Introduction to Classical Test Theory: How do we measure a latent concept such as love?

Hsueh-Sheng Wu

CFDR Workshop Series

Summer 2009

Outline of Workshop

- Sternberg's triangular love theory
- The key concepts of classical test theory and its applications
- Question 1: What is love?
- Question 2: Does love have different meanings for men and women?
- Question 3: Does the meaning of love change over time?
- Conclusion

Sternberg's triangular love theory

- Three components of the love: *passion*, *intimacy*, *commitment*
- Sternberg's triangular love scale (45 items)
- Three questions about love
  - What is love?
  - Does love have different meanings for men and women?
  - Does the meaning of love change over time?

Key Concepts of Classical Test Theory

- The observed score is the sum of the true score and an error
- The error is not correlated with the true score
- The error is randomly distributed with a mean of 0

9 Select Items Asking about Love

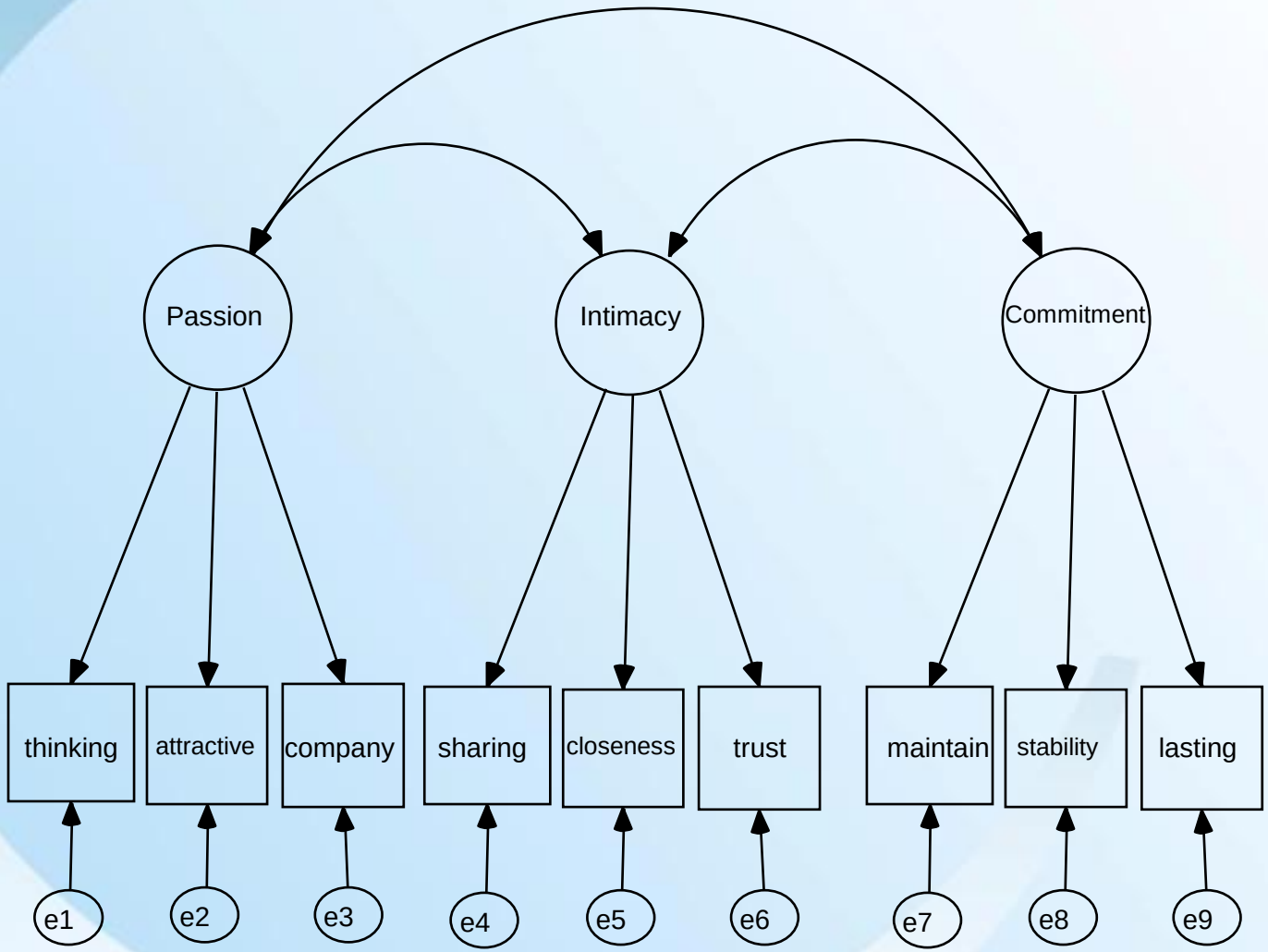
- Passion Component
  - I find myself thinking about Mary frequently during the day.
  - I find Mary to be very personally attractive.
  - I would rather be with Mary than with anyone else.

- Intimacy component
  - I am willing to share myself and my possessions with Mary.
  - I feel close to Mary.
  - I feel that I can really trust Mary.

- Commitment Component
  - I am committed to maintaining my relationship with Mary.
  - I have confidence in the stability of my relationship with Mary.
  - I expect my love for Mary to last for the rest of my life.

Response categories: 9-point scale, ranging from 1 “not at all” to 5 “moderately” to 9 “extremely”

Factor Model of the 9 Items



Interpretation of the Factor Model

- There are 9 observed variables. Each observed variable is influenced by two unobserved factors: a latent variable and an error
- Three correlated latent variables account for the associations of these 9 observed variables
- Important parameters of the model:
  - The number, mean, and variance of latent variables
  - The associations between latent variables
  - The associations between observed variables and the latent variables
  - The magnitudes of errors

Criteria for Determining If Measurements are Equivalent

- Do they measure the same latent variables?
- Do they measure the latent variables with the same degrees of precision?
- Do they measure the latent variables on the same scales?
- Do they contain the same amounts of error?

Evaluation of the Model Fit

Goodness of fit statistics for a single model

- Root Mean Square Error of Approximation (RMSEA) statistics
- Chi-square statistics
- Bentler Bonett Index or Normed Fit Index (NFI)
- Non-normed fit index (NNFI)
- Comparative fit index (CFI)

Statistics for Comparing Two Nested Models

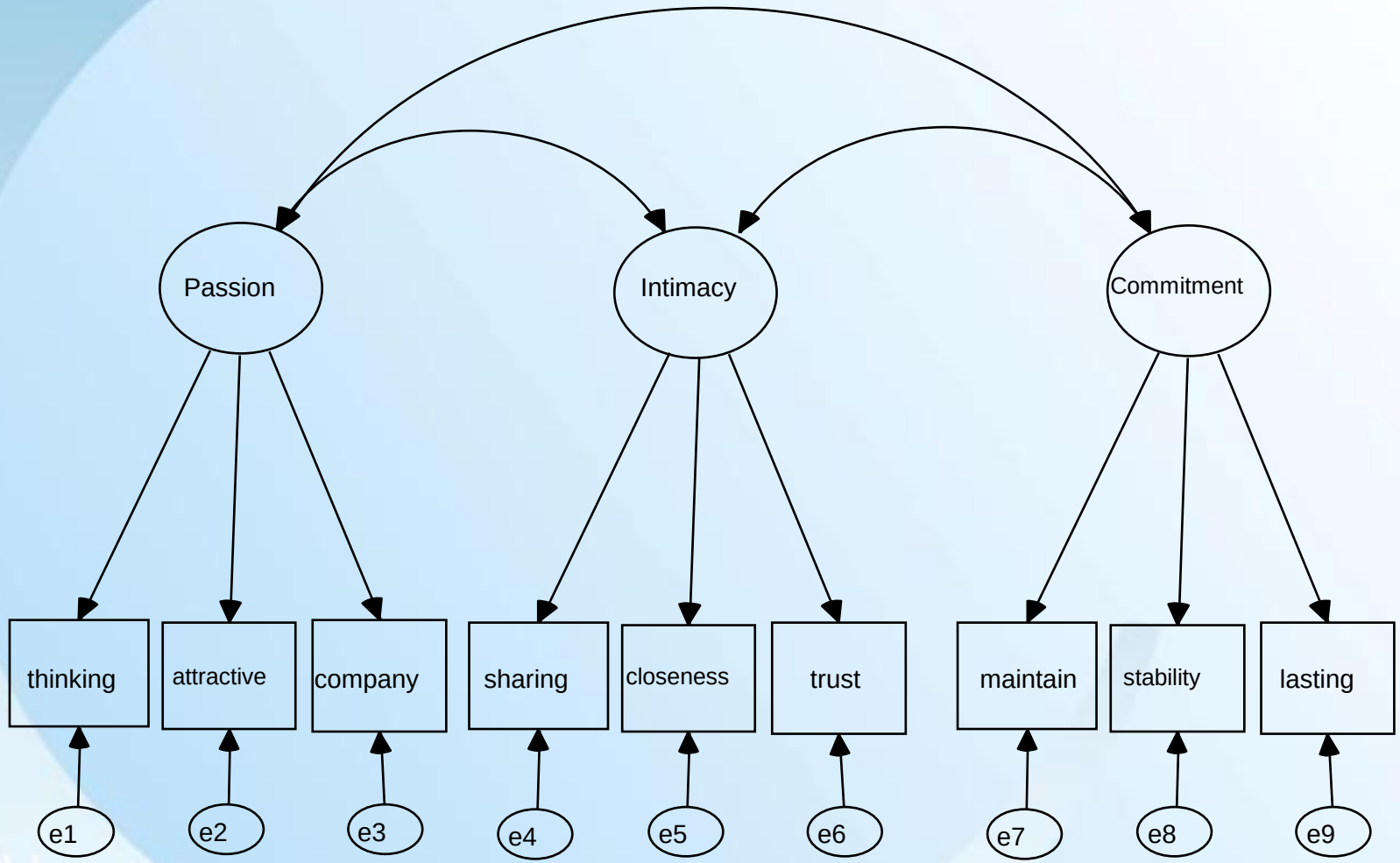
- Akaike Information Criterion (AIC)
- Bayesian Information Criterion (BIC)

Question1: What is love?

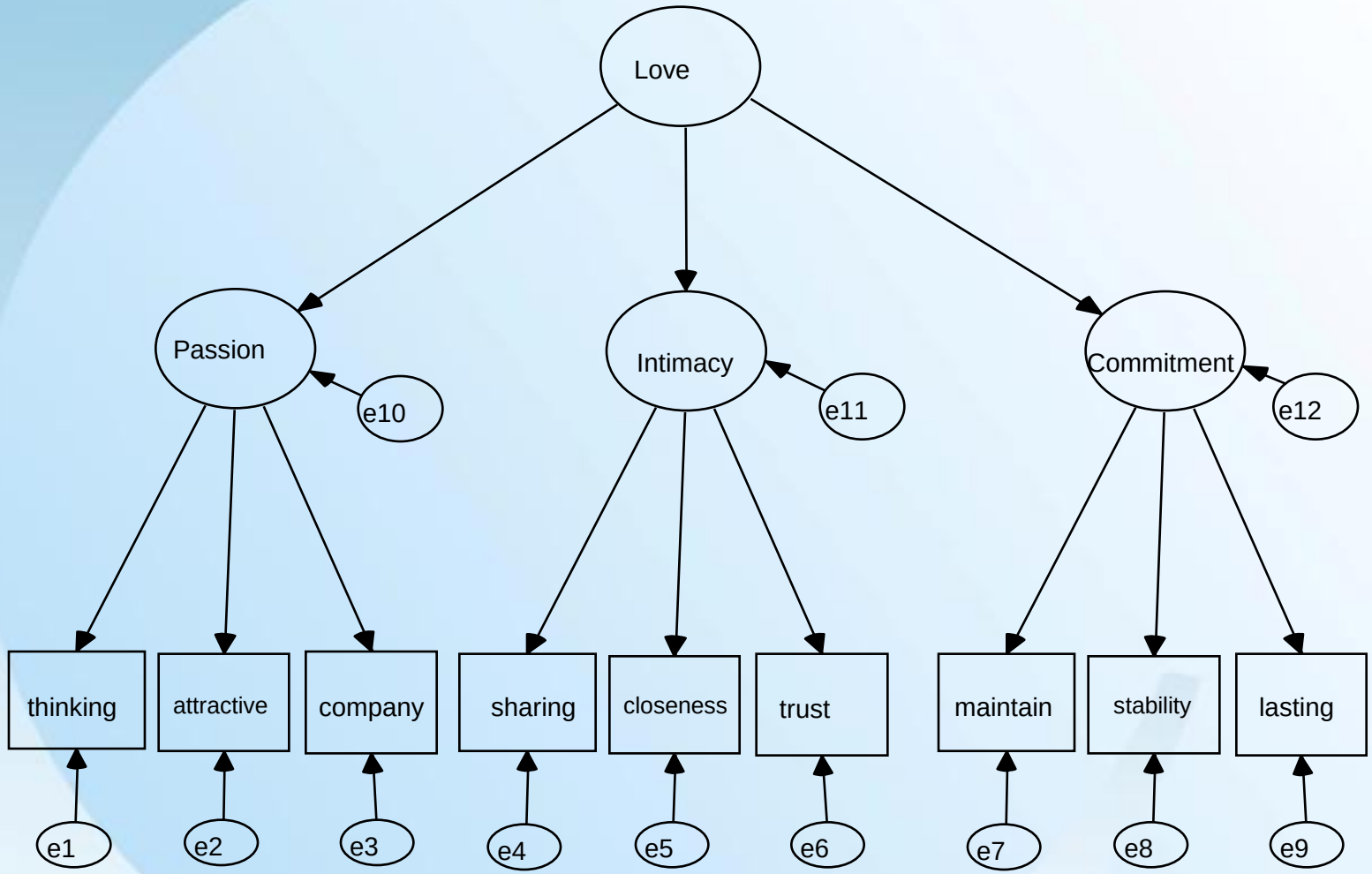
Different assumptions of the factor structure tell different stores about love

- Model 1: A three correlated-factor model
- Model 2: A second-order factor model
- Model 3: A one-factor model

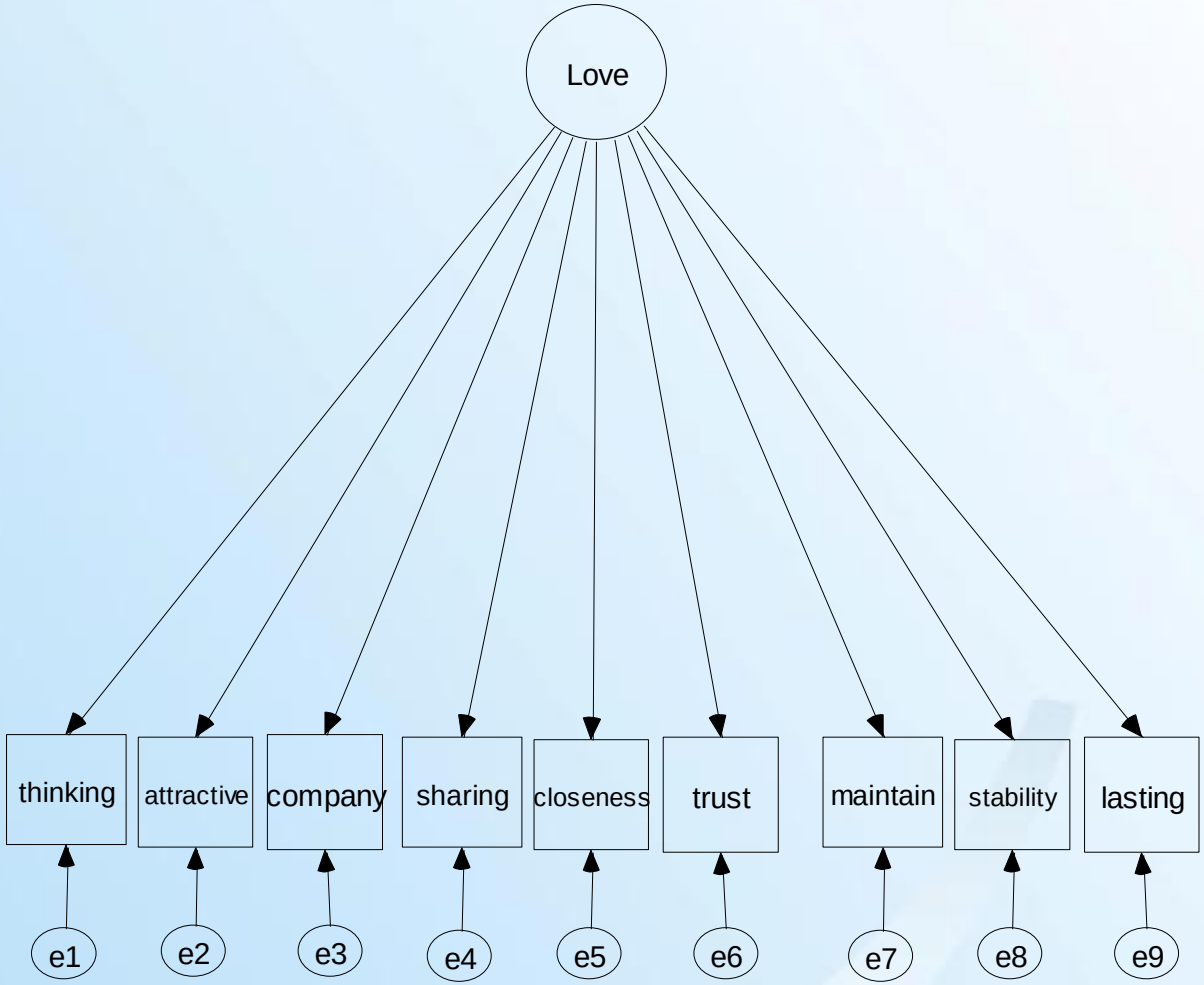
Model 1: A three correlated-factor model



Model 2: A second-order factor model



Model 3: A one-factor model



Question 2: Does the meaning of love differ for men and women?

- Fit the same measurement model to the data collected from men and women, respectively.
- Test if significant differences exist in the parameters of the factor models obtained from men and women.
  - Do they measure the same latent variables?
  - Do they measure the latent variables with the same degrees of precision?
  - Do they measure the latent variables on the same scale?
  - Do they contains the same amounts of error?

Question 3: Does the meaning of love change over time?

- Fit the same measurement model to the data collected from same individuals at time 1 and time 2, respectively.
- Test if significant differences exist in the parameters of the factor models obtained at these two time points.
  - Do they measure the same latent variables?
  - Do they measure the latent variables with the same degrees of precision?
  - Do they measure the latent variables on the same scale?
  - Do they contains the same amounts of error?

Conclusion: Why do we need classical test theory?

- Focus on latent variables rather than observed variables
- Allow for different hypotheses about the factorial structures of the observed variables
- The measurement equivalent model allows us to pinpoint exactly which part of a measurement model differs by gender or time.