Alpha, Beta, & Gamma
Change: Who Said Nobody Likes Change?

Presented by:
Angela Dumoulin, Numrah Irfan, Dana Knoll, and Lisa Thompson
Presentation Outline

● Introduction
  ● What is Alpha, Beta, & Gamma Change?

● Methods for Identifying Alpha, Beta, & Gamma Change
  ● Actual & Ideal Measures
  ● Pre, Post, and Retrospective Then Measures
  ● Confirmatory Factor Analysis

● Comparison of Techniques

● Conclusion & Recommendations
**Survey Item: Indicate your level of peer support**

<table>
<thead>
<tr>
<th>Time 1: 1st Year in Undergrad</th>
<th>Time 2: 4th Year in Undergrad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student (N=100)</strong></td>
<td><strong>Student (N=100)</strong></td>
</tr>
<tr>
<td>Peer Support (1-7 scale)</td>
<td>Peer Support (1-7 scale)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Frank</td>
<td>Frank</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Marie</td>
<td>Marie</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Ashley</td>
<td>Ashley</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
Alpha Change

- Actual/true change

  - Unbiased measure of variation between Time 1 and Time 2 when measured on a constantly calibrated instrument

  - Reflects a “true” change

Golembiewski, Billingsley, & Yeager, 1976
Survey Item: Indicate your level of peer support

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→ Alpha Change: Frank level of peer support has truly increased
Beta Change

- Scale recalibration
  - Observed variation in some state where the apparent change is due to an instrument that has been recalibrated by the participant between assessments
  - A.k.a. Instrumentation bias

Golembiewski, Billingsley, & Yeager, 1976
Survey Item: Indicate your level of peer support

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→ Beta Change: Marie’s “actual level” of peer support is the same from T1 to T2, but the scale on which she assesses it has changed.
Gamma Change

- Criterion reconceptualization
  - Reconceptualization or redefinition by the participant of the phenomenon being measured

Golembiewski, Billingsley, & Yeager, 1976
Survey Item: Indicate your level of peer support

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Gamma Change: Peer support has a different meaning to Ashley in 4th year
Water Example

State

Condition (Temperature)

Solid H$_2$O

Liquid H$_2$O

Gas H$_2$O
Examples

- Can anyone think of examples where you would hypothesize:
  - Alpha change
  - Beta change
  - Gamma change
Golembiewski, Billingsley, & Yeager (1976)

- Method to assess change compares the results of factor analyses between two periods

- Criticism – inability to distinguish between beta and gamma change
Methods of Evaluating Change

- Actual and Ideal scores
- Pre, Post, and Then ratings
- Confirmatory Factor Analysis
Individual-Level vs. Group-Level Analysis

- Desirable to use group-level change data in addition to individual-level change data
  - Large changes in means for a few individuals
  - Identify which individuals the change occurred
  - Differential intervention effects
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- Conclusion & Recommendations
**Actual v. Ideal Scores**

Example item: To what extent do persons in your work group offer each other constructive criticism?

<table>
<thead>
<tr>
<th>Time 1 (T₁) Pre-test</th>
<th>Actual: This is how it is <em>now</em></th>
<th>Ideal: This is how I’d <em>like</em> it to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time 2 (T₂) Post-test</th>
<th>Actual: This is how it is <em>now</em></th>
<th>Ideal: This is how I’d <em>like</em> it to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
The Logic of Actual v. Ideal Scores

- Rating of actual conditions may reflect alpha, beta, or gamma change
- Ideal scores are gathered to detect beta and gamma change; however, do not inform us about alpha change

(Zmud & Armenakis, 1978)
Actual v. Ideal Scores: Group Level Analysis

Detecting Gamma Change

- Calculate Coefficients of Congruence to detect Gamma Change
  - Use them to compare *factor structures* of $T_1$ and $T_2$ scores
  - Positive coefficients (+1) indicate high congruence between factor structure of $T_1$ and $T_2$
  - Negative coefficients (-1) indicate low congruence between factor structure of $T_1$ and $T_2$

(Zmud & Armenakis, 1978)
Actual v. Ideal Scores: Group Level Analysis

Detecting Beta & Alpha Change

\[
D_1 = I_1 - A_1
\]
\[
= 5 - 1 = 4
\]

\[
D_2 = I_2 - A_2
\]
\[
= 4 - 2 = 2
\]

(Zmud & Armenakis, 1978)
### Detecting Beta & Alpha Change

<table>
<thead>
<tr>
<th>Does D1=D2?</th>
<th>Does A1=A2?</th>
<th>Does I1=I2?</th>
<th>Alpha</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Yes</td>
<td>No</td>
<td>No</td>
<td>---</td>
<td>✓</td>
</tr>
<tr>
<td>3. No</td>
<td>Yes</td>
<td>No</td>
<td>?</td>
<td>✓</td>
</tr>
<tr>
<td>4. No</td>
<td>No</td>
<td>No</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5. No</td>
<td>No</td>
<td>Yes</td>
<td>✓</td>
<td>---</td>
</tr>
</tbody>
</table>

\[(D = I - A)\]

(Zmud & Armenakis, 1978)
**Actual v. Ideal Scores: Individual Level Analysis**

Detecting Beta & Alpha Change

Create regression line for individual subject responses

\[ Y_i' = a + bX_i \]

<table>
<thead>
<tr>
<th>Participant #1 Responses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td>( X_i ) = Time 1 ideal (raw) scores</td>
</tr>
<tr>
<td>1</td>
<td>( X_1 )</td>
</tr>
<tr>
<td>2</td>
<td>( X_2 )</td>
</tr>
<tr>
<td>3</td>
<td>( X_3 )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( n )</td>
<td>( X_n )</td>
</tr>
</tbody>
</table>

\( Y_i' \) = Time 2 ideal scores  
\( X_i \) = Time 1 ideal scores  
\( a \) = intercept constant  
\( b \) = regression coefficient/weight

Bedeian, Armenakis, & Gibson, 1980
## Actual v. Ideal Scores: Individual Level Analysis

### Detecting Beta & Alpha Change

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>Regression Eq.</th>
<th>Type of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0*</td>
<td>1*</td>
<td>( Y' = a + 1X )</td>
<td>No beta change:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( T_1 ) ideal scores = ( T_2 ) ideal scores</td>
</tr>
<tr>
<td></td>
<td>( \neq 0 )</td>
<td>( Y' = a + 1X )</td>
<td>Type I Beta change:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>“simple scale displacement”</td>
</tr>
<tr>
<td>Any value</td>
<td>( b \neq 1 )</td>
<td>( Y' = a + bX )</td>
<td>Type II Beta change:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1) Scale interval stretching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2) Scale interval sliding</td>
</tr>
</tbody>
</table>

*is not significantly different than*
Type II Beta Change

(1) *Scale interval stretching*: respondents lengthen the psychological distance between scale intervals:

<table>
<thead>
<tr>
<th>Time 1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 2(a)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Time 2(b)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Type II Beta Change

(2) *Scale interval sliding*: shifting of some, but not all, responses to a higher or lower interval.
If Beta Change has occurred...

- Calculate correlation between $T_1$ and $T_2$ ideal scores to obtain item response consistency
  - Weak correlation indicates gamma chance
  - Strong correlation, when rating frequencies and means are significantly different verifies occurrence of Beta change
  - Strong correlation, when rating frequencies and means are the same, verifies lack of Beta change

- Once beta change has been detected, a transformation can be applied to fix this
Advantages of Actual/Ideal Approach

- Can easily conduct individual level analysis (i.e., compute regression equation)
- Analysis does not involve advanced statistical techniques
- Transformation can be applied to data if Beta change has been detected, according to this methodology
Limitations of Actual/Ideal Approach

- **Use of Ideal Scores:**
  - Multiple definitions
  - Range restriction

- **Limited in detecting Gamma**
  - weak correlations between $T_1$ and $T_2$ ideal scores, which indicate gamma change, may not necessarily indicate reconceptualization of the construct

- **Alpha and beta cannot occur together**

(Terborg, Maxwell, Howard, 1982)
Limitations of Actual/Ideal Approach

- Regression Analysis
  - Independence is violated because all scores used in generating the equation come from the same person
  - Small sample size (equal to number of items in scale)

- Survey must be lengthened to include Ideal measure
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Proposed Approach

- Pre-intervention
  - Pre-ratings
- Post-Intervention
  - Post-ratings
  - Then-ratings

Terborg, Howard, & Maxwell, 1980
Example

- Sample: Supervisors within an organization
- Experimental and control group
- Measuring: Adaptability to “problem” situations with employees
- Training: video tapes, role playing/workshops
- Measures obtained at two time periods:
  - One week before intervention
  - One week after intervention
Retrospective Then Ratings

- 2 ways:
  - How participants now perceive themselves to have been at the time of the last observation
  - Participants would rate the phenomenon in reference to how they currently perceive it to have been at the time of the first observation
Retrospective Then Ratings Cont’d

| $T_1$ | $T_2$ | $T_3$ | $T_4$ |
Retrospective Then Ratings Cont’d

| $T_1$ | $T_2$ | $X$ | $T_3$ | $T_4$ |
Retrospective Then Ratings Cont’d

<table>
<thead>
<tr>
<th>Pre₁</th>
<th>Pre₂</th>
<th>Post₁</th>
<th>Post₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>T₂</td>
<td>X</td>
<td>T₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T₄</td>
</tr>
</tbody>
</table>
Retrospective Then Ratings Cont’d

<table>
<thead>
<tr>
<th>Pre₁</th>
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<td>T₄</td>
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Then Then Then
Retrospective Then Ratings Cont’d

<table>
<thead>
<tr>
<th>Pre₁</th>
<th>Pre₂</th>
<th>Post₁</th>
<th>Post₂</th>
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Then Then Then
Retrospective Then Ratings Cont’d

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<td>$T_1$</td>
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<tr>
<td>$T_4$</td>
<td></td>
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Then

Then

Then
Profile Analysis

- Method for examining differences between 2 patterns of scores on the same set of items or scales
- Pairs of profiles can be compared according to their level, shape, and dispersion
Profile Analysis Cont’d

- **Similarity**
  - **Level** – **mean** of item scores in one profile is not significantly different from the mean of item scores in the other profile
  - **Shape** – **correlations** between the two profiles are positive and statistically significant from zero
  - **Dispersion** – **standard deviation** of item scores in one profile is not significantly different from the standard deviation of item scores in the other profile
Method for Assessing Change

- Pre, Post, and Then measures acquired (from both experimental and control groups) – scale items are data points
- Calculate standard deviations using all scale items as data points
Method for Assessing Change
Cont’d

- Calculate $t$-statistic for each supervisor for the following comparisons:
  - Pre vs. Then (yields $t_{\text{Pre, Then}}$)
  - Post vs. Pre (yields $t_{\text{Post, Pre}}$)
  - Post vs. Then (yields $t_{\text{Post, Then}}$)
- Calculate correlations for each supervisor ($r_{\text{Pre, Then}}$, $r_{\text{Post, Pre}}$, and $r_{\text{Post, Then}}$)
Method for Assessing Change Cont’d

● Gamma change:
  ● Shape differences in profiles
    ● Using computed correlations, calculate the following differences:
      ● $r_{\text{Post, Then}} - r_{\text{Post, Pre}}$
      ● $r_{\text{Post, Then}} - r_{\text{Pre, Then}}$
      ● $r_{\text{Post, Pre}} - r_{\text{Pre, Then}}$
Method for Assessing Change
Cont’d

- Gamma change cont’d:
  - Shape differences in profiles
    - Compare experimental differences with control differences
  - Gamma change occurs with the following:
    - $r_{\text{Post, Then}} - r_{\text{Post, Pre}}$ for experimental group $\neq r_{\text{Post, Then}} - r_{\text{Post, Pre}}$ for control
    - $r_{\text{Post, Then}} - r_{\text{Pre, Then}}$ for experimental group $\neq r_{\text{Post, Then}} - r_{\text{Pre, Then}}$ for control
    - $r_{\text{Post, Pre}} - r_{\text{Pre, Then}}$ for experimental group $= r_{\text{Post, Pre}} - r_{\text{Pre, Then}}$ for control
Method for Assessing Change Cont’d

- Gamma change cont’d:
  - Dispersion differences in profiles
    - Using computed standard deviations, calculate the following differences:
      - $SD_{\text{Then}} - SD_{\text{Pre}}$
      - $SD_{\text{Post}} - SD_{\text{Pre}}$
      - $SD_{\text{Post}} - SD_{\text{Then}}$
Method for Assessing Change Cont’d

- Gamma change cont’d:
  - Dispersion differences in profiles
    - Compare experimental differences with control differences
  - Gamma change occurs with the following:
    - $SD_{Then} - SD_{Pre}$ for experimental group $\neq SD_{Then} - SD_{Pre}$ for control
    - $SD_{Post} - SD_{Pre}$ for experimental group $\neq SD_{Post} - SD_{Pre}$ for control
    - $SD_{Post} - SD_{Then}$ for experimental group $= SD_{Post} - SD_{Then}$ for control
Method for Assessing Change
Cont’d

● Beta change
  ● When the group mean on the Pre measure is different from the group mean on the Then measure for the intervention group, while no difference between these measures is found for the control group
  ● If beta change occurs:
    ● $t_{\text{Pre, Then}}$ for experimental group $>$ $t_{\text{Pre, Then}}$ for control group
Method for Assessing Change
Cont’d

● Alpha change
   ● Difference between Post and Then group means
   ● If alpha change occurs:
     ● \( t_{\text{Post, Pre}} \) for experimental group > \( t_{\text{Post, Pre}} \) for control group
     ● \( t_{\text{Post, Then}} \) for experimental group > \( t_{\text{Post, Then}} \) for control group (if beta change occurs)
Important to Note

- All evaluations of alpha, beta, and gamma change should be judged descriptively.
- Guidelines for the identification of individual-level change are abstract not by choice but owing to the lack of appropriate test statistics.
Modification of Terborg et al. Approach

- Use of correlation coefficients, rather than correlation differences to test for gamma change
  - Should be possible to test by comparing $r_{\text{Post, Pre}}$, $r_{\text{Pre, Then}}$, and $r_{\text{Post, Then}}$ correlations between experimental and control groups directly
  - If gamma change occurs:
    - $r_{\text{Post, Pre}}$ for experimental group < $r_{\text{Post, Pre}}$ for control
    - $r_{\text{Pre, Then}}$ for experimental group < $r_{\text{Pre, Then}}$ for control
    - $r_{\text{Post, Then}}$ for experimental group = $r_{\text{Post, Then}}$ for control

Porras & Singh (1986)
Contrasting the 2 Methods

- Terborg et al.’s method
  - Profile shapes:
    - Gamma change
  - Profile dispersions:
    - No gamma change

- Porras and Singh’s method
  - No gamma change
Contrasting the 2 Methods

- Both methods
  - $\Rightarrow$ Beta change

- Both methods
  - $\Rightarrow$ Alpha change
Should I Rely on Pre, Post, and Then Ratings?

- A good idea, unless:
  - Participants give false Then responses
  - Participants are confused as to the instructions
  - Where participants in a no-treatment control group are asked to give Post and Then ratings within a few hours or days of the Pre ratings
Utility of Then approach

- Past research: no instances where Pre/Post analyses produced significant results while Then/Post analyses produced nonsignificant results.
- Results from the Then/Post measurement approach were more similar to objective (observer) ratings of change in behaviour and performance than were the results obtained from traditional Pre/Post self-report methods.
Utility of Then Approach Cont’d

- Systematic memory bias - mean memory ratings were virtually identical to Pre ratings, but significantly different from the Then scores.
- Subjects had an uncanny recollection of their pre-intervention responses - now saw their Pre test responses as inaccurate assessments of their pre-intervention level of functioning.
Limitations

- Impossible to perform meaningful significance tests at the individual level
- Assumption that the items on the scale are uni-dimensional (important for gamma change)
- In an investigation of 3 types of change at the group level, a large number of significance tests are conducted
Advantages

- Ability to tailor for the individual feedback regarding the effectiveness of the intervention
- Ability to use method on small samples
- Ability to assess the 3 types of change independently
WE'RE CALLING IT "PUMPKIN PI."

I'LL PUT THIS AT THE END, UNTIL WE BUY MORE.
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What if you want to test for gamma and beta change, but don’t want to lengthen your questionnaire?
What if you want to test for gamma and beta change, but don’t want to lengthen your questionnaire?

- Use Confirmatory Factor Analysis
Confirmatory Factor Analysis

- Schmitt (1982) proposed that changes in factor structure be studied through CFA.

- Schmitt’s procedure compares the pre and post intervention factor structures as well as path coefficients to determine whether gamma or beta changes exist.
Confirmatory Factor Analysis

Schmitt’s method involves four steps:

1. Test of the homogeneity of the variance-covariance matrices
2. Test of the factor pattern of the before-after measurements
3. Test of the equality of the scaling units and factor variances
4. Test of the equality of uniqueness associated with the measured variables
Step 1: Test of Homogeneity of Variance-Covariance Matrices

- Tests Hypothesis 1: that the pre and post variance-covariance matrices are equal
- A significant difference implies either:
  1. The factor pattern is different (i.e., gamma change),
  2. The scale units are different (i.e., beta change),
  3. The uniquenesses are different, or
  4. Some combination of the above
Step 2a: Test of Factor Pattern of Before-After Measurements

- Tests Hypothesis 2: that the pre-post measurements are measuring the same concepts
- If the same factors are being measured, the number of factors and the pattern of factor loadings will be the same and there will be no evidence of beta or gamma change
Step 2a: Test of Factor Pattern of Before-After Measurements

- If the suggested factor structure adequately describes the before and after data, the chi-square testing the difference between the observed and reproduced matrices will be nonsignificant.

- A nonsignificant chi-square would indicate a lack of gamma change and a significant chi-square would indicate gamma change.
Step 2b: Test of Factor Pattern of Before-After Measurements

- One could further test for gamma change using Hypothesis 3: that the variance-covariance matrices for the common factors are similar for the pre and post measures.
Step 2b: Test of Factor Pattern of Before-After Measurements

- This hypothesis involves fixing the model to assume no gamma change.

- To test for gamma change, compare the difference between the chi-square produced in testing Hypothesis 2 with that produced in Hypothesis 3.
Step 3: Test of Equality of Scaling Units and Factor Variances

- Tests Hypothesis 4: that factor loadings are equal across measurements

- Significant differences imply beta change
Step 3: Test of Equality of Scaling Units and Factor Variances

- Involves evaluating the factor model where loadings for the before-after measures would be set as equal.

- To test for beta change, compare the difference between the chi-square produced in testing Hypothesis 3 with that produced in Hypothesis 4.
Step 4: Test of Equality of Uniqueness Associated with Measured Variables

- Tests Hypothesis 5: that the uniquenesses associated with the measured variables are invariant across time

- Examines whether there is difference with respect to the reliability of the measurement before and after the intervention
Step 4: Test of Equality of Uniqueness Associated with Measured Variables

- Involves evaluating the factor model where the uniqueness for the before-after measures would be set as equal.
- A significant decrease in the variance accounted for by the model signals that there is a difference with respect to the reliability of the measurement before and after the intervention.
Alpha Change

● Once these tests have been completed and the possibility of gamma change, beta change, and measurement reliability have been eliminated, mean differences could be compared and alpha change could then be assessed.
Is Schmitt’s CFA Approach Accurate?

- Schmitt transformed employment data to induce gamma, beta, or alpha change and then assessed whether these changes were correctly identified by his approach.

- The method proved to be successful!
Examples of CFA Approach

Schaubroeck and Green (1989)

- Sample: students entering a doctoral program
- Assessed changes in level of work related constructs:
  - Commitment
  - Satisfaction
  - Quality of advisor relationship
- Measures obtained at two time periods:
  - Within 1 month
  - 9 months later
Step 1

- Hypothesis - Time 1 and Time 2 variance-covariance matrices are equal

- Result – Significant $\chi^2$ indicates matrices are different

- Therefore gamma and/or beta change may exist
Step 2a

- Tested if factor model holds across time

- The fit indices suggested good fit at both time 1 and time 2

- Therefore no evidence of gamma change
Step 2b

- Testing the equivalence of the common factor covariance

- Change in fit between this model and that in which the covariance is free to vary was significant

- Therefore gamma change may have occurred
Step 3

- Testing the equivalence of the common factor covariance

- Change in fit between this model and in which only the covariance was fixed was not significant

- Therefore no evidence of beta change
Step 4

- Determining whether the scale has been recalibrated

- Change in fit between this model and that in which both covariance and variance are fixed was not significant

- Therefore no evidence of beta change
Step 5

- Examining Alpha Change
- Used repeated-measures MANOVA. This was significant.
- Therefore evidence for alpha change.
- t-tests indicated that job satisfaction and organizational commitment decreased significantly from time 1 to time 2. Quality of relationship did not change.
CFA in Use
---
Example 2
Example 2

Vanderberg and Self (1993)

- Examined the level of four organizational constructs in newcomer’s to an organization
  - Organizational Commitment
  - Affective Commitment
  - Continuance Commitment
  - Organizational Identification
- Took measures on: 1\textsuperscript{st} day, 3\textsuperscript{rd} mth & 6\textsuperscript{th} mth
- Replicated the procedure used by Schraubroeck and Green (1989)
Results

Vanderberg and Self (1993)

- Variance-covariance matrices are not equivalent indicating some change
- The fit indices examining gamma change were significant
- The fit indices examining beta change were significant
- The test of scale recalibration was inconsistent
Conclusions

Vanderberg and Self (1993)

- Gamma change occurred
  - Participants changed their understanding of the constructs after entry into the organization
- Differences between levels of some measure at time 1 and time 2 needs to account for instability in measurement continua before the differences can be meaningfully interpreted.
Example 3

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Variation on CFA Approach
Variation on CFA Approach

Millsap and Hartog (1988)

- A method for evaluating intervention effects when either alpha, beta, or gamma change may have occurred.

Definition of gamma change:
- Any change in the factor pattern matrix from pre to post test
Gamma Change
Millsap and Hartog (1988)

- Two types of gamma change:

  - Differential gamma change - post-test factor pattern matrices differ across groups.
  - Parallel gamma change - groups have identical post-test factor patterns, but the pre-test and post-test pattern matrices differ.
Beta Change

Millsap and Hartog (1988)

- Recall - Schmitt (1982) proposed that differences between the variances of the pre-test and post-test latent variables are one indication of beta change.

- Millsap and Hartog evaluate beta change within the latent variable approach of Schmitt (1982), but focus specifically on the regression of post-test on pre-test latent variables.
Beta Change

Millsap and Hartog (1988)

- Beta change can alter the form of the regression in two ways:
  - Change in linearity of the regression
  - Change in the size of the regression coefficients between treatment and control groups
    - Inequality can mean no beta occurred, or it occurred to the same extent in both groups
    - If change occurs equally, it cannot be attributed to the intervention
Limitations of CFA Approach

- Interpreting fit statistics
  - Large sample size
  - Small sample size
  - Non-equivalent control group design/lack of random assignment
- Inability to test causes of change
- Complexity
Presentation Outline

● Introduction
  ● What is Alpha, Beta, & Gamma Change?
● Methods for Identifying Alpha, Beta, & Gamma Change
  ● Actual & Ideal Measures
  ● Pre, Post, and Retrospective Then Measures
  ● Confirmatory Factor Analysis
● Comparison of Techniques
● Conclusion & Recommendations
Comparison of Techniques

- Schmitt, Pulakos, & Lieblein (1984) compared the:
  - Actual and Ideal Approach proposed by Zmud and Armenakis (1978)
  - Pre, Post, and Then Approach proposed by Terborg, Howard, and Maxwell (1980), and
  - CFA proposed by Schmitt (1982)
Method

- 110 students in an I/O course
- Experimental and control group
- Measures
  - Instructor Involvement
  - Student Interest
  - Course Demands
  - Course Organization
- Intervention = exam
Actual and Ideal Approach

- **Method**
  - To identify gamma change, Zmud & Armenakis proposed using coefficient of congruence to assess the similarity between the factor structures of before and after measures.
  - Alpha and beta change are differentiated using two forms of measurement (actual and ideal scores) in both pre and post data collecting.
Actual and Ideal Approach

- Results
  - There was little evidence for gamma, beta, and alpha change in the experimental group
  - There was some evidence for gamma change in the control group
Pre, Post, and Then Approach

Method

- Terborg et al. suggested using “then” measures to identify change
- Profile shapes and dispersions used to indicate gamma change
- Differences between the pre and then measures are taken as evidence of beta change
Pre, Post, and Then Approach

Results

- There was evidence for a small amount of gamma change in both the control and the experimental group.
- Significantly greater beta change occurred in the control group than in the experimental group for Student Interest.
- Significant alpha change was observed for Student Interest and Course Organization.
Confirmatory Factor Analysis

● Method
  ● Schmitt proposed comparing the pre and post intervention factor structures as well as path coefficients to determine whether gamma or beta changes exist
Confirmatory Factor Analysis

- Results
  - There was gamma change in the control group
  - There was beta change in the experimental and control group
## Comparison of Techniques

<table>
<thead>
<tr>
<th></th>
<th>Actual &amp; Ideal</th>
<th>Pre, Post &amp; Then</th>
<th>CFA</th>
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<tbody>
<tr>
<td></td>
<td>E</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>Gamma</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Beta</td>
<td>X</td>
<td>X</td>
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<tr>
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Presentation Outline

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## Conclusions

### Advantages

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<tbody>
<tr>
<td>• Allows Individual level analysis</td>
<td>• Tailored to individual feedback</td>
<td>• Questionnaire length</td>
</tr>
<tr>
<td>• Relatively simple statistical techniques</td>
<td>• Can be used on small samples</td>
<td>• Differentiate beta and gamma</td>
</tr>
<tr>
<td>• Transformations available to correct for Beta change</td>
<td>• Can independently assess all 3 types of change</td>
<td>• Availability of statistical tests of fit</td>
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</table>

- CFA: Confirmatory Factor Analysis
- Pre, Post & Then: Pretest, Posttest, and Then
## Conclusions

### Limitations

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<tr>
<td>● Questionnaire Length</td>
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<td>● Difficult analytic procedure</td>
</tr>
<tr>
<td>● Range restriction</td>
<td>● Significance tests at individual level</td>
<td>● Data may not fit model</td>
</tr>
<tr>
<td>● Alpha &amp; Beta cannot occur together</td>
<td>● Assumption that items on scale are uni-dimensional</td>
<td>● Flaws with significance testing</td>
</tr>
<tr>
<td>● Regression – assumption of independence violated</td>
<td>● Large number of statistical tests required</td>
<td></td>
</tr>
</tbody>
</table>
Recommendations

● Types of change should be considered

● “Then” ratings can provide useful qualitative data

● Appropriate method will depend on the individual study
Questions?