

Test Dimensionality

- I. Concept of Multiple Factors
- II. Reliability with Multiple Factors

I. Concept of Multiple Factors

If more than one psychological attribute (hypothetical construct) is measured by a set of items, the scale has more than one *dimension* or *factor*

Factors are the subtopics or distinct hypothetical constructs underlying a set of items

I. Concept of Multiple Factors

Examples

The Graduate Record Exam (GRE) has three dimensions: analytic writing, verbal reasoning, quantitative reasoning

Depression measures usually have three dimensions: positive affect, negative affect, somatic symptoms

The Wechsler Intelligence Test for Children, Fifth Edition (WISC-V) has five dimensions: Verbal Comprehension Index, Visual Spatial Index, Fluid Reasoning Index, Working Memory Index, and Processing Speed Index

The Grit Scale has two factors: consistency of interest, and perseverance of interest

I. Concept of Multiple Factors

Negative Social Exchange Items

Factor	In the past month, how often did the people you know. . . (0 = never, 1 = not very often, 2 = sometimes, 3 = often, 4 = very often)
Unwanted advice or intrusion	<ul style="list-style-type: none"> .. .give you unwanted advice? .. .question or doubt your decisions? .. .interfere or meddle in your personal matters?
Failure to provide help	<ul style="list-style-type: none"> .. .let you down when you needed help? .. .ask you for too much help? .. .fail to give you assistance that you were counting on?
Unsympathetic or insensitive behavior	<ul style="list-style-type: none"> .. .do things that were thoughtless or inconsiderate? .. .act angry or upset with you? .. .act unsympathetic or critical about your personal concerns?
Rejection or neglect	<ul style="list-style-type: none"> .. .leave you out of activities you would have enjoyed? .. .forget or ignore you? .. .fail to spend enough time with you?

Newsom, J.T., Rook, K.S., Nishishiba, M., Sorkin, D., & Mahan, T.L. (2005). Understanding the relative importance of positive and negative social exchanges: Examining specific domains and appraisals. *Journals of Gerontology: Psychological Sciences*, 60B, P304-P312.

I. Concept of Multiple Factors

Composite scores can be calculated for each subscale separately, but may often be computed for the full scale

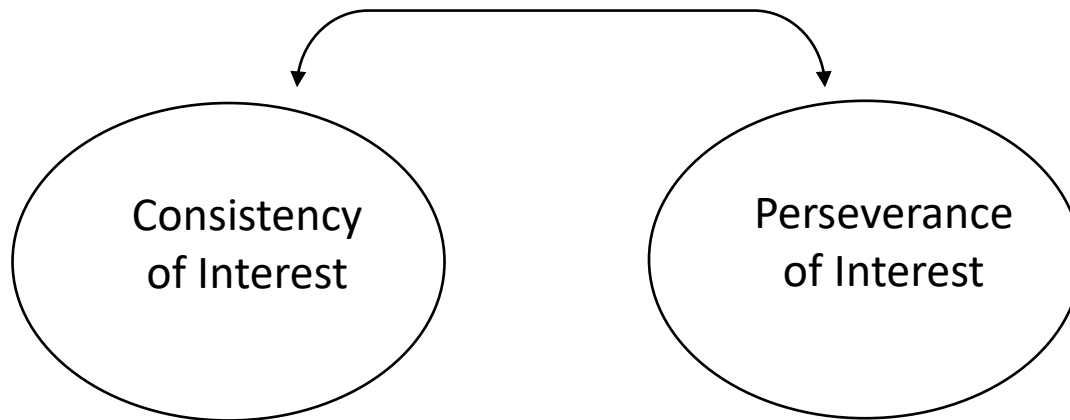
Factors can be correlated with one another—higher scores on one factor associated with higher scores on another factor

Those who score higher on the GRE analytic writing factor may score higher on quantitative reasoning factor

Those higher on negative affect may be lower on positive affect

I. Concept of Multiple Factors

Correlated factors



I. Concept of Multiple Factors

Factors may be uncorrelated ($r = 0$), also termed *orthogonal*

Uncommon in practice to find two factors from the same scale uncorrelated, but possible

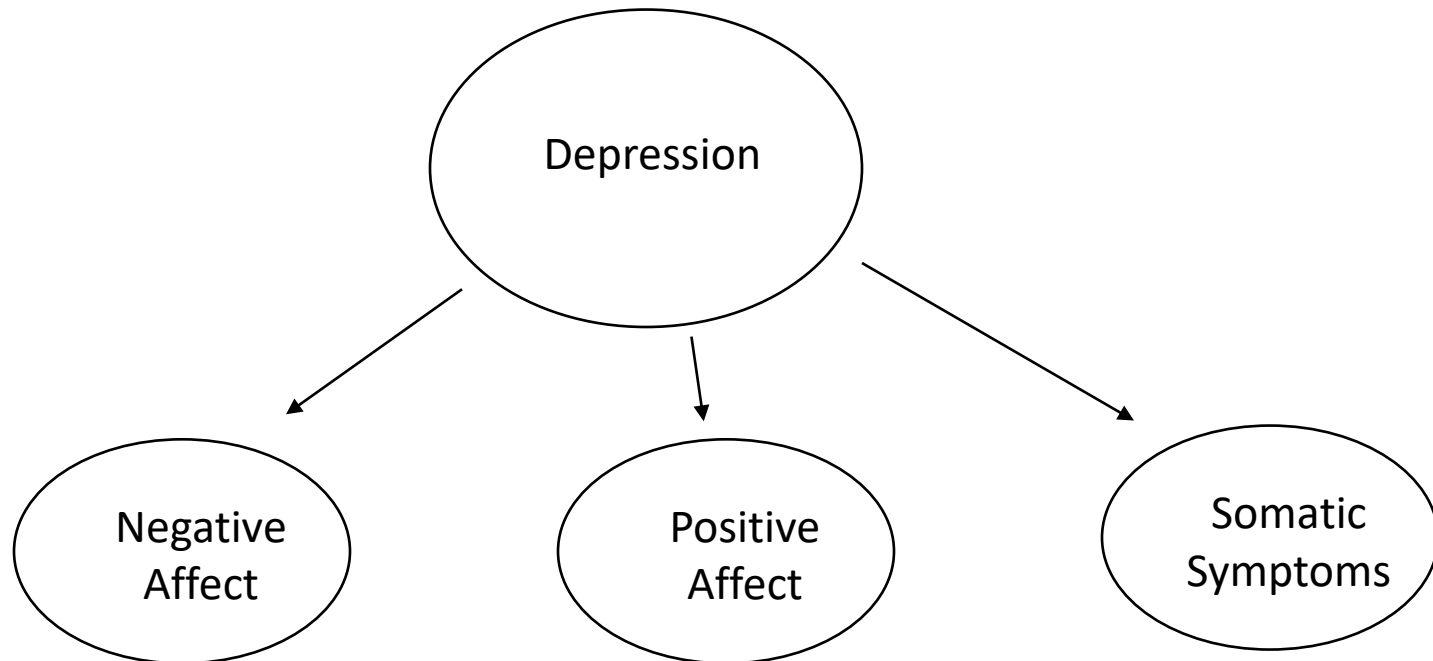
Correlated factors may be indicative of a larger more general construct

May or may not want to use a composite score from full scale if multiple factors exist

Do you have questions about the independent effects of each subscale?

I. Concept of Multiple Factors

Higher-order Hypothetical Construct



CES-D items: https://nida.nih.gov/sites/default/files/Mental_HealthV.pdf

II. Reliability Estimates with Multiple Factors

Cronbach's alpha assumes one dimension (factor), so alpha will often be lower if there is more than one factor

Some reliability coefficients for multiple dimension scales

Stratified alpha (Cronbach, Schoneman, & McKie, 1965)

Other multidimensional reliability coefficients (Mosier, 1943; Wang & Stanley, 1970)

II. Reliability Estimates with Multiple Factors

Stratified alpha (Cronbach, Schoneman, & McKie, 1965)

$$\alpha_{stratified} = 1 - \frac{\sum s_i^2 (1 - \alpha_i)}{s_x^2}$$

s_i^2 is the variance of one subtest (factor, dimension), α_i is the reliability coefficient of that subtest, and s_x^2 is the variance of the total scale

II. Reliability Estimates with Multiple Factors

Stratified alpha for two factors

$$\alpha_{stratified} = 1 - \frac{s_1^2 (1 - \alpha_1) + s_2^2 (1 - \alpha_2)}{s_x^2}$$

s_1^2 is the variance of the first subtest, α_1 is the reliability coefficient of the first subtest, s_2^2 is the variance of the second subtest, α_2 is the reliability coefficient of the second subtest, and s_x^2 is the variance of the total scale

II. Reliability Estimates with Multiple Factors

Wang and Stanley's (1970) reliability coefficient for scales with multiple factors

Based on work of Mosier (1943); Shown here for two factors only

$$R_{xx} = \frac{w_1^2 \alpha_1 + w_2^2 \alpha_2 + 2w_1 w_2 r_{12}}{w_1^2 + w_2^2 + 2w_1 w_2 r_{12}}$$

w_1 and w_2 are weights to give the factors different importance; α_1 is the reliability of the first factor and α_2 is the reliability of the second factor; r_{12} is the correlation between the factors.