in early adolescents consistent with adults?
- Any evidence of sex-based differences in development?
- Any developmental patterns consistent with SDT

Character Foundations Survey

- Previously validated
- Modified for use with children
- 48 items, 6 per factor

8 Factors

- Animal Physical
- Human Physical
- Human Emotional
- Justice
- Autonomy
- Authority
- Loyalty
- Sanctity



KU

Rate the following situations:

	Not Bad	A Little Bad	Bad	Very Bad	Extremely Bad
You see a teenage girl at the lunch table offer to kiss anyone on the lips.	○	○	○	○	○
	Not Bad	A Little Bad	Bad	Very Bad	Extremely Bad
You see a woman swerving her car in order to intentionally run over a squirrel.	○	○	○	○	○
	Not Bad	A Little Bad	Bad	Very Bad	Extremely Bad
You see a girl repeatedly interrupting her	○	○	○	○	○

UTTyler
THE UNIVERSITY OF TEXAS AT TYLER

Confirm psychometric validity of CFS for assessing adults



Test psychometric validity for assessing adolescents



Interpret results based on theory to create psychometrically valid assessment



Use psychometrically valid assessment to compare latent factor means to search for developmental patterns

Participants

- 3 suburban middle schools in Kansas
- n = 822
- M = 12.37 years old
- Predominantly Republican/Conservative counties

Adult Factor Covariances, 48-item Subset, Clifford et al. (2015) Data

	Animal Physical	Human Physical	Human Emotional	Justice	Autonomy	Authority	Loyalty
Animal Physical	1						
Human Physical	0.696	1					
Human Emotional	0.623	0.782	1				
Justice	0.537	0.677	0.704	1			
Autonomy	0.594	0.663	0.691	0.547	1		
Authority	0.367	0.621	0.785	0.701	0.632	1	
Loyalty	0.365	0.497	0.712	0.627	0.567	**0.837**	1
Sanctity	0.495	0.639	0.762	0.718	0.547	**0.815**	0.766

All p-values < .001
*Covariances greater than **.8** in bold.*

n = 416
M = 34 years old

Greater covariances between adolescent latent factors suggests a different factor structure than adults.

So an exploratory factor analysis was conducted…

Latent Factor Covariance Table of 8-Factor Model, Adolescent Data

	Animal Physical	Human Physical	Human Emotional	Justice	Autonomy	Authority	Loyalty
Animal Physical	1						
Human Physical	0.758	1					
Human Emotional	0.717	**0.886**	1				
Justice	0.607	**0.858**	**0.903**	1			
Autonomy	0.708	0.695	**0.814**	0.729	1		
Authority	0.631	**0.835**	**0.906**	**0.973**	0.680	1	
Loyalty	0.439	0.560	0.597	0.654	0.626	0.706	1
Sanctity	0.489	0.732	**0.808**	**0.851**	0.572	**0.918**	0.640

All p-values < 0.001
*Covariances greater than **.8** in bold.*

n = 822
M = 12.37 years old

6-Factor EFA (Promax Rotation), Adolescent Data

Loading	ID	MFT Fact.	Item
			Factor 1
0.617	Q2_1	Hum. Emot.	...a girl laughing at another student forgetting her lines at a school play.
0.522	Q3_1	Hum. Emot.	...a woman commenting out loud about how bad another woman's hair looks.
0.802	Q1_3	Justice	...a student copying a classmate's answer sheet on a final exam.
0.470	Q2_3	Justice	...a runner taking a shortcut on the course during the marathon in order to win.
0.579	Q3_3	Justice	...someone cheating in a card game while playing with a group of strangers.
0.733	Q1_5	Authority	...a girl repeatedly interrupting her teacher as he explains instructions.
0.584	Q2_5	Authority	...a teenage girl coming home late and ignoring her parents' rules.
0.617	Q5_6	Authority	...a student say that her teacher is a fool during an afternoon class.
0.589	Q1_7	Sanctity	...a teenage girl at the lunch table offer to kiss anyone on the lips.
0.451	Q4_7	Sanctity	...a boy spit on the floor in the hallway.
			Factor 2
0.694	Q1_8	Anim. Phys.	...a man beating his pony with a whip for getting loose from its pen.
0.738	Q2_2	Anim. Phys.	...a woman throwing her cat across the room for scratching the furniture.
0.549	Q3_2	Anim. Phys.	...someone leaving his dog outside in the rain after it dug in the trash.
0.501	Q4_2	Anim. Phys.	...a boy throwing rocks at cows in a field.
0.565	Q5_2	Anim. Phys.	...a zoo trainer jabbing a dolphin to get it to entertain his customers.
0.433	Q3_8	Hum. Phys.	...a woman spanking her child with a spatula for getting bad grades in school.
			Factor 3
0.642	Q6_2	Hum. Phys.	...a boy placing a thumbtack sticking up on the chair of another student.
0.668	Q6_9	Hum. Phys.	...a girl whip a boy with a rope because she doesn't like him.
0.416	Q1_1	Hum. Emot.	...a teenage boy laughing at another boy with a disability.
0.448	Q4_3	Justice	...a referee intentionally making bad calls that help his favored team win.
0.683	Q6_3	Justice	...a teacher giving a bad grade to a student just because he dislikes him.
			Factor 4
0.490	Q2_4	Autonomy	...a mother telling her son that she is going to choose all of his friends.
0.497	Q3_4	Autonomy	...a man forbidding his wife to wear clothing that he has not first approved.
0.730	Q4_4	Autonomy	...a woman pressuring her daughter to become a famous evening news reporter.
0.666	Q6_4	Autonomy	...a mother forcing her daughter to enroll as a medical student in college.
			Factor 5
0.636	Q5_8	Sanctity	...a man blow his nose into his shirt.
0.634	Q6_8	Sanctity	...a woman not wash her hands after using a public toilet.
			Factor 6
0.443	Q1_6	Loyalty	...a coach celebrating with the other team's players who just won the game.
0.552	Q2_6	Loyalty	...a former US General saying publicly he would never buy any American product
0.500	Q3_6	Loyalty	...a mayor saying that the neighboring town is a much better town.
0.432	Q4_6	Loyalty	...a teacher publicly saying she hopes another school wins the math contest.

- Abstract, rule-based violations
- And/or unclear victim
- Or possibly culpable victim

Animal Physical

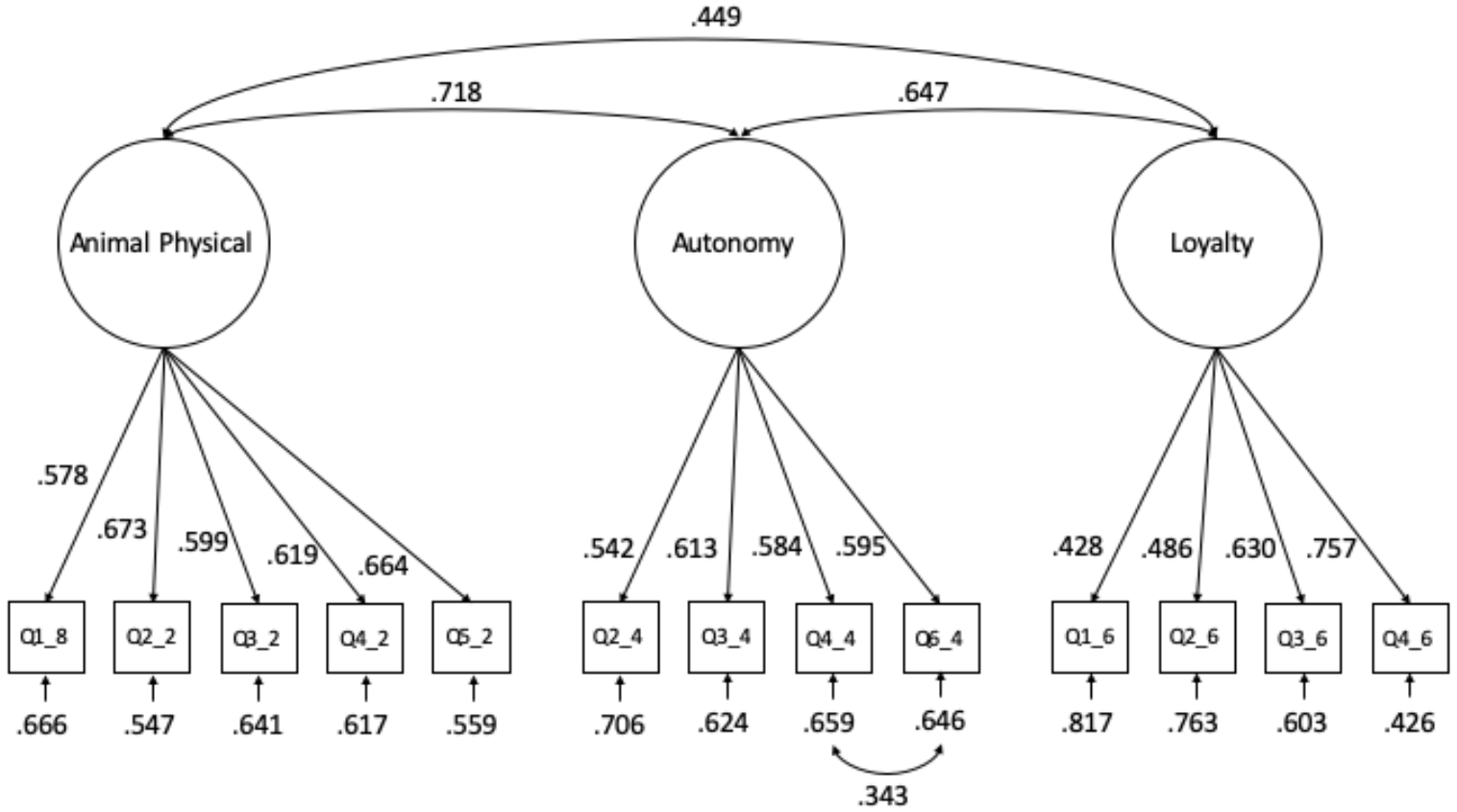
- Clearly innocent victim
- Obvious harm that is easy to empathize with

Autonomy

Sanctity

Loyalty

3 Factor Model

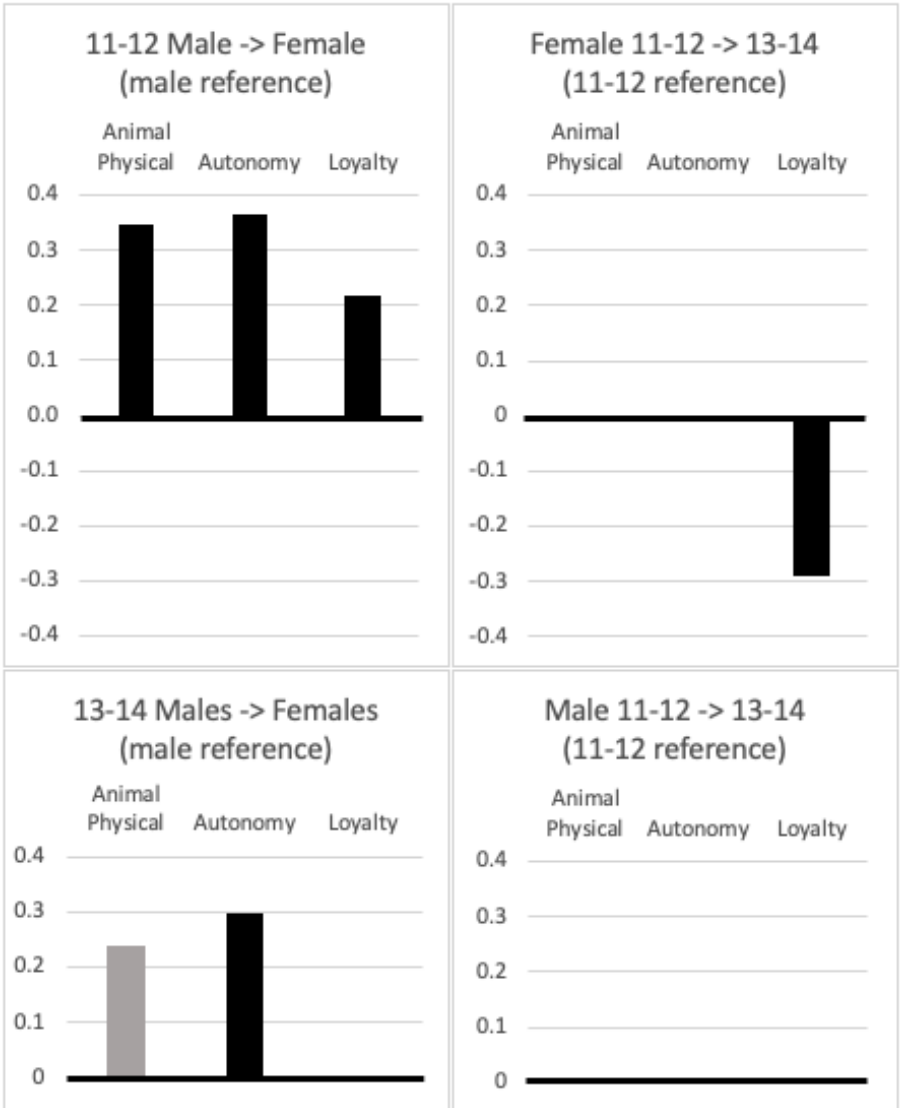


UTTyler
THE UNIVERSITY OF TEXAS AT TYLER

Invariance Testing

- **Configural:** Both groups see the same constructs in the items. The questions “hang together” the same way.
- **Metric:** The items mean the same thing to both groups. A one-unit change in the construct shows up as the same change in item responses.
- **Scalar:** Both groups use the same starting point on the scale. People with the same level of the construct give the same answers, regardless of group.

Latent Factor Mean Comparison



Modification Indices

You see…

…a girl repeatedly interrupting her teacher as he explains instructions.

…a teenage girl coming home late and ignoring her parents' rules.

modification indices

…a boy turning up the TV as his father talks about his military service.

…a teaching assistant talking back to the teacher in front of the classroom.

…a student say that her teacher is a fool during an afternoon class.

…a star player ignoring her coach's order to come to the bench during a game.

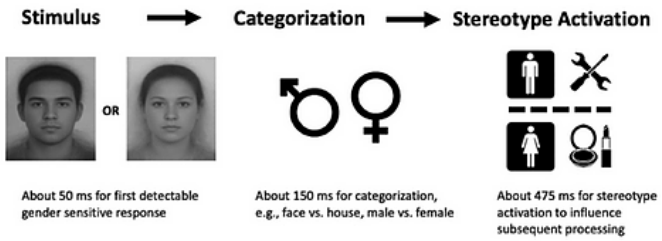


Figure 2. Time course of rapid gender response, categorization, and stereotype activation. A 50 ms response is the earliest detectable response to gendered facial information. Categorization is theorized to occur at about 150 ms, and stereotype activations that can influence subsequent processing (e.g. semantic priming) is theorized to be accomplished by about 475 ms. Face stimulus image licensed under Creative Commons Attribution 4.0 International, cited in Tappe et al. (2013).

Neural and Linguistic Considerations for Assessing Moral Intuitions Using Text-Based Stimuli
Journal of Psychology
Brandon L. Bretl
https://doi.org/10.1080/00223980.2020.1832034

UTTyler
THE UNIVERSITY OF TEXAS AT TYLER

Condition 1

Female-gendered noun intro

You see a girl…her…

Condition 2

Neutral intro, female pronoun

You see a student…her…

Condition 3

Male-gendered noun intro

You see a boy…his…

Condition 4

Neutral intro, male pronoun

You see a student…his…

Violation Type	Conditions Compared	Mean Ratings	
		Republican	Democrat
Authority	1, 2	3.15, 2.86 *	2.61, 2.71
	3, 4	3.03, 3.07	2.78, 2.66
	1, 3	3.15, 3.03	2.61, 2.78 *
Justice	1, 2	3.61, 3.38	3.36, 3.31
	3, 4	3.50, 3.58	3.47, 3.36
	1, 3	3.61, 3.50	3.36, 3.47

Republicans, authority violations

Condition 1
Female-gendered noun intro

You see a girl…her…

Condition 2
Neutral intro, female pronoun

You see a student…her…

Democrats, authority violations

Condition 1

Female-gendered noun intro

You see a girl…her…

Condition 3

Male-gendered noun intro

You see a boy…his…

Factor analysis is right for you if…

- You believe an unobservable construct (e.g., motivation, self-efficacy) causes responses on several indicators.
- You have multiple indicators per construct, ideally 4 or more.
- You're developing, validating, or adapting an instrument.
- You need to check whether an existing scale's structure holds in your population.
- You have a theory to test (CFA) or a reasonable basis for exploring structure (EFA).
- You plan to compare groups and need to establish measurement invariance first.
- Your sample is reasonably large: a common starting point is 200 or more, with more needed for complex models or ordinal data.
- Your items are meaningfully intercorrelated.

Probably not right for you if…

- Your indicators define the construct rather than reflect it. SES built from income, education, and occupation is an example
- You just want to reduce many variables to fewer scores for prediction. PCA is the better tool.
- You want to group people, not variables. Use latent class/profile analysis or clustering.
- You care about item difficulty and precision across ability levels. IRT is a better fit.
- You have single-item measures or only 1–2 items per construct.
- Your sample is small (roughly under 100–150) or your items are weakly correlated.
- You’re hoping the analysis will generate a theory with no conceptual starting point.

Creating Instruments

- Define the construct(s) clearly before writing items.
- Write more items than needed per construct (expect some to be dropped).
- Keep items clear, specific, and single-idea (avoid double-barreled wording).
- Ensure items reflect the full construct domain, not just one narrow aspect.
- Include a mix of items with enough variation but avoid redundant wording.
- Use a consistent response scale appropriate to the construct and population.
- Pilot test for clarity and comprehension before formal data collection.
- Plan for adequate sample size and item-to-response coverage.
- Use EFA for exploration/refinement, then CFA for confirmation (ideally in a new sample).
- Keep theory central: statistics guide revision, but theory drives decisions.

Workflow

- Start with purpose and construct clarity
- Write/review items
- Pilot and collect data
- Run item statistics
- Check dimensionality (EFA/CFA as appropriate)
- Revise and re-test
- Document decisions for transparency and defensibility

Decision Guide

Question 1: What is my actual goal?

If your goal is to...	Example question	Best fit
Discover the structure of a new item pool	“What dimensions are in my 40 new items?”	EFA
Test a hypothesized structure	“Does this scale have the 3 factors theory predicts?”	CFA
Validate an existing scale in a new population or translation	“Does this scale work with rural Texas middle schoolers?”	CFA
Compare group means on a construct	“Do boys and girls differ in math anxiety?”	Multi-group CFA (invariance first)
Relate constructs while removing measurement error	“Does self-efficacy predict persistence?”	SEM
Reduce many variables to a few scores for prediction	“Can I summarize 20 predictors into 4?”	PCA
Sort people into types	“Are there distinct engagement profiles?”	Latent profile/class analysis
Evaluate how items perform across ability levels	“Which items discriminate among high achievers?”	IRT
Build an index from defining components	“Create a school-resources index”	Composite score

Need additional help?

Thank you!

BBRETL@uttyler.edu