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Jumpstart Mplus

5. Data that are skewed, incomplete or categorical

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Questions

- How do I deal with missing values?
- How do I deal with non normal data?
- How do I deal with categorical data?

Missing values

- Missing completely at random (MCAR):
  - Missing by design (to avoid fatigue); by chance...
- Missing at random (MAR)
  - Missing values that are function of an unrelated variable; not of the variables(s) under investigation
  - E.g. Depression: Missing values on suicidal thoughts do not depend on the level of suicidal thoughts. It might depend on gender; females being more prone to answer to this question than males.
- Missing not at random (MNAR)
  - Missing values that are function of the variables under investigation
  - E.g. Depression: Missing values on suicidal thoughts that depend on the level of suicidal thoughts: The higher the number of suicidal thoughts a person has, the less likely this person will provide an answer to this question.

Missing values

- MCAR and MAR are “ignorable”
  - Usually no special treatment is needed.
  - In Mplus missing data are imputed.
    - For imputation method:
    - http://www.statmodel.com/discussion/messages/22/22.html
  - Missing are all ( )
  - ML can be used (or robust ML; MLR)
- MNAR = PROBLEM...
  - Consider collecting more data
  - At the very least interpret results with caution.

Missing values

- Missing values need to be identifiable by something (positive or negative; 999, -999).
- MISSING ARE ALL
  - (-999)
  - variable (#);
  - . ;
  - * ;
  - BLANK;
- A note: type = missing not necessary anymore in Mplus

That's it!

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Example

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Missing values

SUMMARY OF DATA

Number of missing data patterns 9

COVARIANCE COVERAGE OF DATA

Minimum covariance coverage value 0.100

PROPORTION OF DATA PRESENT

Covariance Coverage

	SHOW	INTER	SKILL	PLEASE	POSIVIEW
SHOW	0.972				
INTER	0.947	0.972			
SKILL	0.943	0.947	0.968		
PLEASE	0.957	0.957	0.954	0.986	
POSIVIEW	0.954	0.954	0.950	0.964	0.979
WELL	0.950	0.950	0.947	0.964	0.957

Covariance Coverage

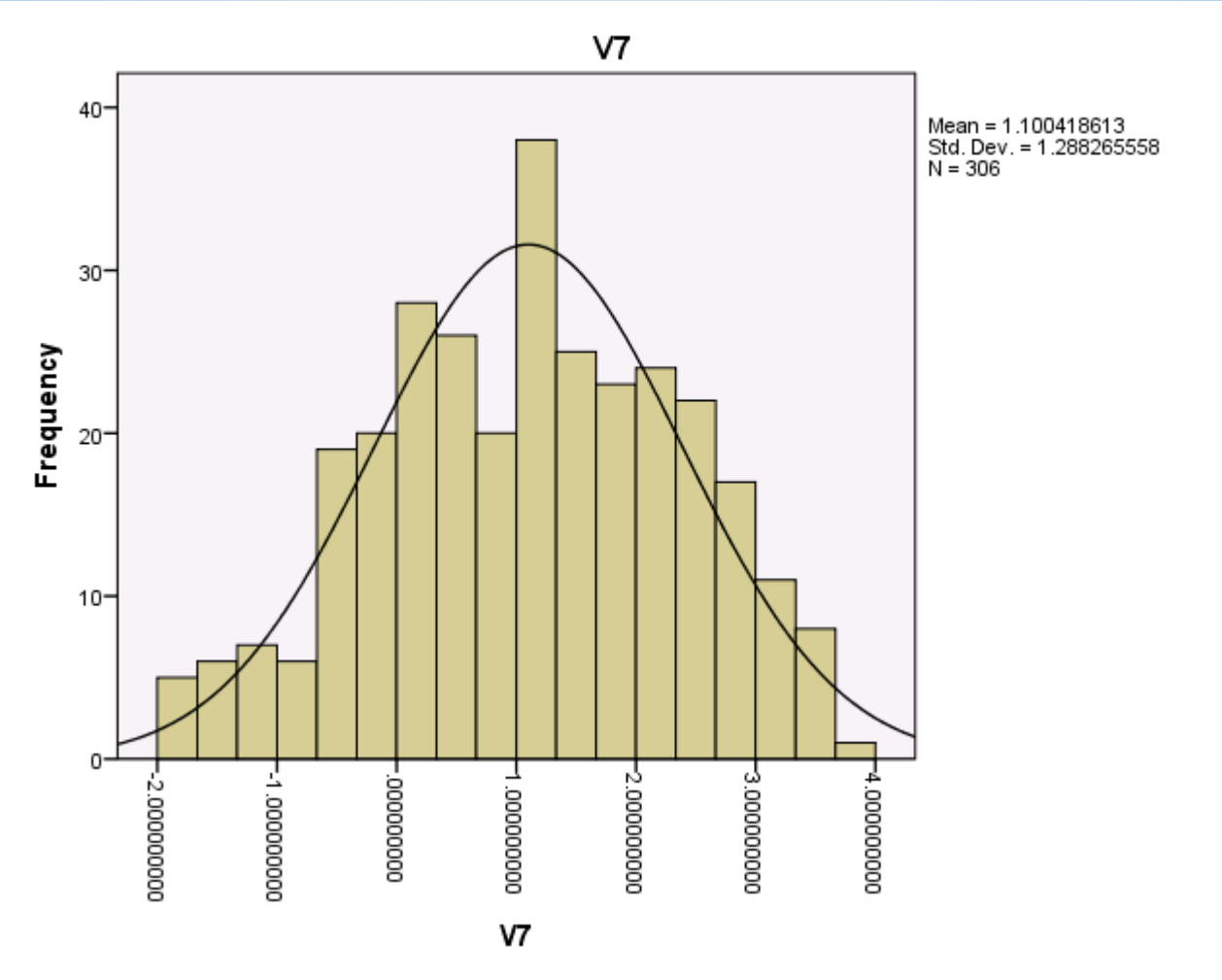
	WELL
WELL	0.979

Non normal data : continuous

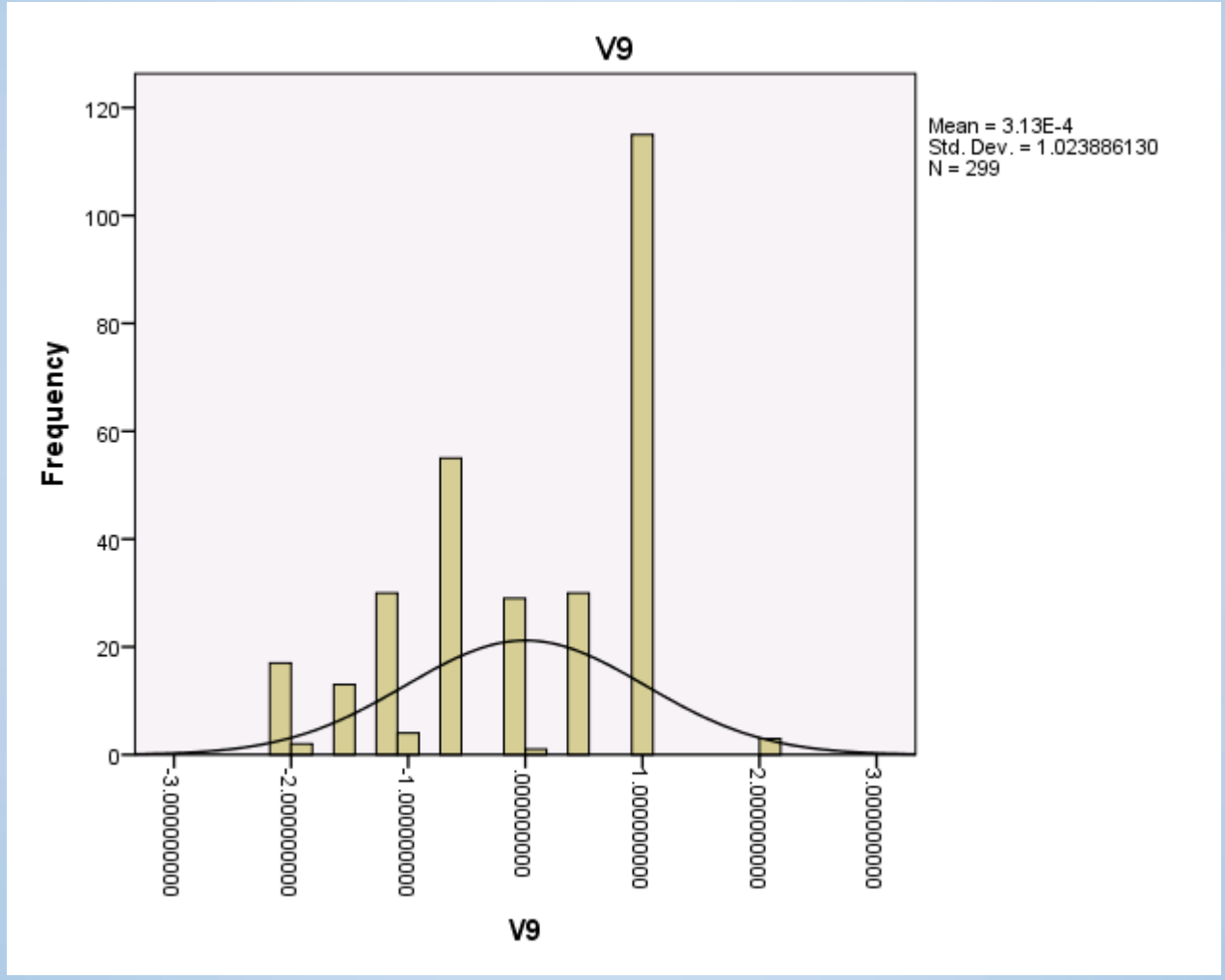
- Data that are skewed or kurtosed

- Potential consequences of using non-normal variables
  - Inflated Chi Square
  - Underestimation of CFI and TLI
  - Underestimation of standard errors

Normal distribution curve

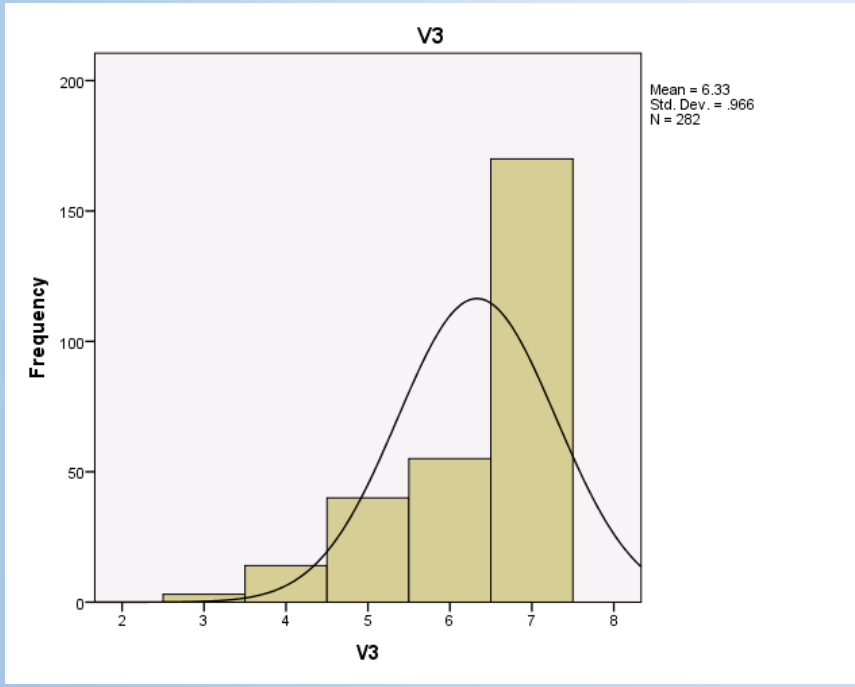


Kurtosis

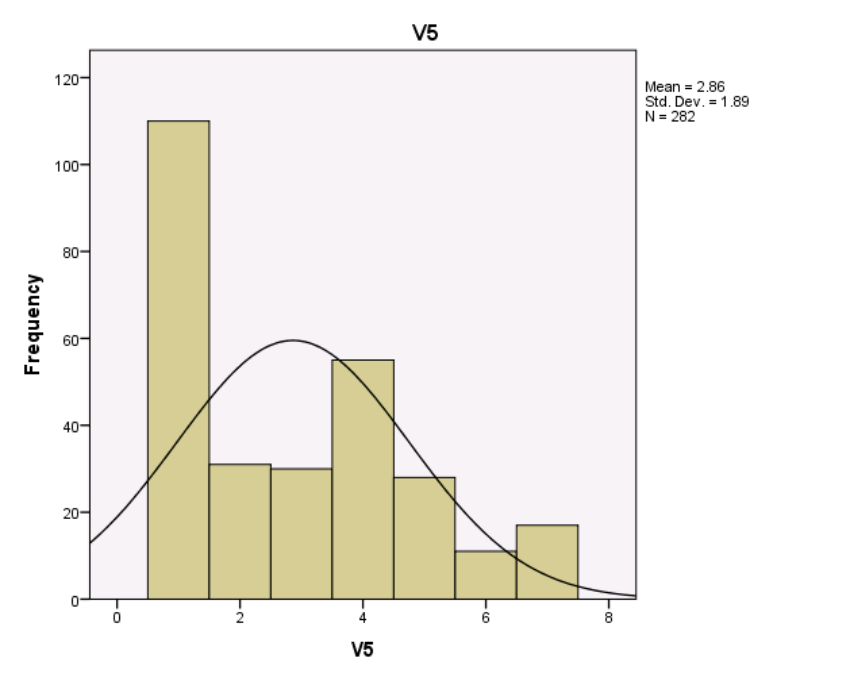

V9
Mean = 3.13E-4
Std. Dev. = 1.023886130
N = 299
Frequency
120
100
80
60
40
20
0
-3.00000000
-2.00000000
-1.00000000
.00000000
1.00000000
2.00000000
3.00000000
V9

Skew

Negative



Positive



Non normal data : continuous

- ML and GLS are robust to minor deviations from normality
  - With a big enough sample size...
- In doubt, use:
  - MLR: Maximum likelihood with robust standard errors
  - WLS: Weighted least square minimises the differences between observed and predicted values. NOT RECOMMENDED

Example

```
Information Criteria

          Akaike (AIC)                       5674.598
          Bayesian (BIC)                     5743.794
          Sample-Size Adjusted BIC           5683.545
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit

          Value                                 5.447*
          Degrees of Freedom                        8
          P-Value                              0.7088
          Scaling Correction Factor             1.0130 !Satorra-Bentler scaled (mean-adjusted) chi-square;  the usual normal-theory chi-square
                for MLR                                !statistic is divided by a scaling correctionto better approximate chi-square under
                                                       !non-normality.


*   The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used
    for chi-square difference testing in the regular way.  MLM, MLR and WLSM
    chi-square difference testing is described on the Mplus website.  MLMV, WLSMV,
    and ULSMV difference testing is done using the DIFFTEST option.

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.000
          90 Percent C.I.                    0.000  0.053
          Probability RMSEA <= .05           0.939

CFI/TLI

          CFI                                1.000
          TLI                                1.015

Chi-Square Test of Model Fit for the Baseline Model

          Value                            341.921
          Degrees of Freedom                    15
          P-Value                           0.0000

SRMR (Standardized Root Mean Square Residual)

          Value                              0.015
```

Categorical data

- Categorical data that are not approximating normal distribution or that have less than 5 categories should not be treated as continuous.
- This might lead to :
  - Overestimation of Chi square
  - Underestimation of the relationships between the variables
  - Incorrect test statistics and standard errors

Categorical data

- So what to do?
  - In the VARIABLE command, add:
    - CATEGORICAL ARE:
  - Use WLSMV (default estimator when CATEGORICAL is mentioned). Based on polychoric or polyserial correlations. It uses robust standard errors.
  - According to Brown (2006), Mplus is the best software to deal with categorical data!

Mplus

Example

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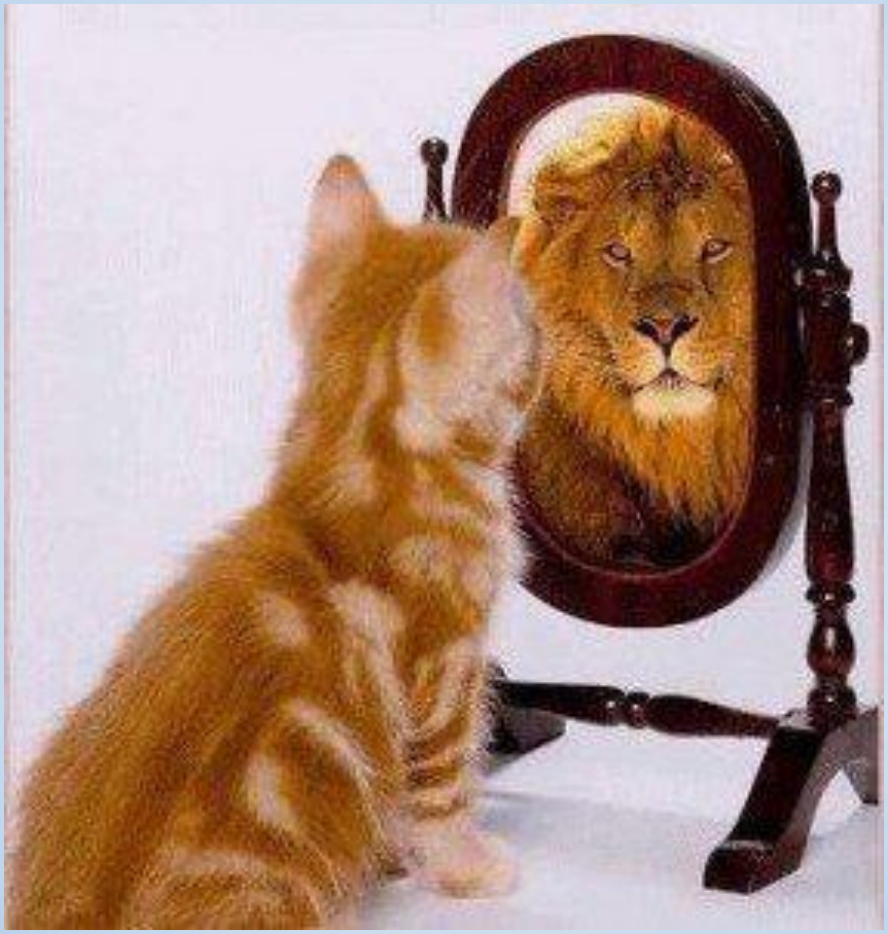
Self Monitoring



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The Study

- Self Monitoring in social psychology refers to an individual's ability or willingness to control their self presentation in social situations.
  - Self Monitoring Questionnaire (Snyder, 1974)
    - 25 statements about behaviours in social situations.
    - Overarching question: Is this statement true to you?
    - Answers = True or False
- We want to assess the factorial validity of a short version (6 questions):
    - I laugh more when I watch a comedy with others than when alone. SM1
    - In groups of people, I am rarely the center of attention. SM2
    - In different situations and with different people, I often act like very different persons. SM3
    - I am not particularly good at making other people like me. SM4
    - Even if I am not enjoying myself, I often pretend to be having a good time. SM5
    - I'm not always the person I appear to be. SM6
- Coding : True = 1 or False = 0

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6. Multiple group

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Objectives

- What is the purpose of multiple group analysis?
- How do I perform multiple group analyses of a measurement model?
- How do I perform multiple group analyses of a causal structure?

Multiple group

General aim: to assess variations of a construct across groups

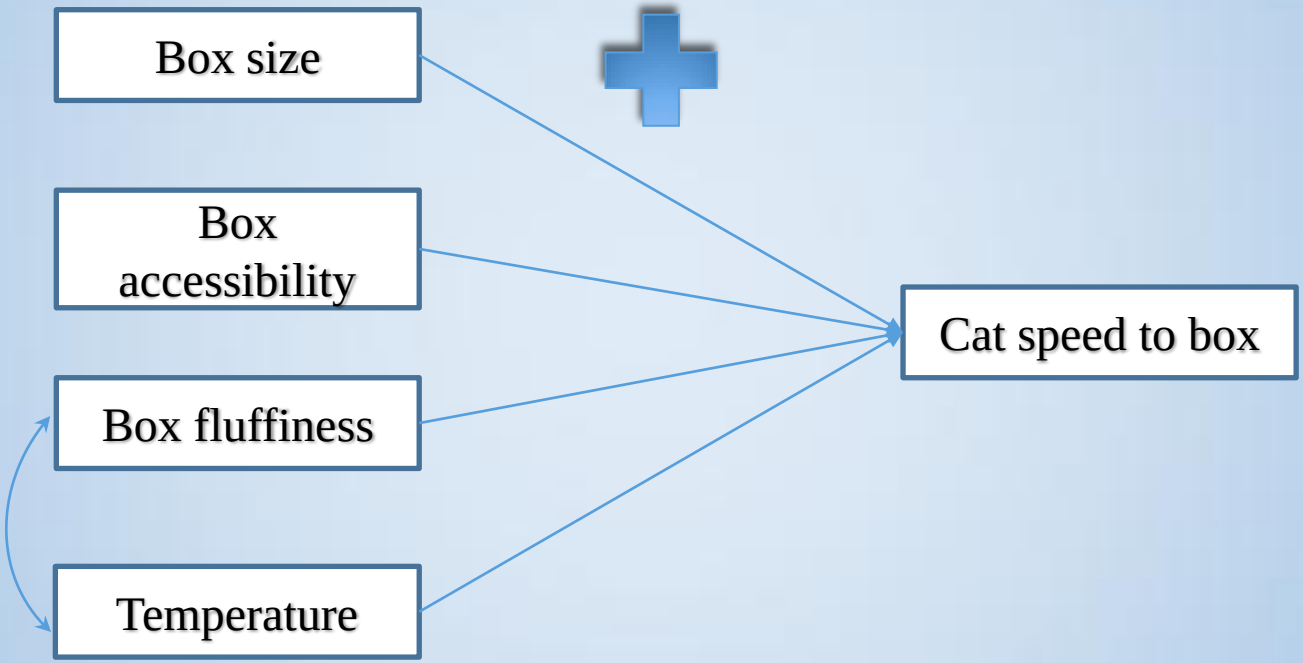
- More than one sample
  - E.g. The same study was conducted in two countries: USA and UK.
- More than one group within one sample
  - E.g. The questionnaire was answered by boys and girls.

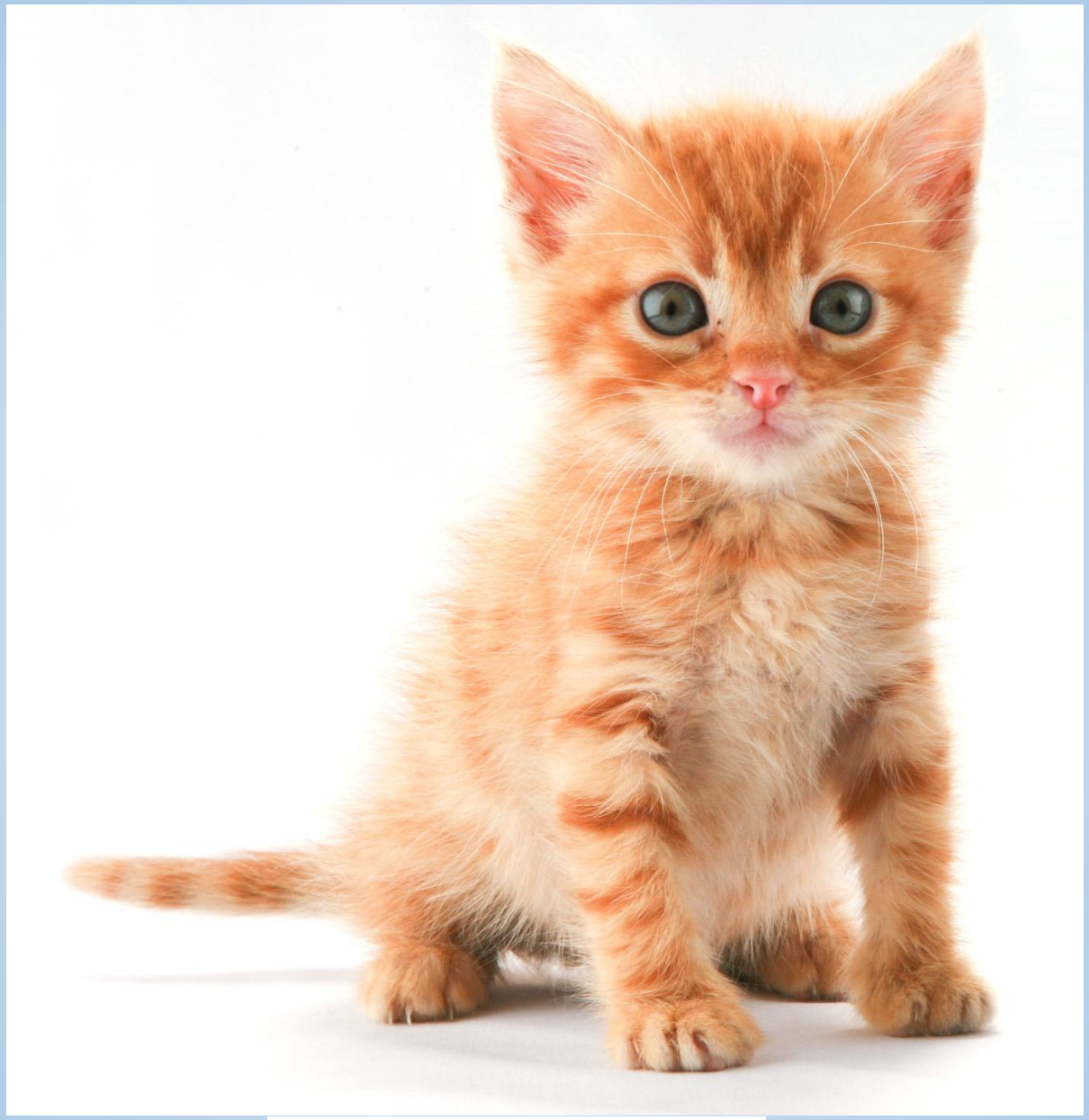
Multiple group

- Questions that can be answered by multiple group analysis:
  - Does the questionnaire function the same way across samples?
  - Is the overall structure similar?
  - Are the factor loadings/regression paths similar?
  - Are the means similar?
  - Are the variances/covariances similar?
  - Are the errors similar?

Study

Study


Box size
Box accessibility
Box fluffiness
Temperature
Cat speed to box



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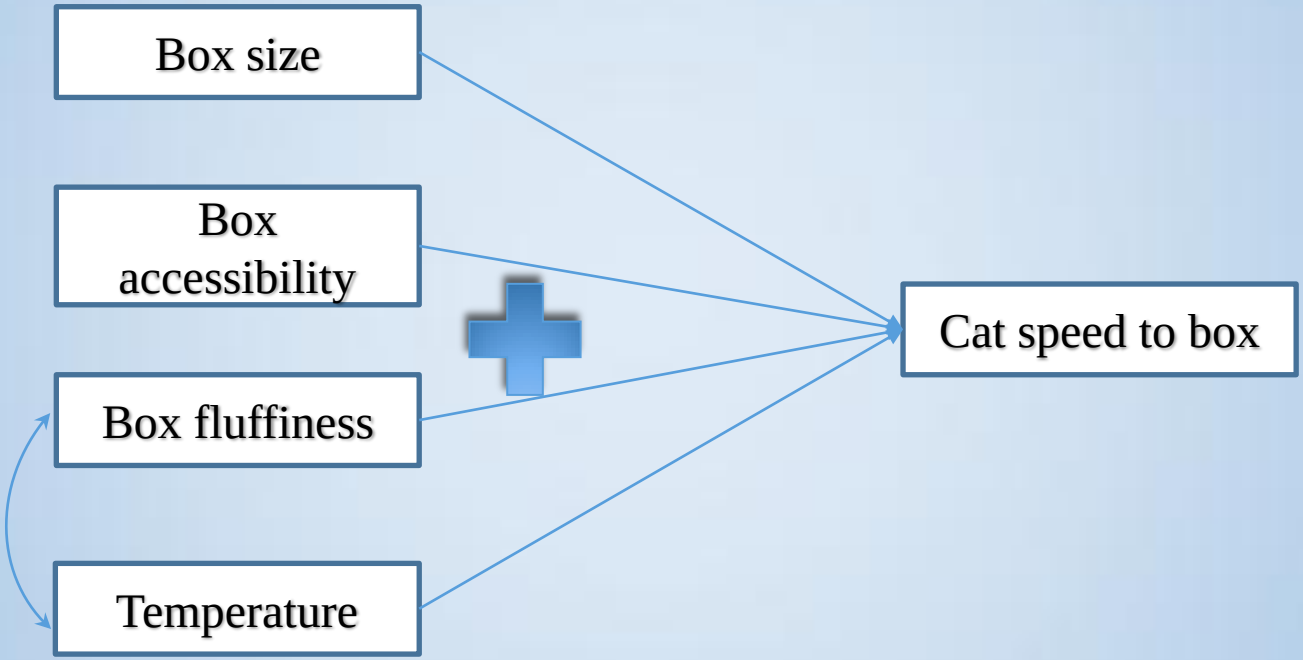
Study


Box size
Box accessibility
Box fluffiness
Temperature
Cat speed to box

Mplus

Example

Multiple group path analysis

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Multiple group path analysis

The study

- Can intrinsic and extrinsic motivation predict the amount of students' work for a course and their final result, depending on the teaching environment?
  - Operationalisation of the variables:
    - Intrinsic and extrinsic motivation: Self report Likert scale 7 points. INTRIN EXTRIN
    - Amount of work: number of hours per week spent on work, max = 8 hours WORK
    - Result = final grade 0 – 100. FINALR

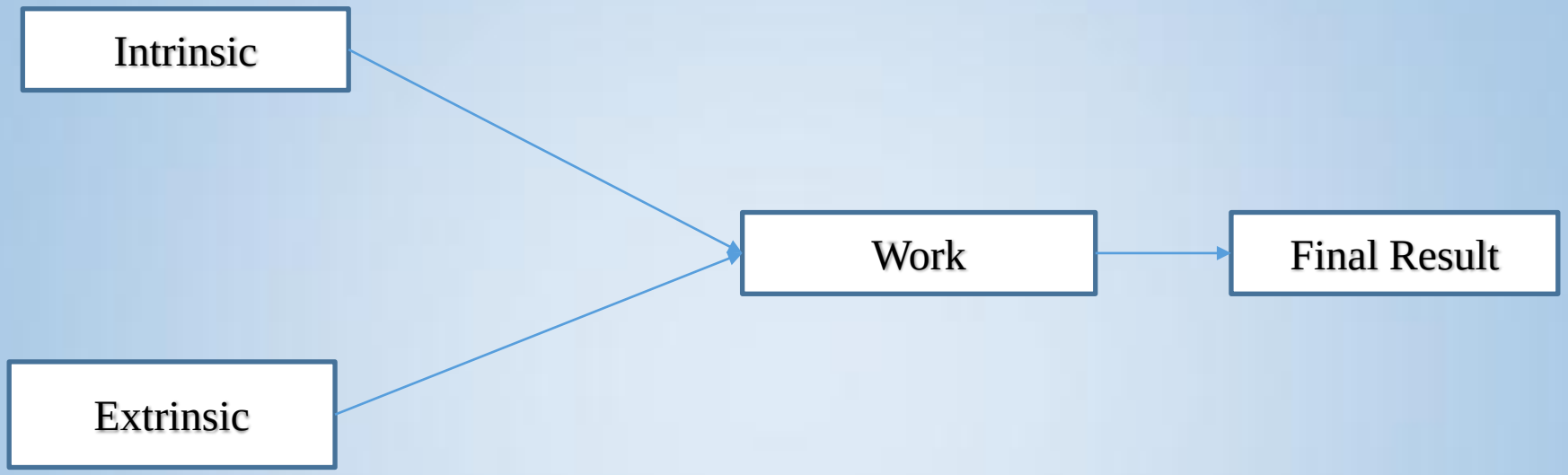
Multiple group path analysis

The study

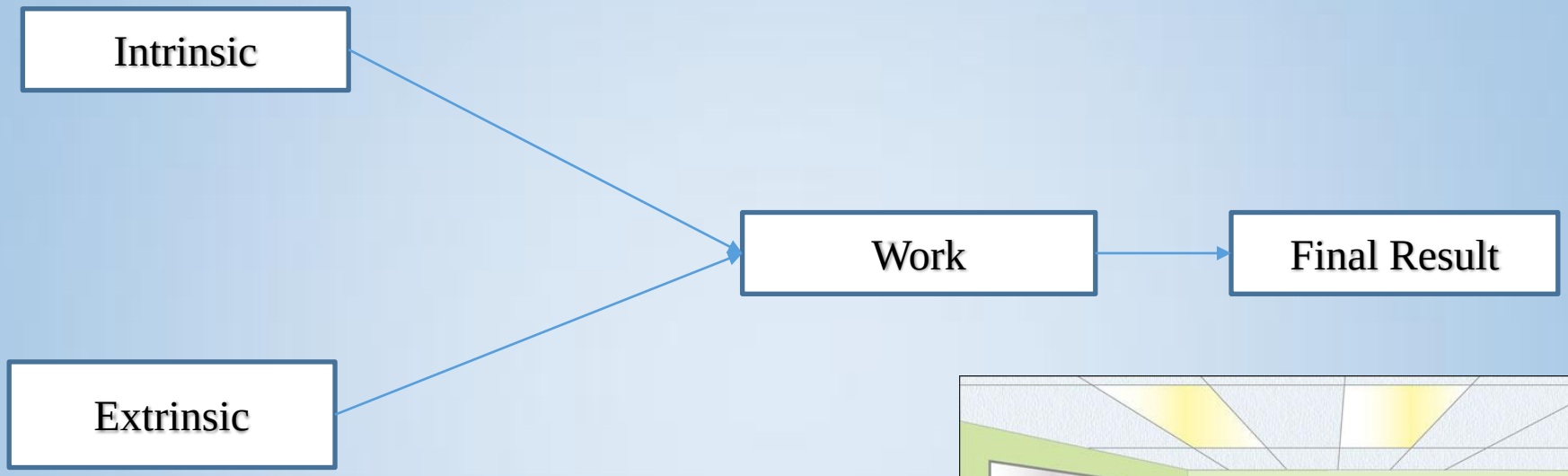
- In three different environments chosen by the teacher:

1. INSIDE
2. OUTSIDE
3. MIXTE

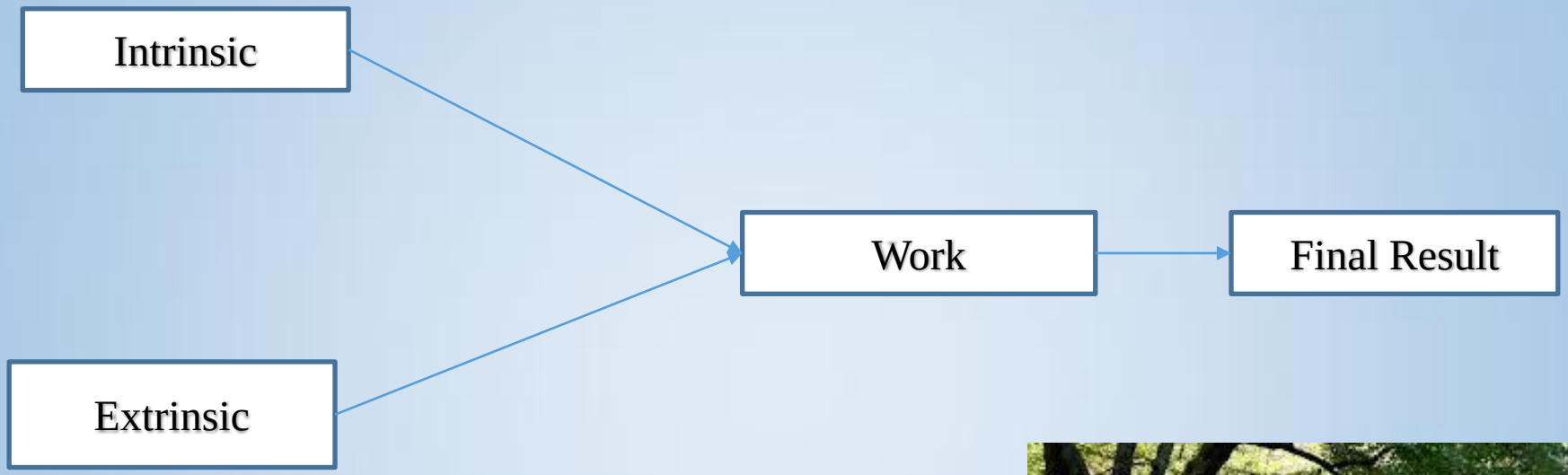
Study



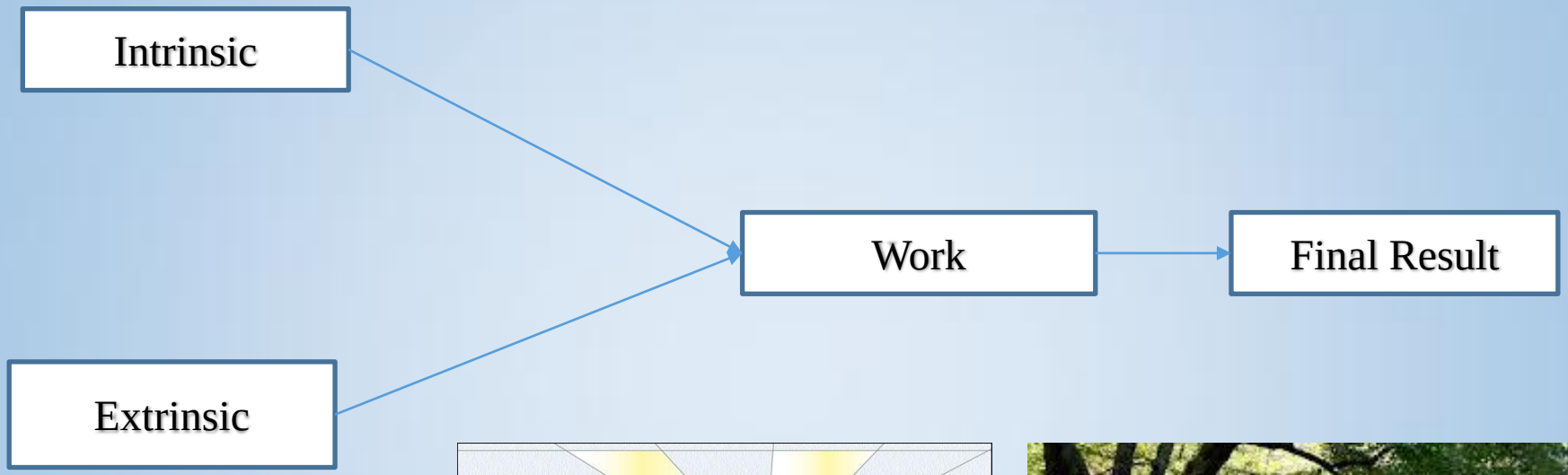
Study



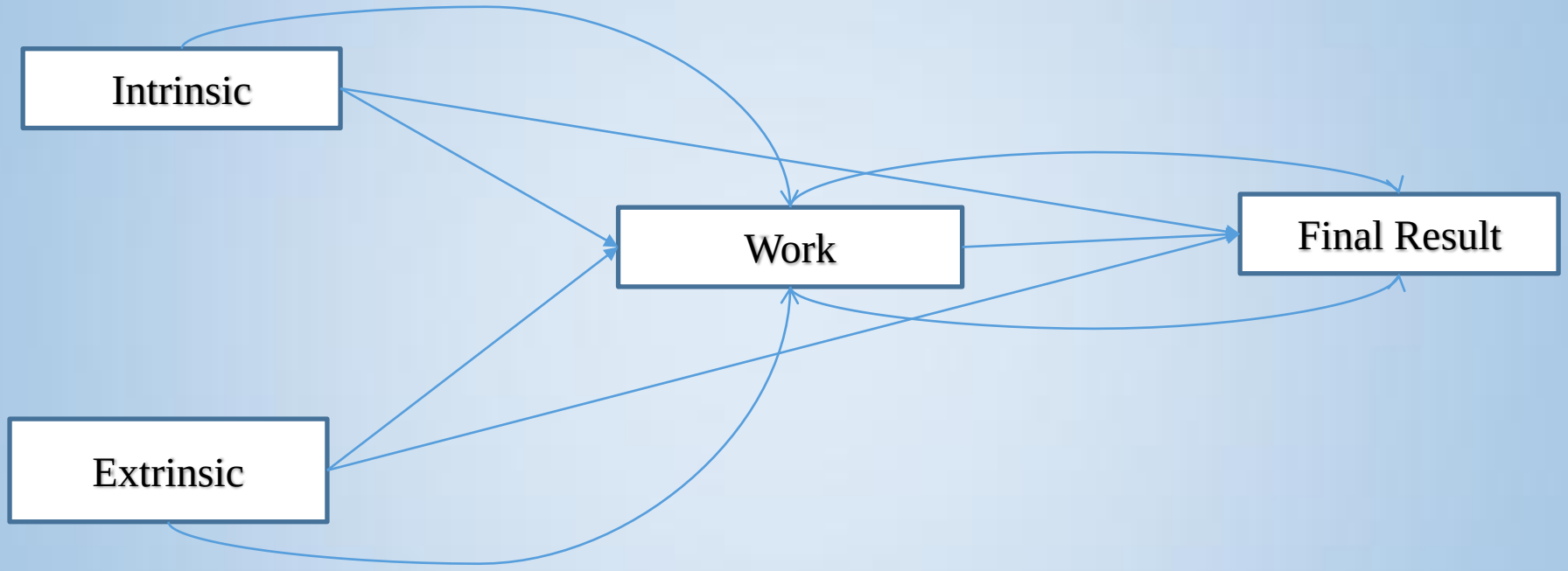
Study



Study



Study
Mediation analysis



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6. Measurement invariance

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Measurement invariance – Why?

Measurement equivalence (aka invariance):

Why?

- Just because we labelled it depression, doesn't mean it ***is*** depression
- Use of same questionnaire = the construct measured ***is*** the same

Steps: Take initial model → place constraints → check if model fit deteriorates

How do you…

- … bake two cakes that are absolutely ‘the same’… without using the same batter?

Cake

300 g

50 ml

200 g

150 g

Flour

Milk

Sugar

Cocoa

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How do you…

- … bake two cakes that are absolutely ‘the same’… without using the same batter?

Cake	Factor
The same ingredients (can’t use milk in one but water in the other)	The same structure (i.e., the same items, with the same pattern of loadings)
The same proportions (can’t use 100g of flour and 20 ml of oil in one, but 70g of flour and 50 ml of oil in the other)	Equal factor loadings (i.e., item 1 must have the same loading onto the factor, in each group)
The same quality of ingredients	Equal intercepts/thresholds

How to examine it

1) Structural invariance (Equal form)
   – Same factor structure present in all groups

2) Weak factorial invariance (Equal loadings)
   – Unit increase in latent variable is associated with comparable increase in indicator in both groups

3) Strong factorial invariance (Equal indicator intercepts)
   – At a given level of the latent variable, indicators have a comparable value in both groups

How to examine it

Tests :

1. Equal form: all CFAs specified in a single model, same factor structure at each time-point

2. Equal factor loadings: The loadings of ‘like’ indicators are equal

3. Equal indicator thresholds: Intercepts/thresholds of ‘like’ indicators are equal

How to examine it

- Constrain parameters of the CFA to be equal in all groups
- Parameters may be:

Free	Unknown; analysis finds optimal value to minimize differences between observed and predicted matrices
Fixed	Known; specified by researcher to a specific value (usually 0 or 1)
Constrained	Unknown; specified by researcher to have certain restrictions, but not to be a specific value

- E.g. if factor loadings are constrained to equality, the analysis finds a single estimate (the best) for all loadings

Cake

300 g

50 ml

200 g

150 g

Flour

Milk

Sugar

Cocoa

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How to examine it

- The next step: compare chi-squares of the 'nested' models.

- http://home.comcast.net/~sharov/PopEcol/tables/chisq.html

Table of Chi-square statistics

t-statistics
F-statistics with other P-values: P=0.05 | P=0.01 | P=0.001

df	P = 0.05	P = 0.01	P = 0.001
1	3.84	6.64	10.83
2	5.99	9.21	13.82
3	7.82	11.35	16.27
4	9.49	13.28	18.47
5	11.07	15.09	20.52
6	12.59	16.81	22.46
7	14.07	18.48	24.32
8	15.51	20.09	26.13
9	16.92	21.67	27.88

Comparison of latent means

!!! Comparison of group means only meaningful when measures are equivalent !!!

- Equal variances:
  - = The groups drew from similar ranges of the latent variable to respond to its indicators
  - – Often does not have substantive implications in applied research, but is a necessary step before comparing means

- Equal means:
  - = Groups do not differ in their levels of the latent variable

Comparison of latent means

- Mean of first group is fixed to 0 ➔ group 1 is the 'reference' group
- Means of other groups = deviations from the mean of the reference group

- A few points:
  - It is possible to choose the reference group to be other than the first group; switching between groups in the selection of the reference group may be important when more than 2 groups are compared
  - Absolute means are not computed (because all indicator intercepts / thresholds are constrained to be equal)

If measures are not equivalent?

- If full measurement invariance is untenable (significant difference in χ^2), partial measurement invariance is possible

- Why it helps:
  - Allows analysis of measurement invariance to proceed (don't have to abandon analyses)
  - Can evaluate structural parameters (e.g. mean differences) of model in context of partial measurement invariance

Partial measurement invariance

- Steps:
  - Establish that measures are not invariant (chi-square difference = sig.)
  - Check modification indices to identify parameters that are not invariant
  - Relax the constraints on noninvariant parameters

- Things to consider:
  - If many indicators are noninvariant, should question whether it is suitable to proceed with further invariance testing
  - May be more problematic when the research interest is psychometric (e.g. test development)

Study

- I- Care:

1. I care about what my family thinks about me.
2. I care about what my partner thinks about me.
3. I care about what my friends think about me.
4. I care about what my pet thinks about me.

Study