Correlational designs

Issues of Reliability, Validity, and Causality

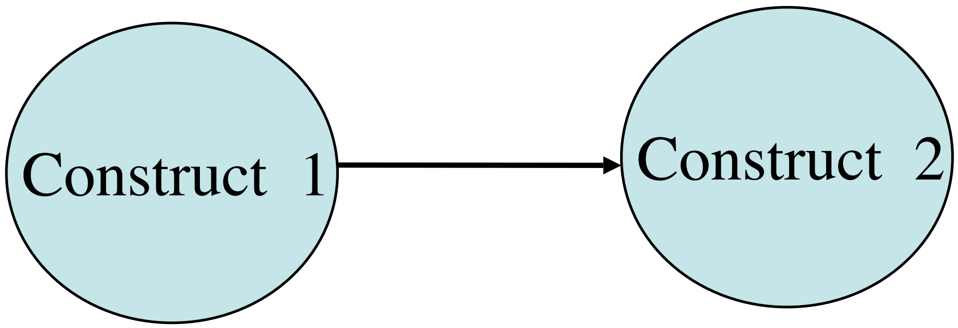
Alternative Explanatory Variables

- A developmental psychologist has noticed that children with bigger feet tend to have greater vocabularies than children with smaller feet?
- This is an example of a simple correlational design. Can you think of a powerful alternative explanation?

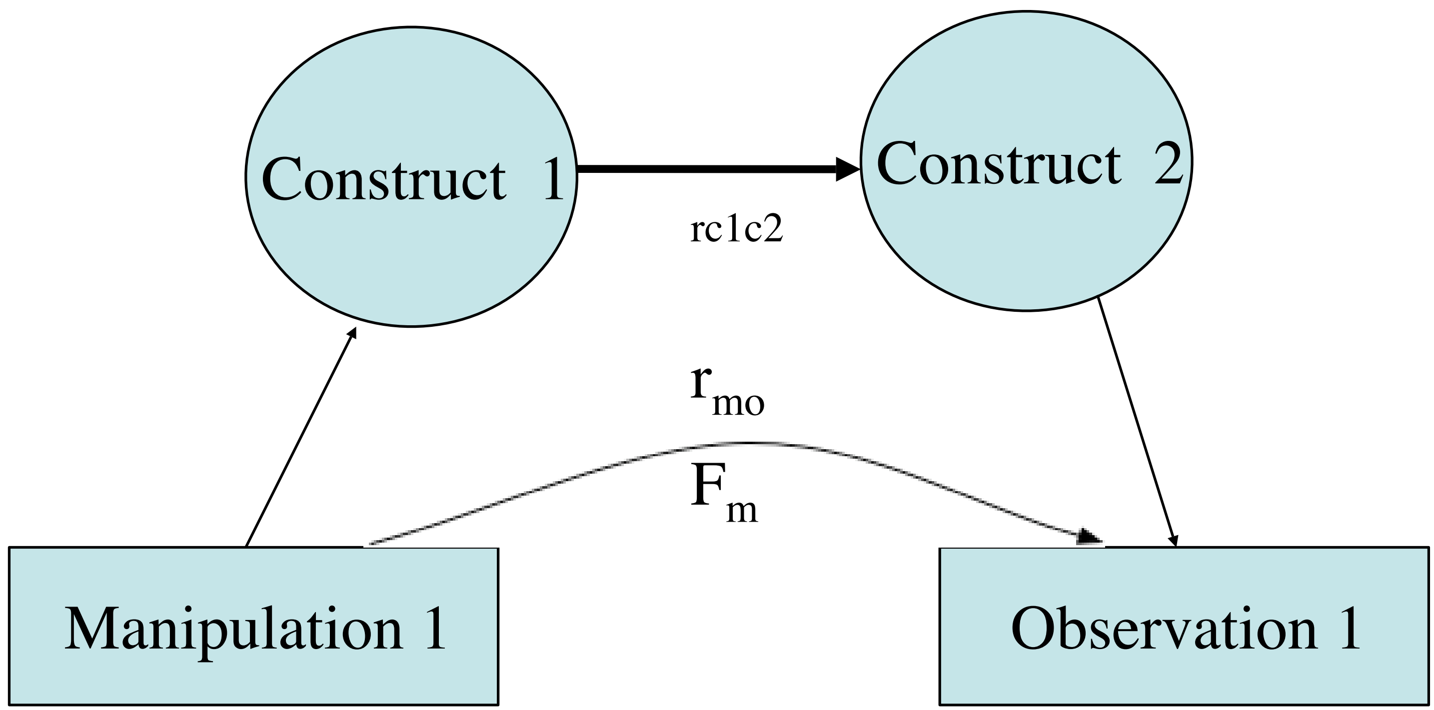
Types of data and correlational designs

- Varieties of data
  - Direct
    - Self report of personality/attitudes/values
    - Peer/supervisor/subordinate ratings of performance
    - Ability scales
  - Indirect
    - Implicit measures (e.g., of attitude)
    - Unobtrusive measures
      - Historical, archival

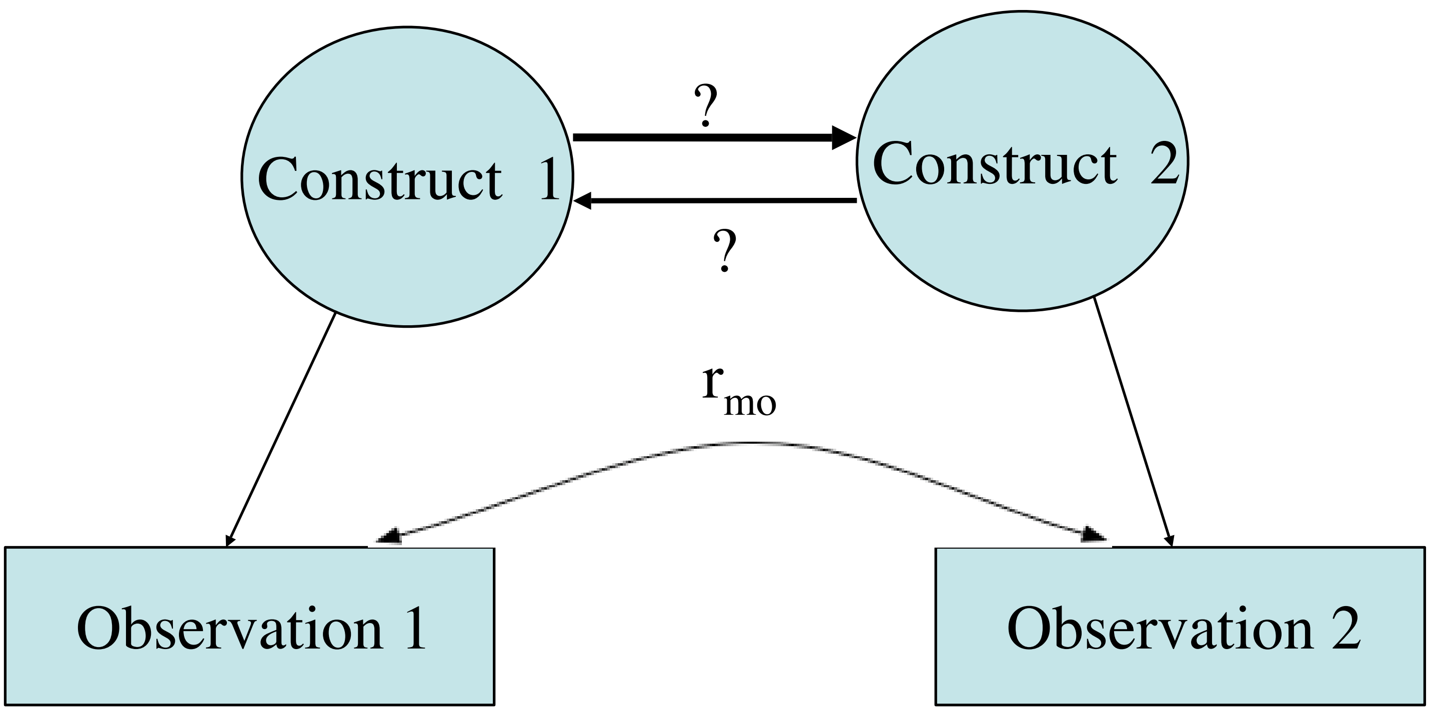
Theory and Theory Testing I: Theory



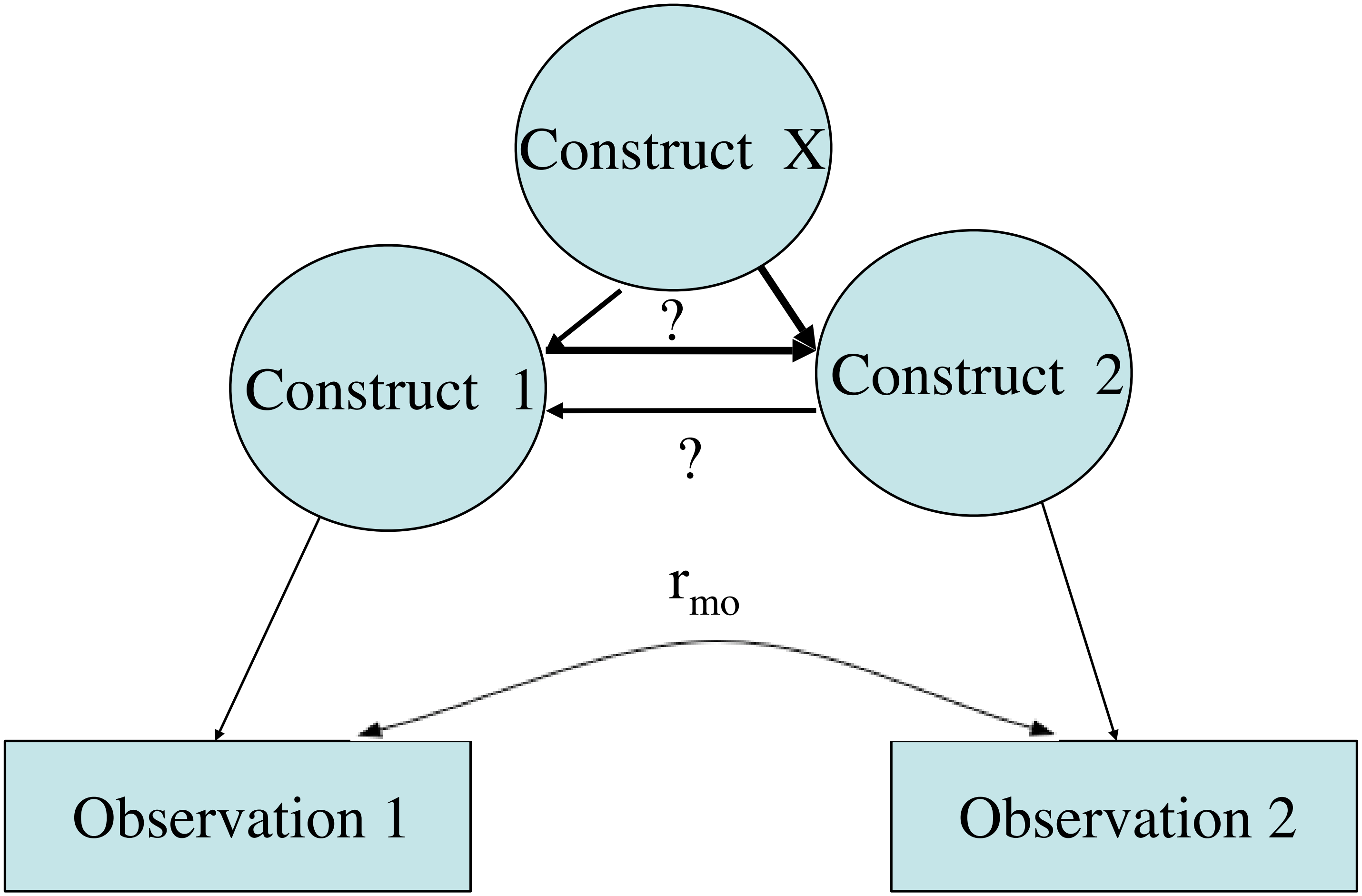
Theory and Theory Testing II: Experimental manipulation



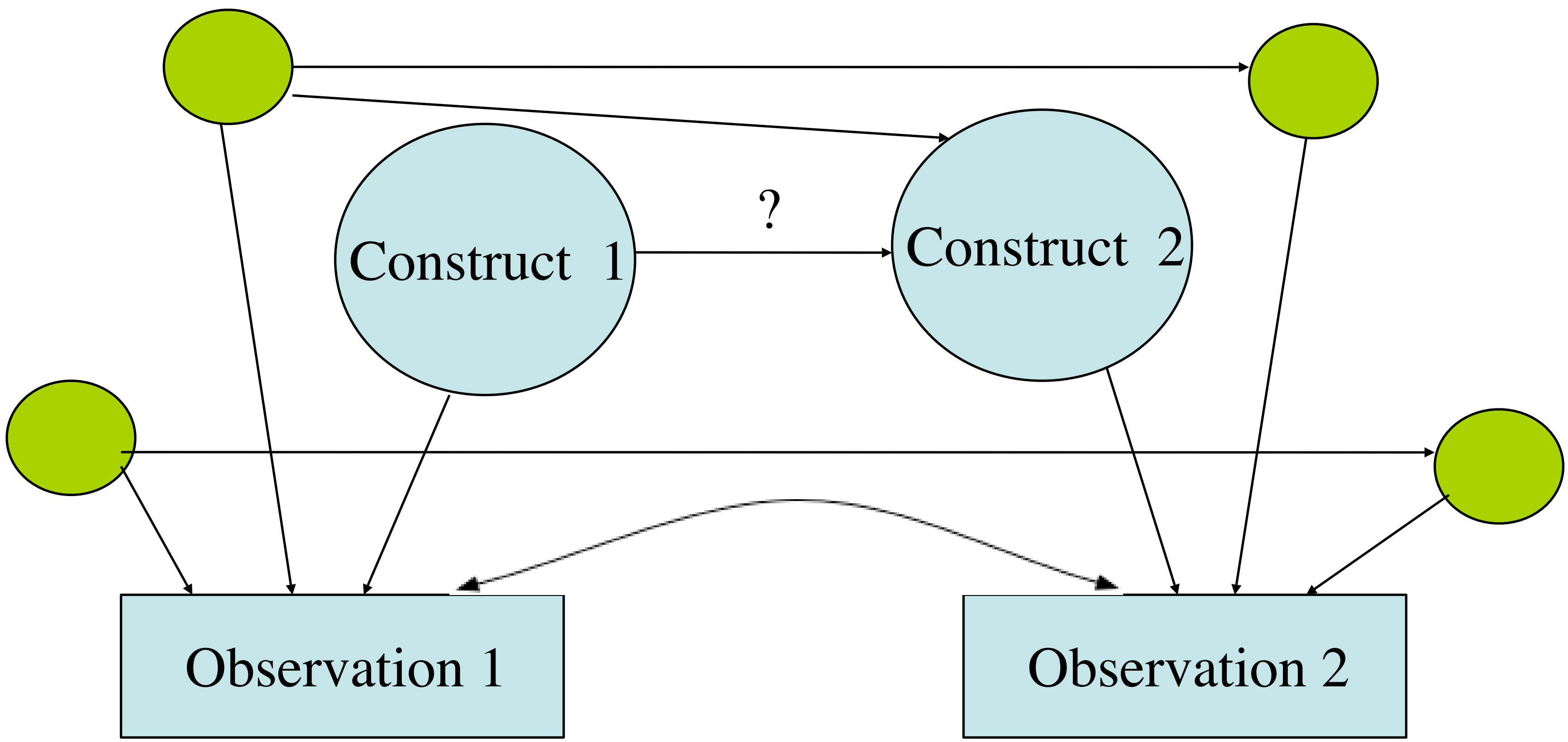
Theory and Theory Testing III: Correlational inference



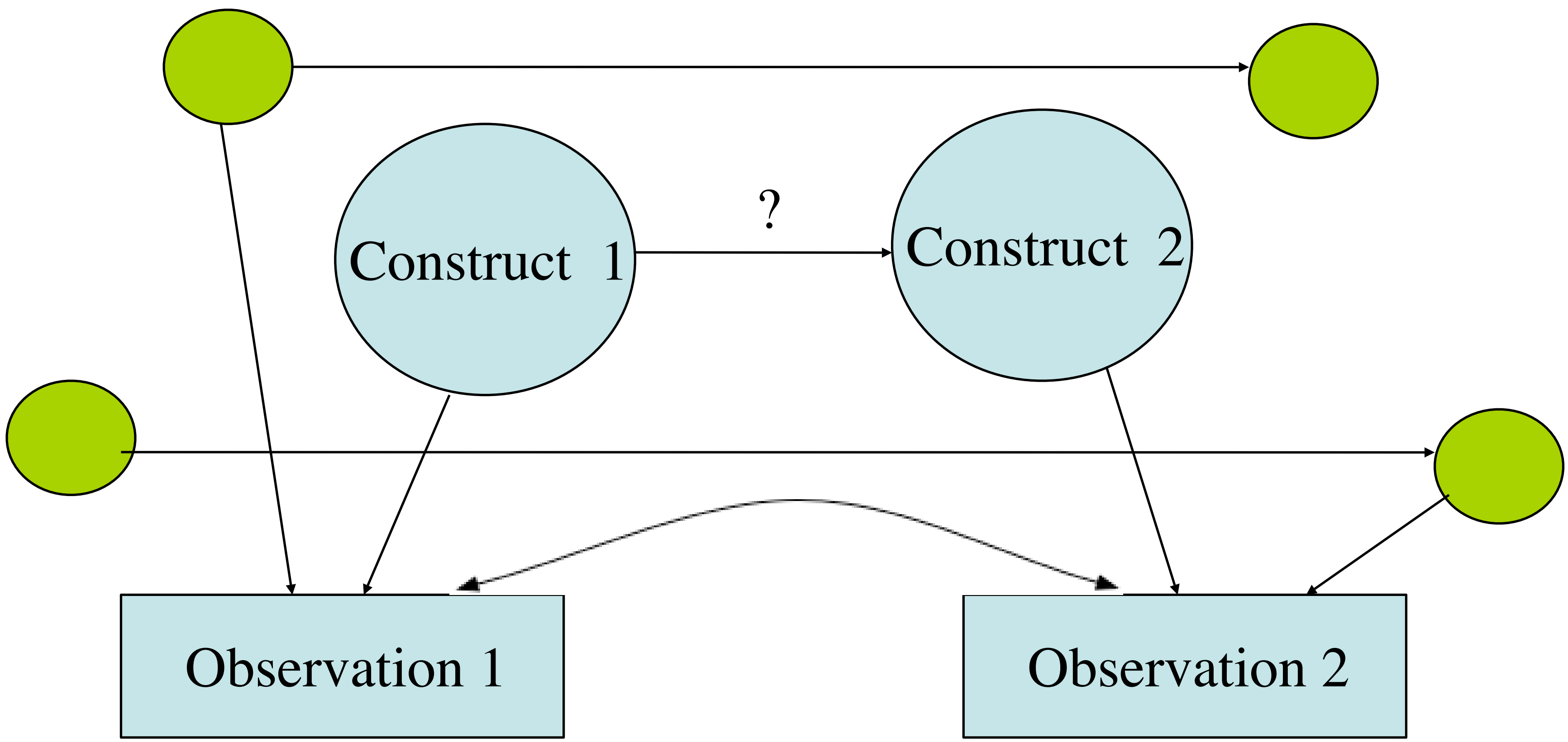
Theory and Theory Testing IV: Correlational inference



Theory and Theory Testing V: Alternative Explanations



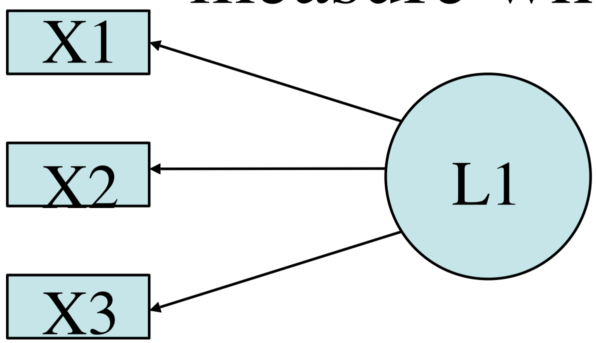
Theory and Theory Testing VI: Eliminate Alternative Explanations



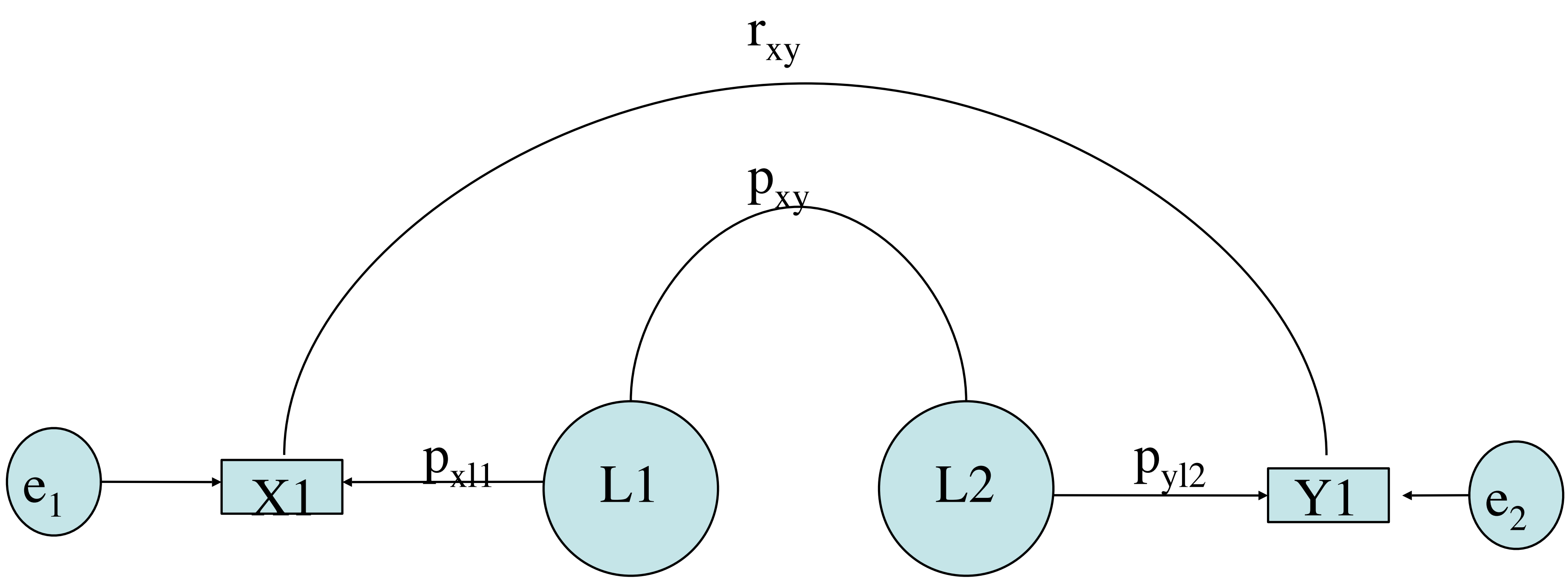
Steps in correlational inference

- Estimate the reliability of the variables
  - Magnitude of correlation is influenced by the reliability of the correlation
  - Varieties of reliability
- Estimate the construct validity of the measures
  - Convergent, Discriminant, Incremental validity
- Consider alternative explananatory variables

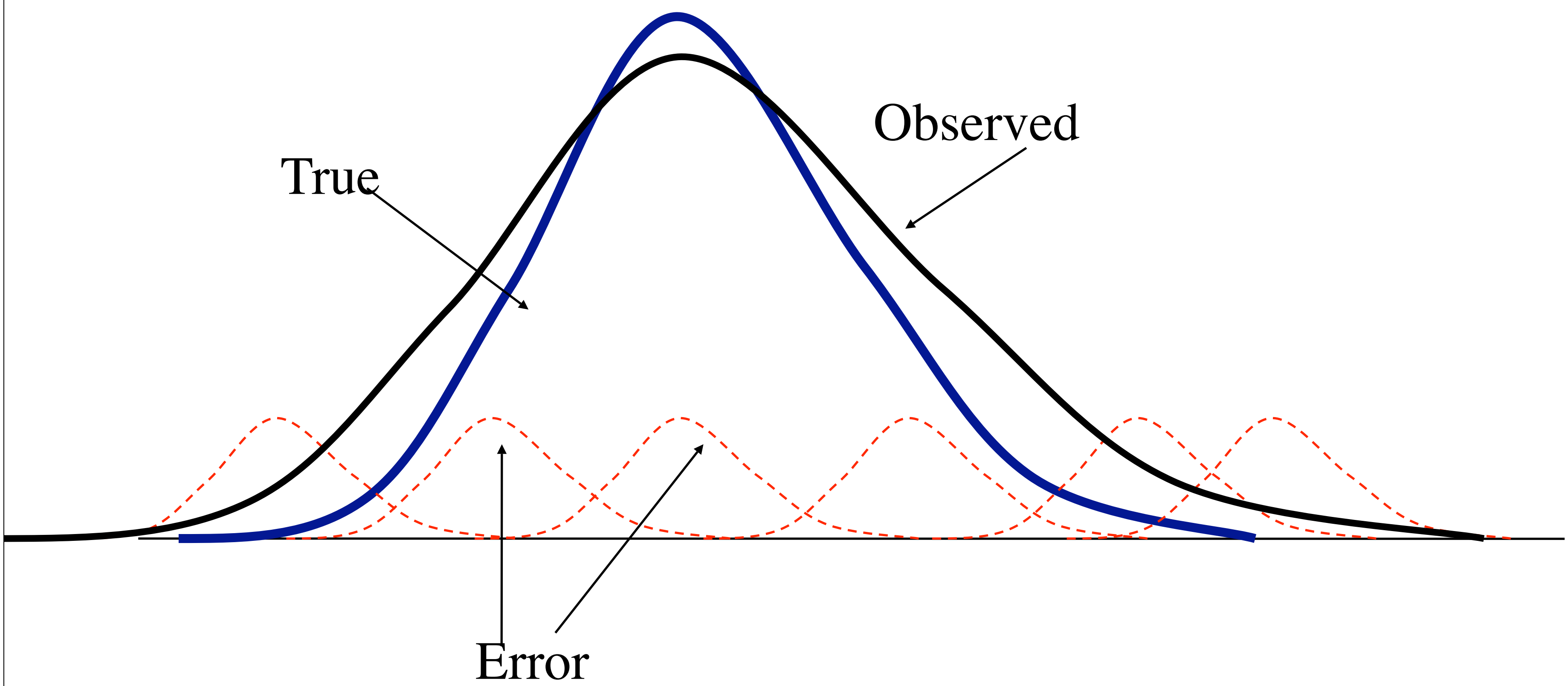
Classic Reliability Theory: How well do we measure what ever we are measuring



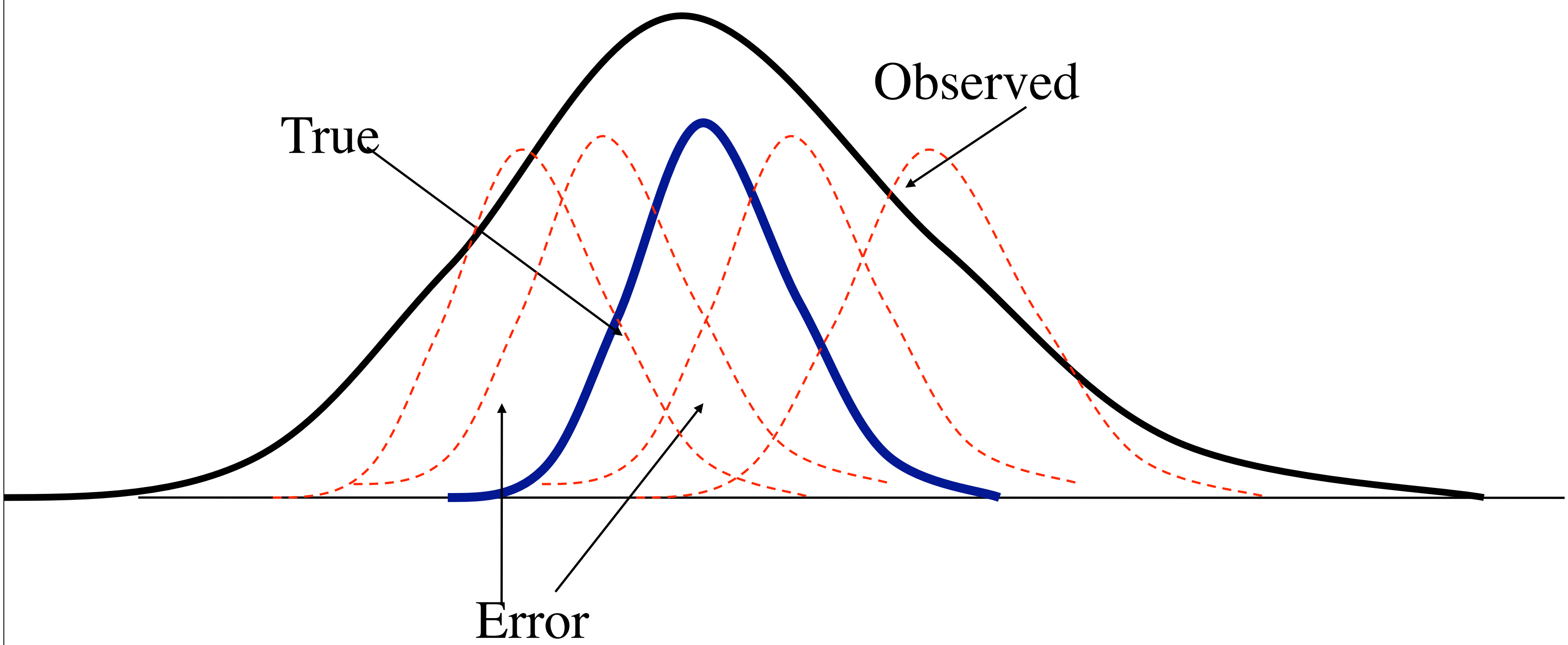
Classic Reliability Theory: How well do we measure what ever we are measuring and what is the relationships between latent variables



Observed= True + Error



Observed= True + Error

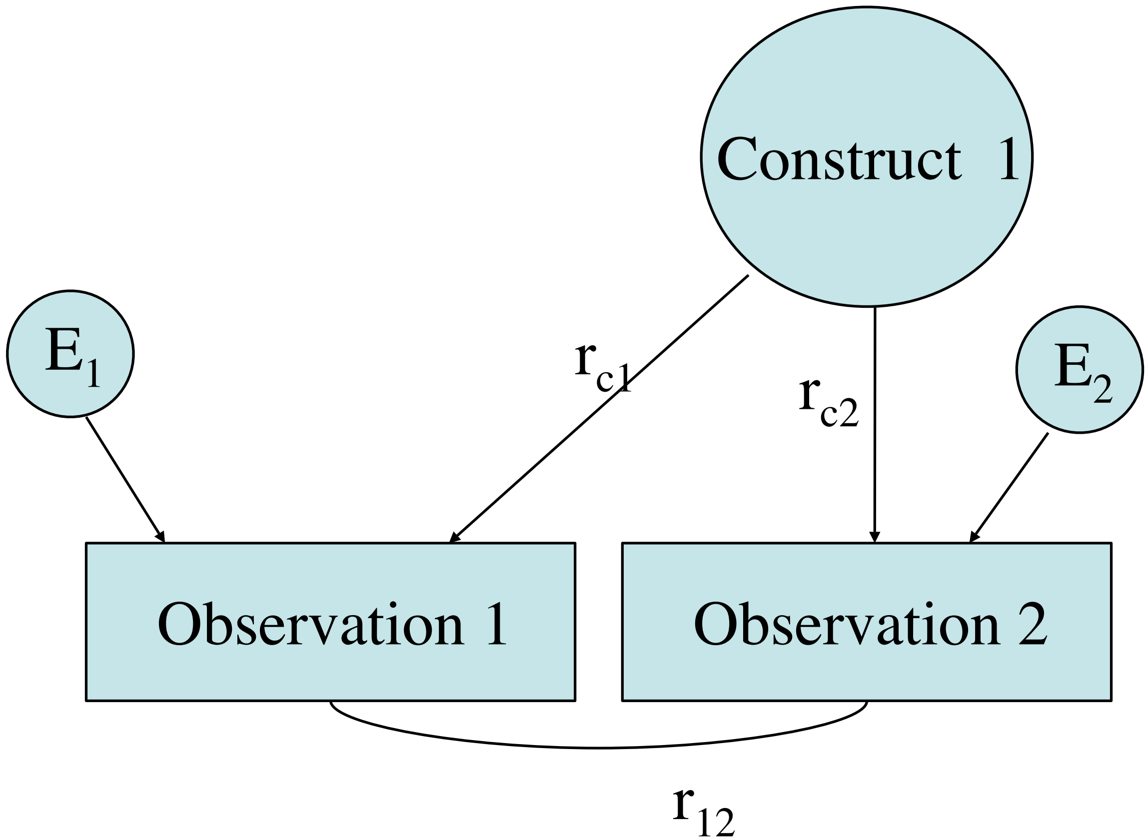


Estimating true score: regression artifacts

- Consider the effect of reward and punishment upon pilot training:
  - From 100 pilots, reward the top 50 flyers, punish the worst 50.
  - Observation: praise does not work, blame does!
  - Explanation?

Reliability of measurement

(how well does an observation reflect the construct)



$r_{12} = r_{c1} * r_{c2}$

Assume

$r_{c1} = r_{c2}$ then

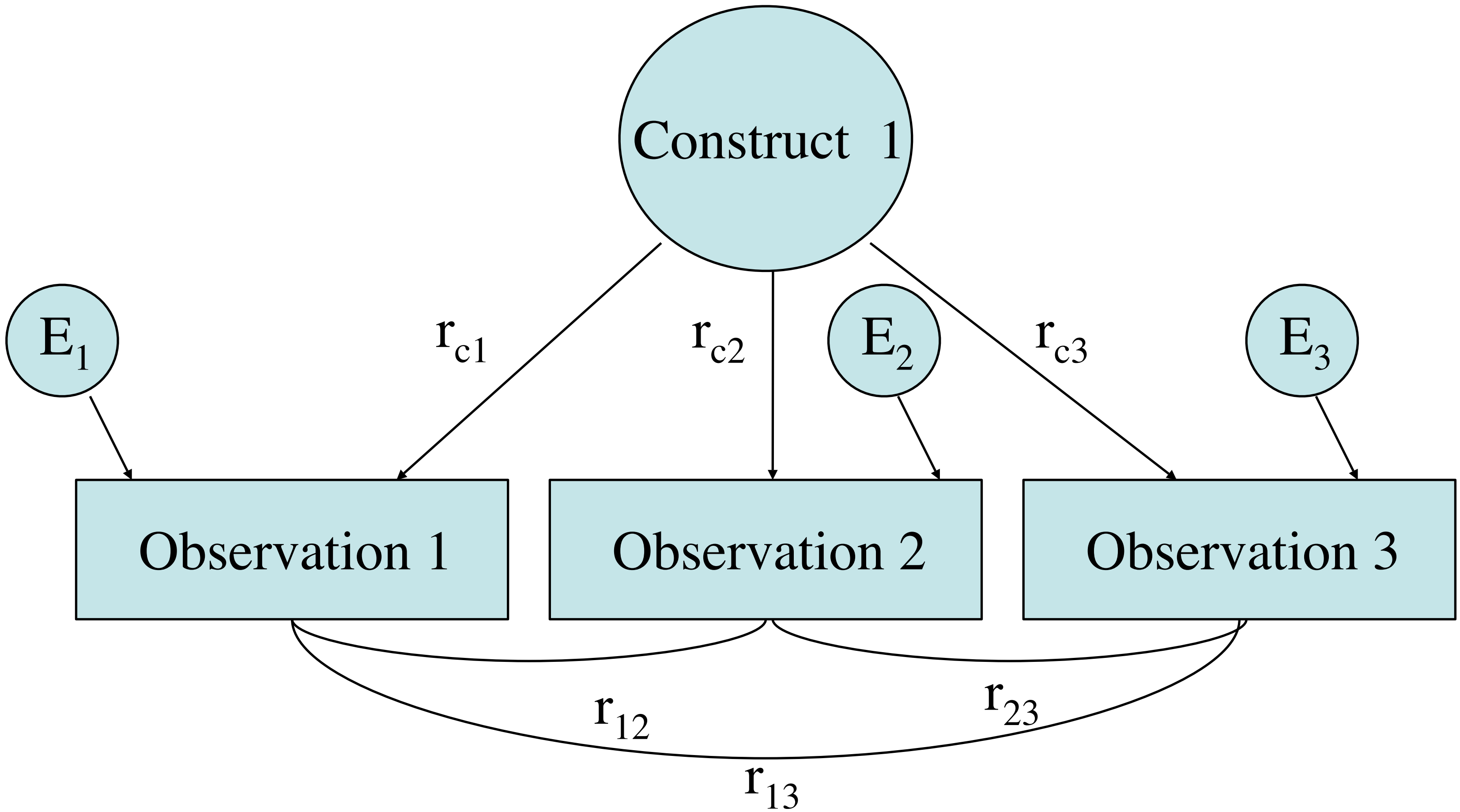
$r_{c1} = \mathrm{sqrt}(r_{12})$

Observed Variance $_1$ = Variance C_1 + Variance E_1

(Vx = Vc + Ve) $\qquad r_{12} = Vc/Vx$

Reliability of measurement

(how well does an observation reflect the construct)



Domain Sampling theory

- Consider a domain (D) of k items relevant to a construct. (E.g., English vocabulary items, expressions of impulsivity). Let Di represent the number of items in D which the ith subject can pass (or endorse in the keyed direction) given all D items. Call this the domain score for subject I. What is the correlation (across subjects) of scores on an item j with the domain scores?

The effect of test length on internal consistency

	Average r	Average r
Number of items	.2	.1
1	.20	.10
2	.33	.18
4	.50	.31
8	.67	.47
16	.80	.64
32	.89	.78
64	.94	.88
128	.97	.93

Find Alpha from correlations

	q_262	q_1480	q_819	q_1180	1742
q_262	1	0.26	0.41	0.51	0.48
q_1480	0.26	1	0.66	0.52	0.47
q_819	0.41	0.66	1	0.41	0.65
q_1180	0.51	0.52	0.41	1	0.49
q_1742	0.48	0.47	0.65	0.49	1

Alpha from correlations

- Total variance = sum of all item correlations
  - = 14.74570
- total covariances = Vt - ∑item variance
  - = 9.74570
- average covariance =
  - (Vt - ∑item variance)/(nvar *(nvar-1)) = .66
- alpha = ((Vt - ∑item variance)/Vt)*(nvar *(nvar-1))
  - = alpha = .83

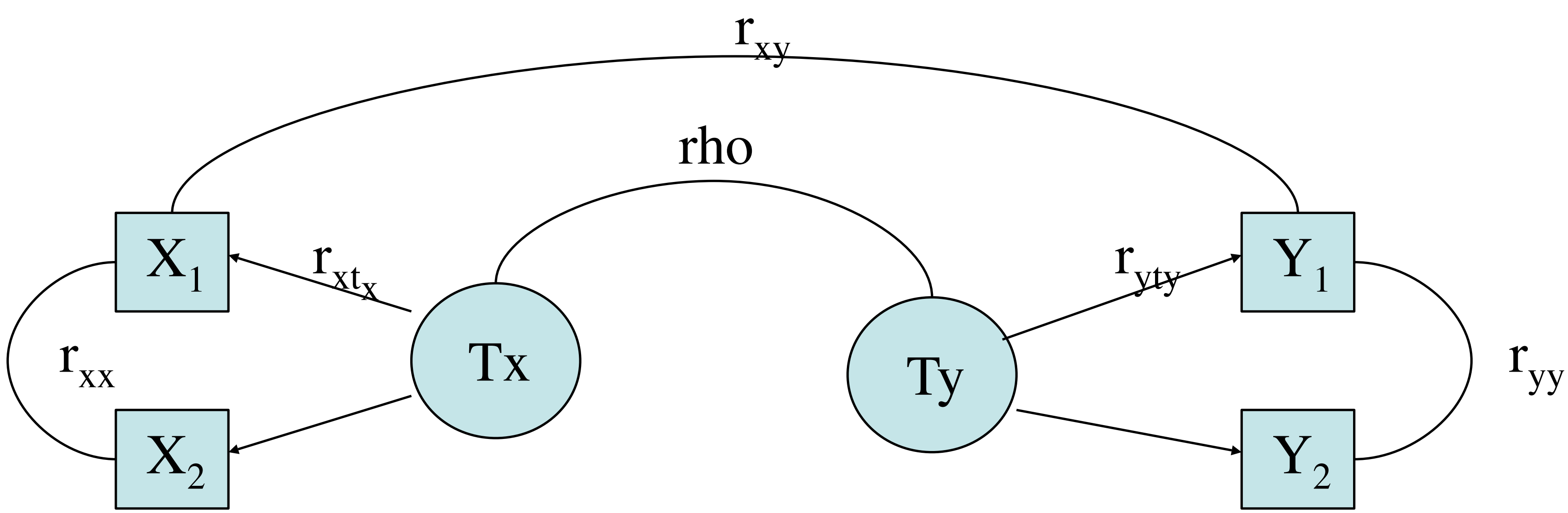
Facets of reliability

Across items	Domain sampling Internal consistency
Across time	Temporal stability
Across forms	Alternate form reliability
Across raters	Inter-rater agreement
Across situations	Situational stability
Across "tests" (facets unspecified)	Parallel test reliability

Types of reliability

- Items in a test of positive affect correlate .3 with other items of positive affect given at the same time.
- An ability test given in 5th grade correlates .6 with an ability test given in college.
- Baseball batting averages correlate .35 from year to year.

Reliability- Correction for attenuation



r_{xt_x}= sqrt(r_{xx})

r_{yty}= sqrt(r_{yy})

Rho = rxy/sqrt(r_{xx}*r_{yy})

Effect of preschool

- A team of educational psychologists examined the effect of early reading in preschool upon later academic attainment. They randomly selected 20 preschools in Evanston and gave a measure of reading skill to 200 children (mean = 5.0, sd =1.0). They followed the progress of the top 50 students (mean score = 6) for a year. At the end of the year they compared their sample students to the mean and found the group was no different from the average. They concluded that preschool hurt these students.

Effect of preschool

- A team of educational psychologists examined the effect of early reading in preschool upon later academic attainment. They randomly selected 20 preschools in Evanston and gave a measure of reading skill to 200 children (mean = 5.0, sd =1.0). They followed the progress of the bottom 50 students (mean score = 4) for a year. At the end of the year they compared their sample students to the mean and found the group was no different from the average. They concluded that preschool helped these students.

Classic reliability - limitation

All of the conventional approaches are concerned with generalizing about individual differences (in response to an item, time, form, rater, or situation) between people. Thus, the emphasis is upon consistency of rank orders. Classical reliability is a function of large between subject variability and small within subject variability. It is unable to estimate the within subject precision for a single person.

The New Psychometrics- Item Response Theory

- Classical theory estimates the correlation of item responses (and sums of items responses, i.e., tests) with domains.
- Classical theory treats items as random replicates but ignores the specific difficulty of the item, nor attempts to estimate the probability of endorsing (passing) a particular item

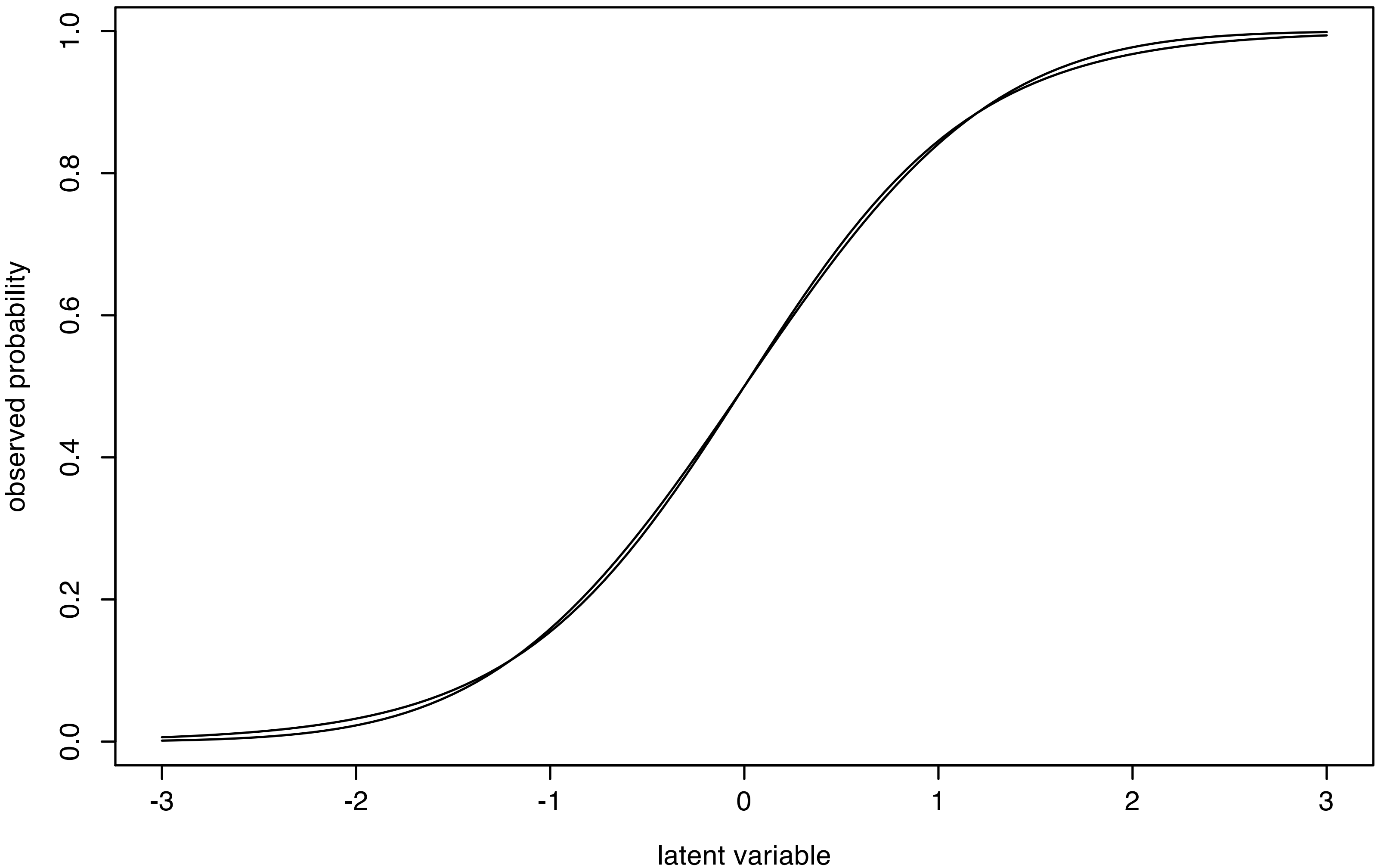
Item Response Theory

- Consider the person's value on an attribute dimension (θ_i).
- Consider an item as having a difficulty δ_j
- Then the probability of endorsing (passing) an item j for person i= $f(\theta_{i,} \delta_j)$
- $p(\text{correct} \mid \theta_{i,} \delta_j) = f(\theta_{i,} \delta_j)$
- What is an appropriate function?
- Should reflect $\delta_j - \theta_i$ and yet be bounded 0,1.

Item Response Theory

- $p(\text{correct} \mid \theta_{i,} \delta_j) = f(\theta_{i,} \delta_j) = f(\delta_j - \theta_i)$
- Two logical functions:
  - Cumulative normal (see, e.g., Thurstonian scaling)
  - Logistic $= 1/(1+\exp(\delta_j - \theta_i))$ (the Rasch model)
  - Logistic with weight of 1.7
    - $1/(1+\exp(1.7*(\delta_j - \theta_i)))$ approximates cumulative normal

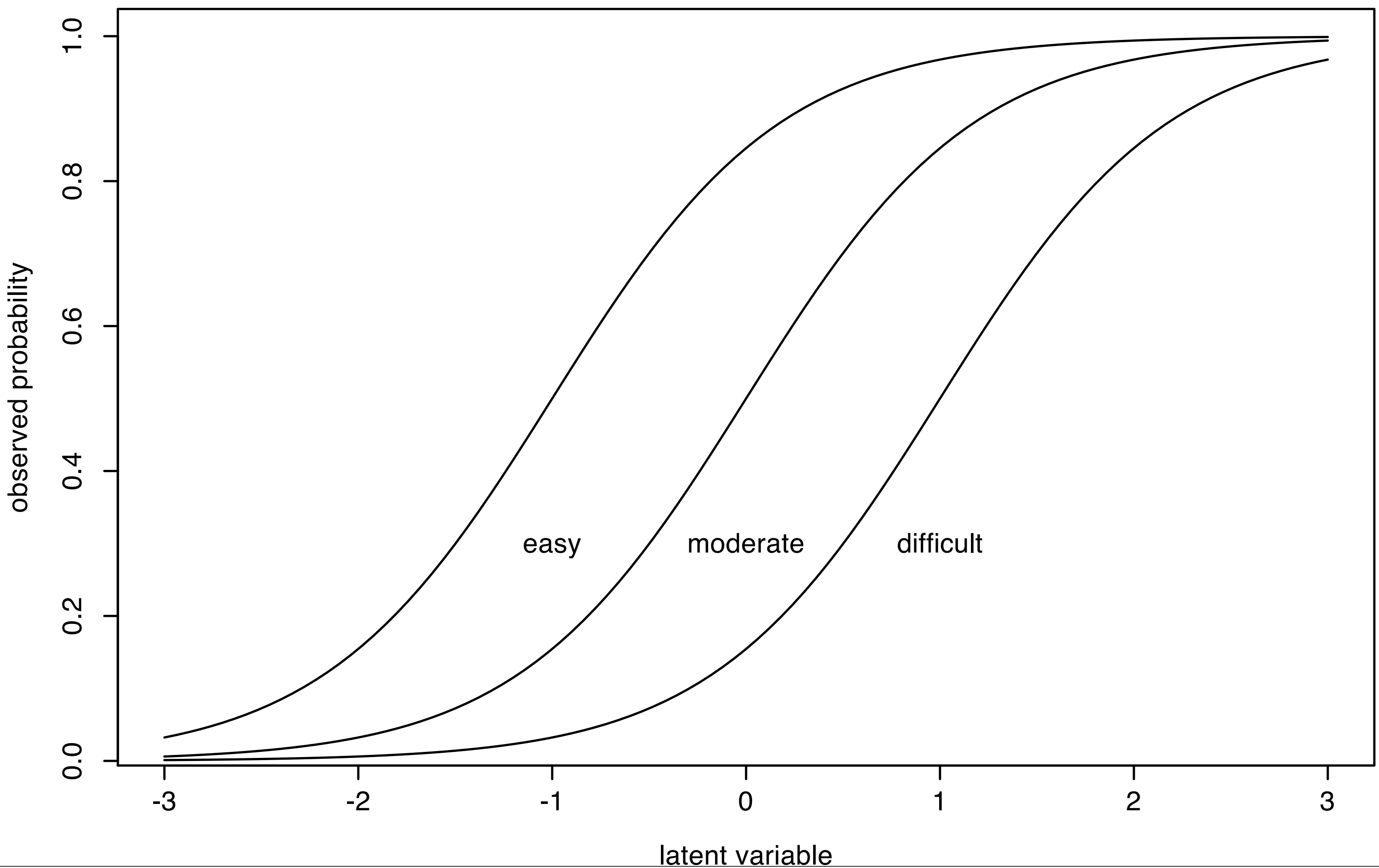
Logistic and cumulative normal



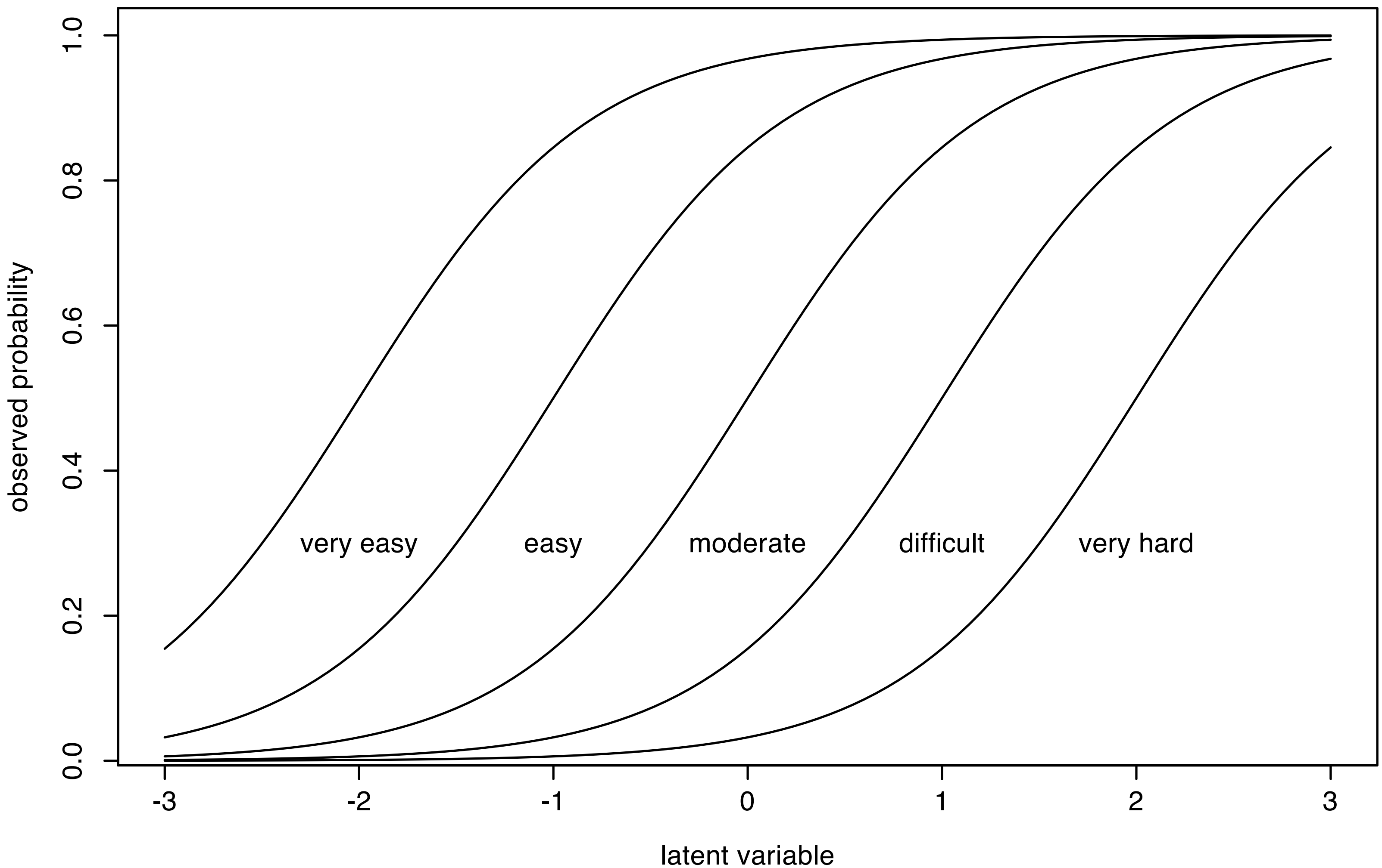
Item difficulty and ability

- Consider the probability of endorsing an item for different levels of ability and for items of different difficulty.
- Easy items ($\delta_j = -1$)
- Moderate items ($\delta_j = 0$)
- Difficulty items ($\delta_j = 1$)

IRT of three item difficulties



item difficulties = -2, -1, 0 , 1, 2



Estimation of ability for a particular person for known item difficulty

- The probability of any pattern of responses (x1, x2, x3, …. Xn) is the product of the probabilities of each response ∏(p(xi)).
- Consider the odds ratio of a response
  - p/(1-p) = $1/(1+\exp(1.7*(\delta_j - \theta_i)))\ /(1 - 1/(1+\exp(1.7*(\delta_j - \theta_i))))$ =
  - p/(1-p) = $\exp(1.7*(\delta_j - \theta_i)))$ and therefore:
  - Ln(odds) = $1.7*(\delta_j - \theta_i)$ and
  - Ln (odds of a pattern) = $1.7\sum(\delta_j - \theta_i)$ for known difficulty

Unknown difficulty

- Initial estimate of ability for each subject (based upon total score)
- Initial estimate of difficulty for each item (based upon percent passing)
- Iterative solution to estimate ability and difficulty (with at least one item difficulty fixed.

Classical versus the "new"

- Ability estimates are logistic transform of total score and are thus highly correlated with total scores, so why bother?
- IRT allows for more efficient testing, because items can be tailored to the subject.
- Maximally informative items have p(passing given ability and difficulty) of .5
- With tailored tests, each person can be given items of difficulty appropriate for them.

Computerized adaptive testing

- CAT allows for equal precision at all levels of ability
- CAT/IRT allows for individual confidence intervals for individuals
- Can have more precision at specific cut points (people close to the passing grade for an exam can be measured more precisely than those far (above or below) the passing point.

Psychological (non-psychometric) problems with CAT

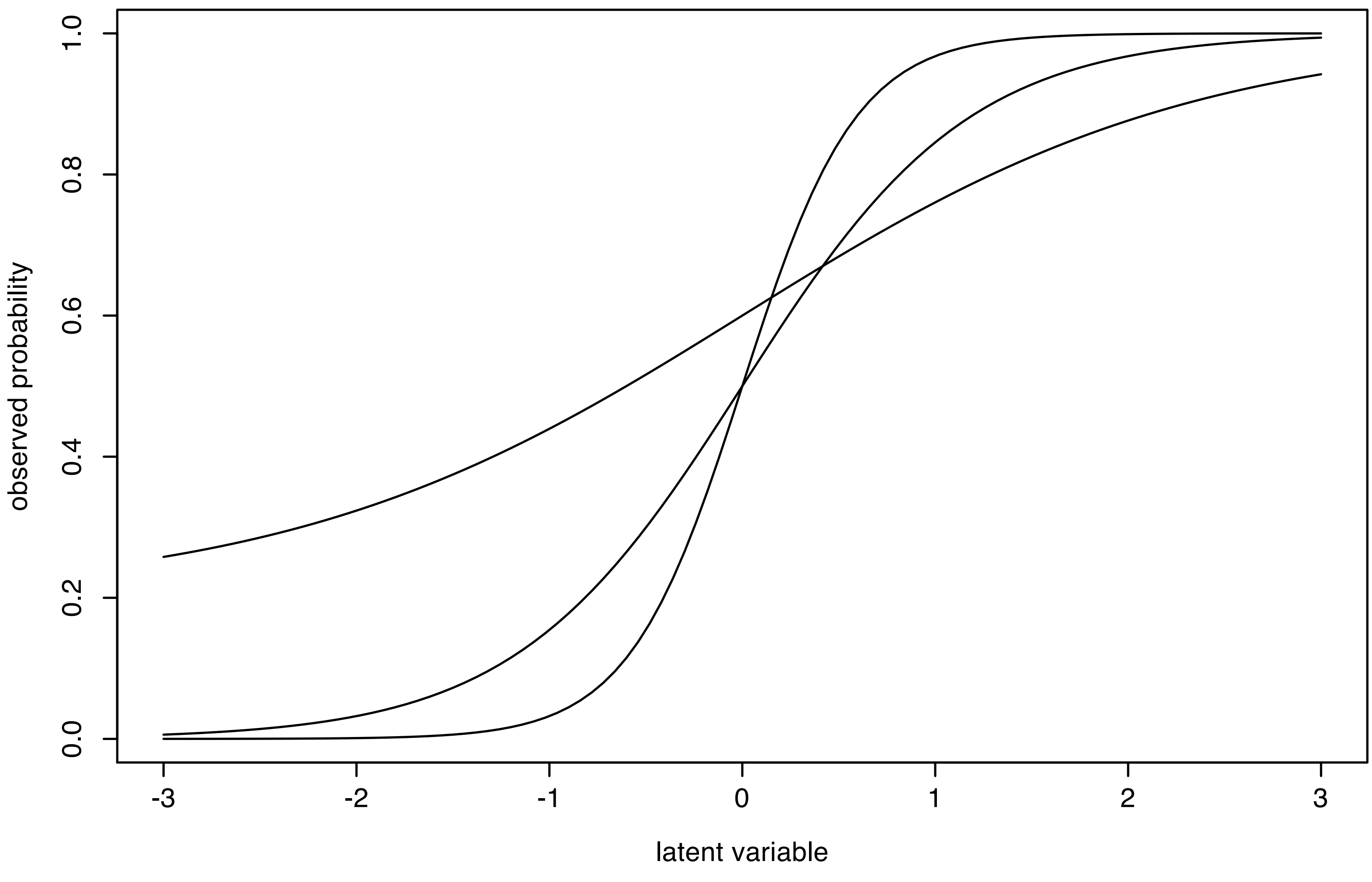
- CAT items have difficulty level tailored to individual so that each person passes about 50% of the items.
- This increases the subjective feeling of failure and interacts with test anxiety
- Anxious people quit after failing and try harder after success -- their pattern on CAT is to do progressively worse as test progresses (Gershon, 199x, in preparation)

Generalizations of IRT to 2 and 3 item parameters

- Item difficulty
- Item discrimination (roughly equivalent to correlation of item with total score)
- Guessing (a problem with multiple choice tests)
- 2 and 3 parameter models are harder to get consistent estimates and results do not necessarily have monotonic relationship with total score

3 parameter IRT

slope, location, guessing



Item Response Theory

- Can be seen as a generalization of classical test theory, for it is possible to estimate the correlations between items given assumptions about the distribution of individuals taking the test
- Allows for expressing scores in terms of probability of passing rather than merely rank orders (or even standard scores). Thus, a 1 sigma difference between groups might be seen as more or less important when we know how this reflects chances of success on an item
- Emphasizes non-linear nature of response scores.

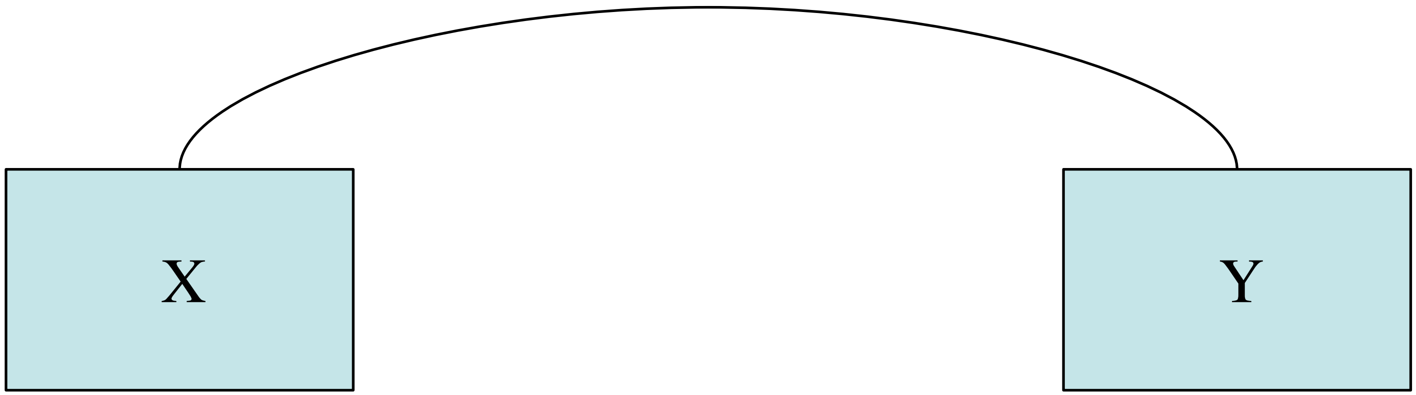
Varieties of Validity

- Face
- Concurrent
- Predictive
- Construct
  - Convergent
  - Discriminant

Face (Faith Validity)

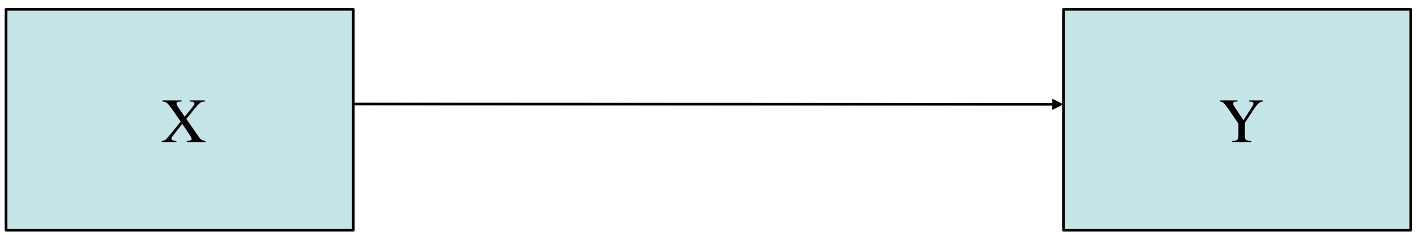
- Representative content
- Seeming relevance

Concurrent Validity



- Does a measure correlate with the criterion?
- Need to define the criterion.
- Assumes that what correlates now will have predictive value.

Predictive Validity

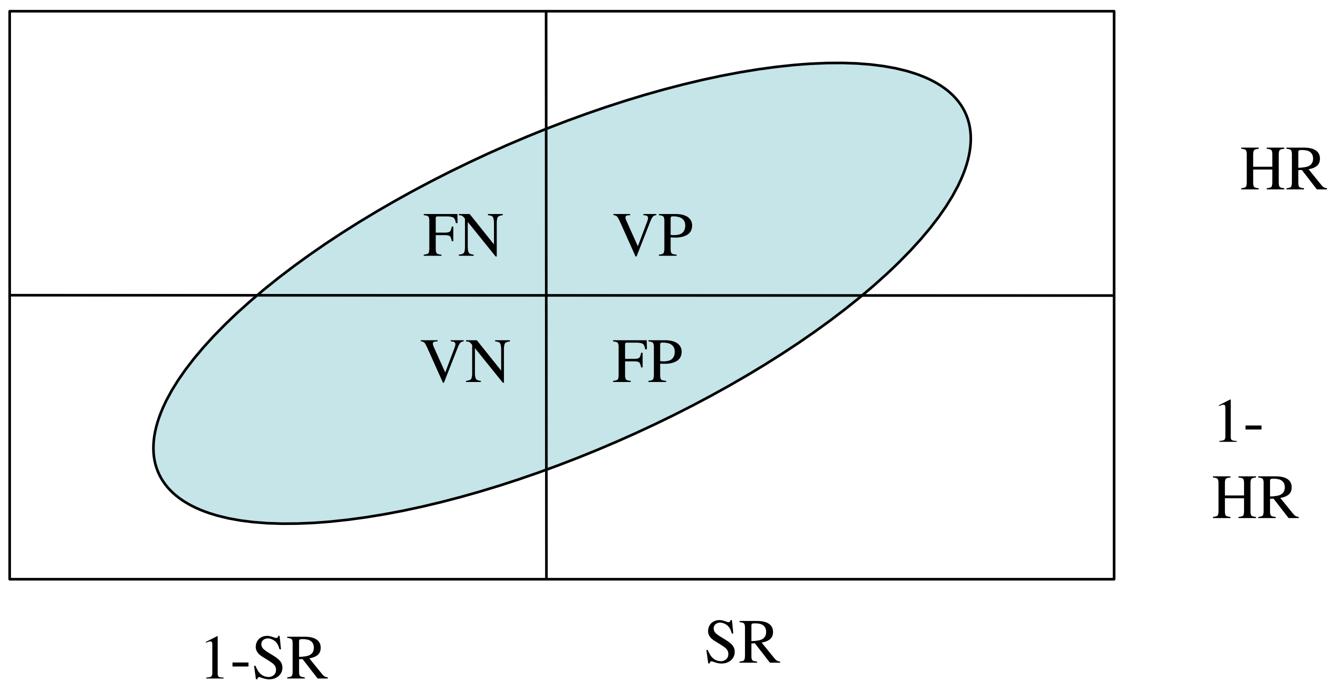


- Does a measure correlate with the criterion?
- Need to define the criterion.
- Requires waiting for time to pass.

Predictive and Concurrent Validity and Decision Making

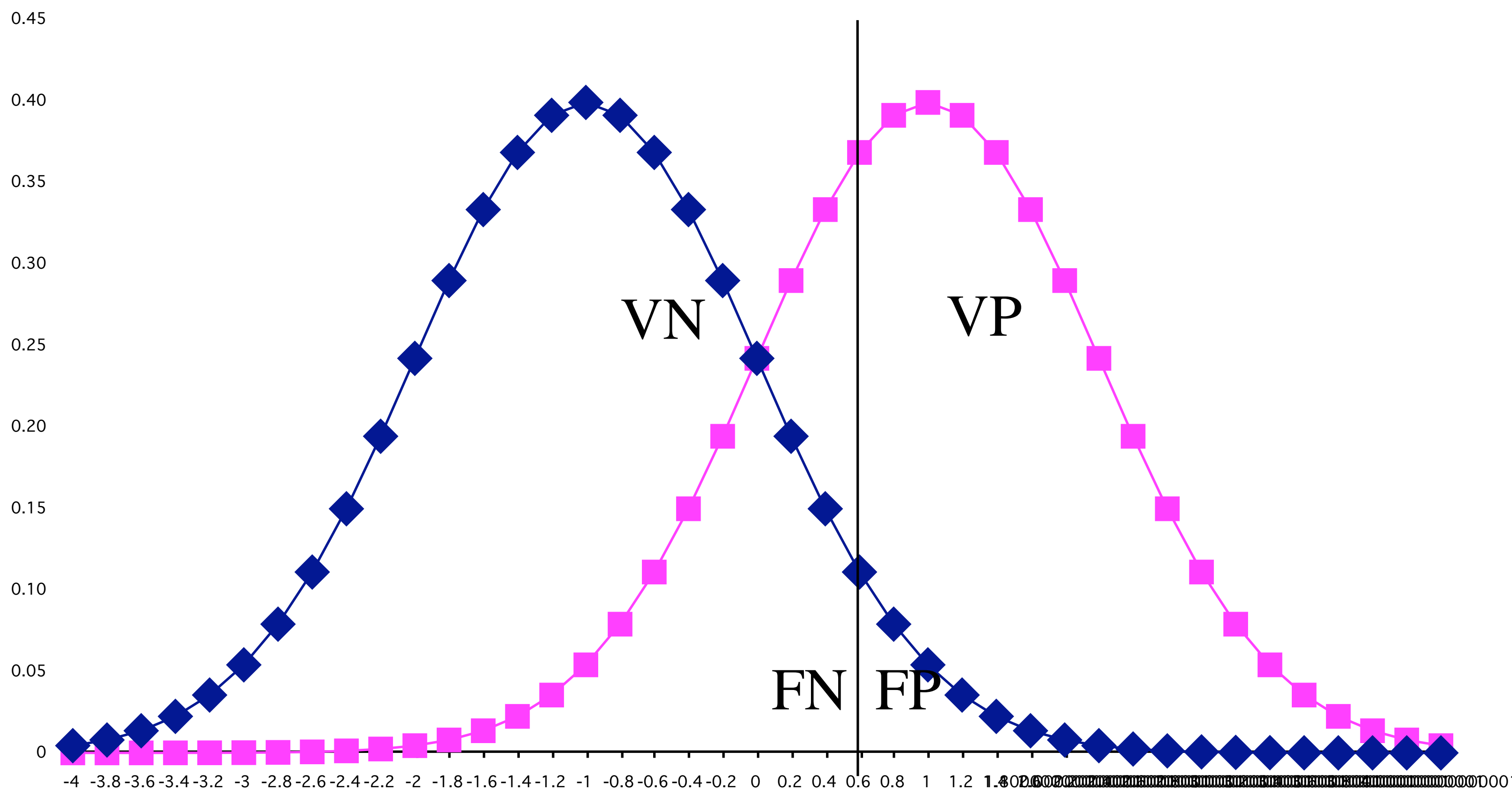
Hit Rate = Valid Positive + False Negative

Selection Ratio = Valid Positive + False Positive

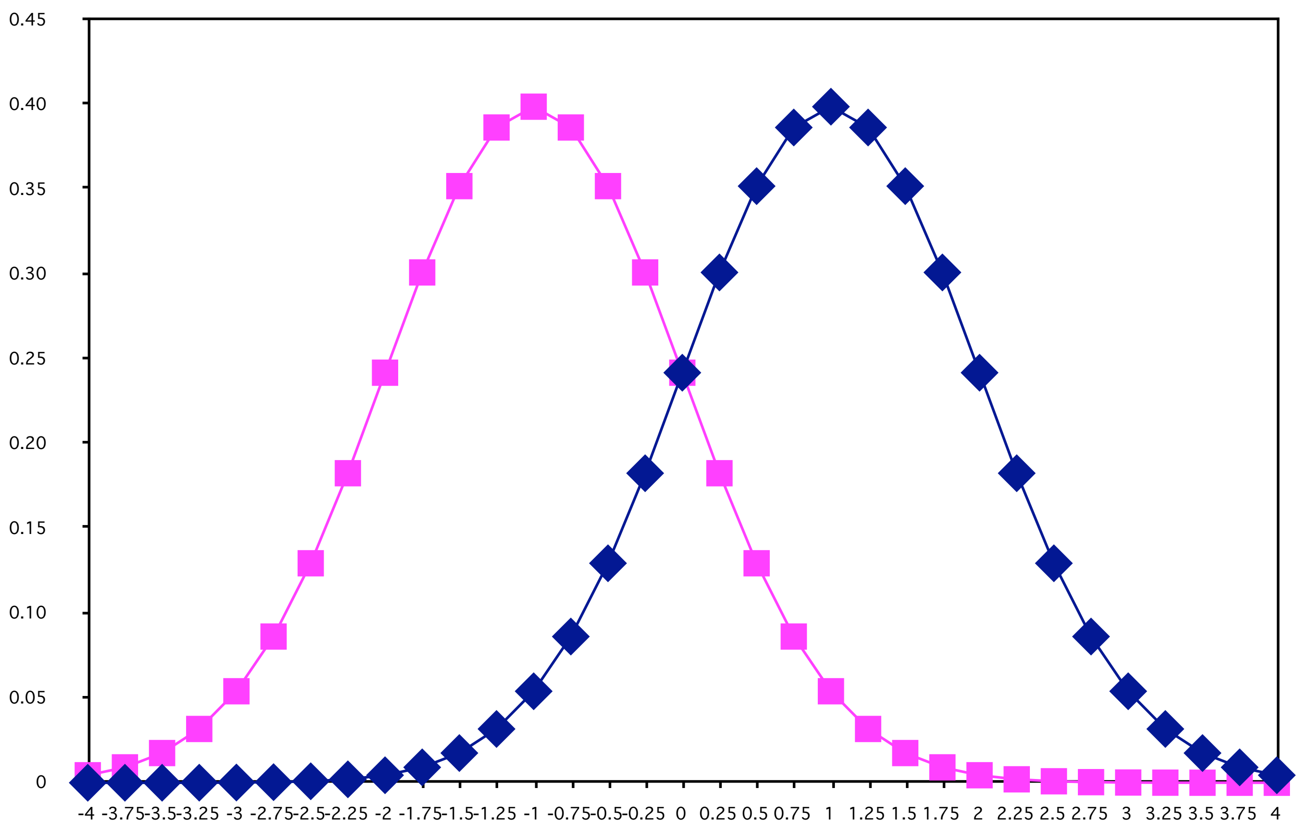


Phi =(VP - HR*SR) /sqrt(HR*(1-HR)*(SR)*(1-SR)

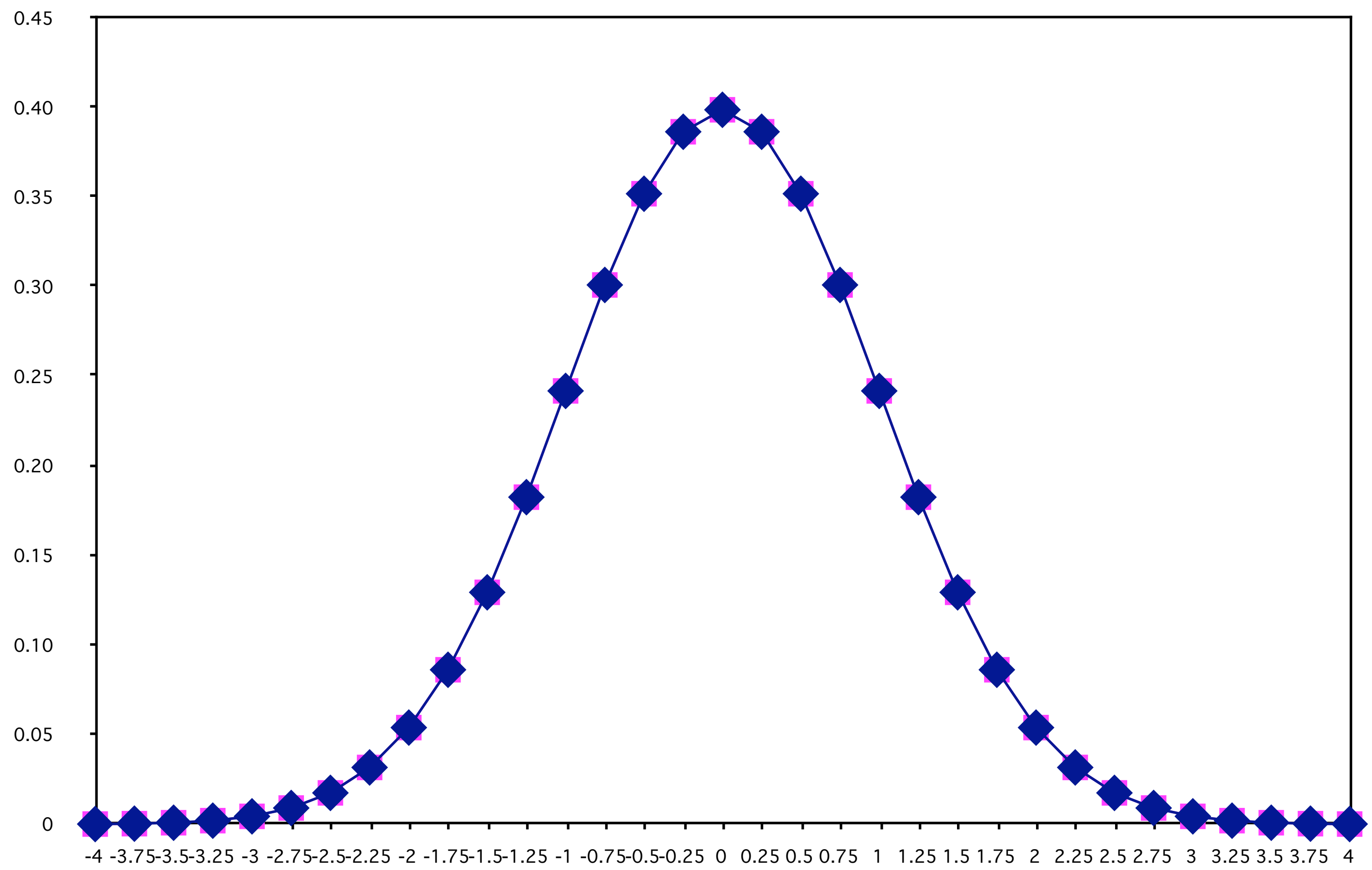
Validity as decision making



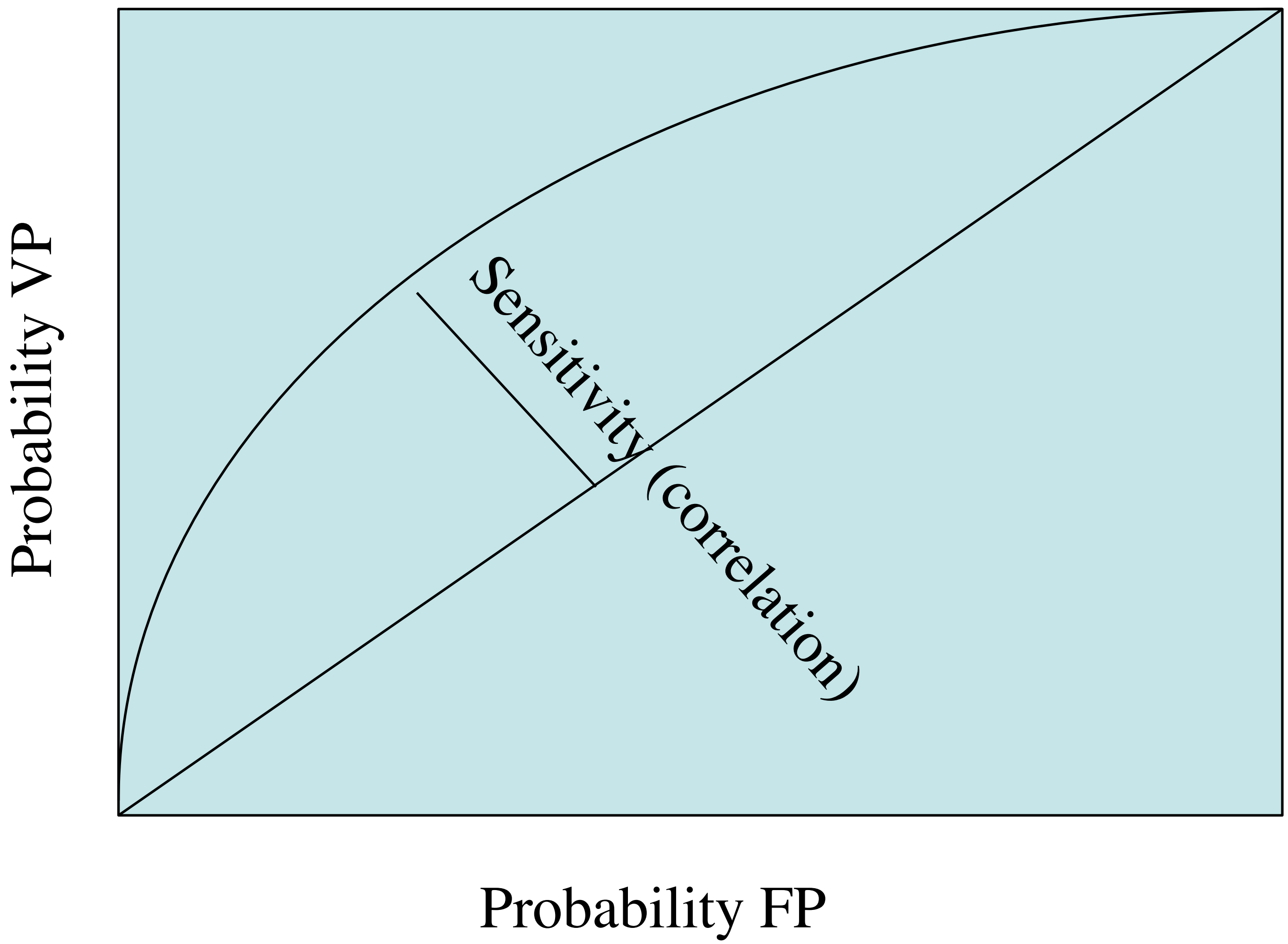
Validity as decision making



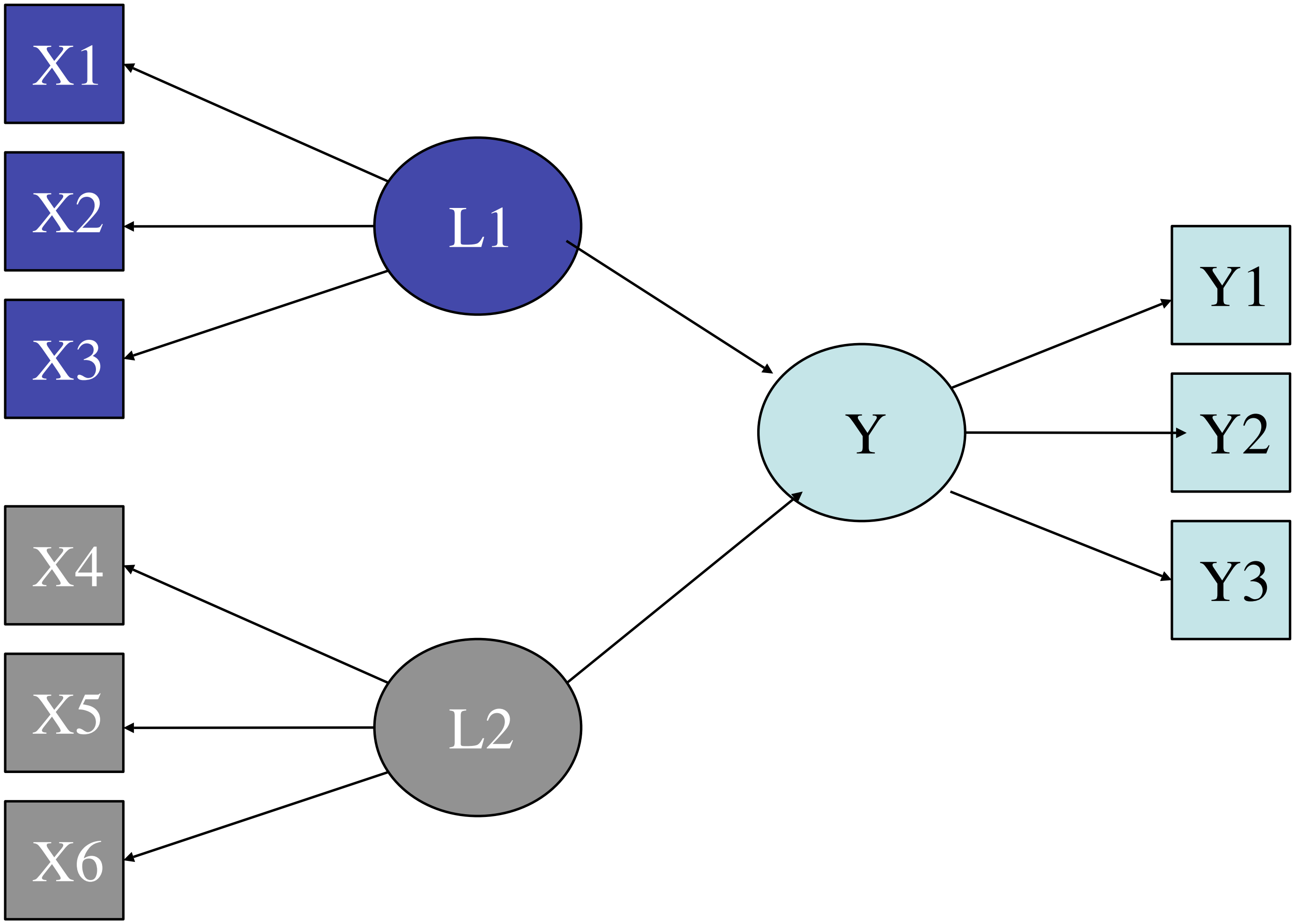
Validity as decision making



Decision Theory and Signal Detection



Construct Validity: Convergent, Discriminant, Incremental



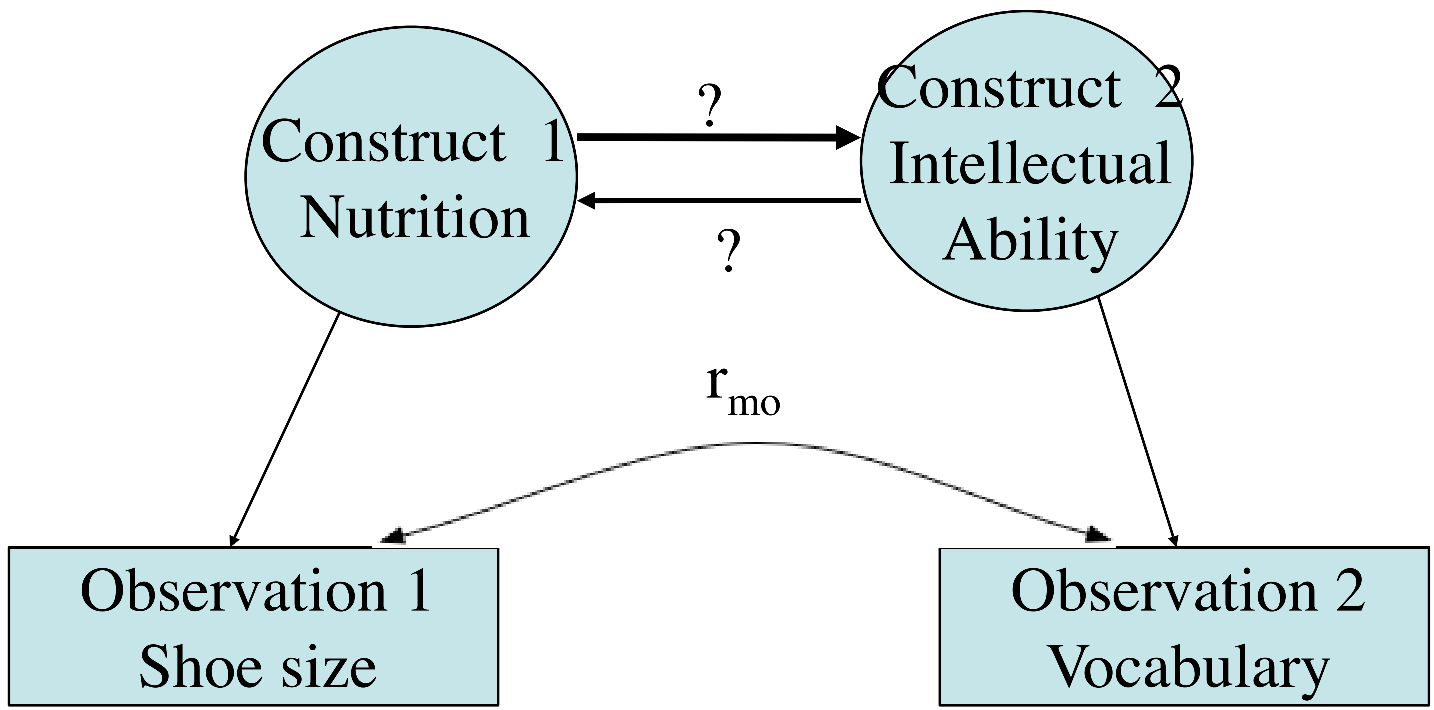
Construct Validity

- Convergent
  - Do alternative measures of the same construct correlate with each other?
- Discriminant
  - Do measures of alternative constructs not correlate with each other
- Incremental
  - Does knowing something about a construct improve the predictability of other constructs more than what you already know?

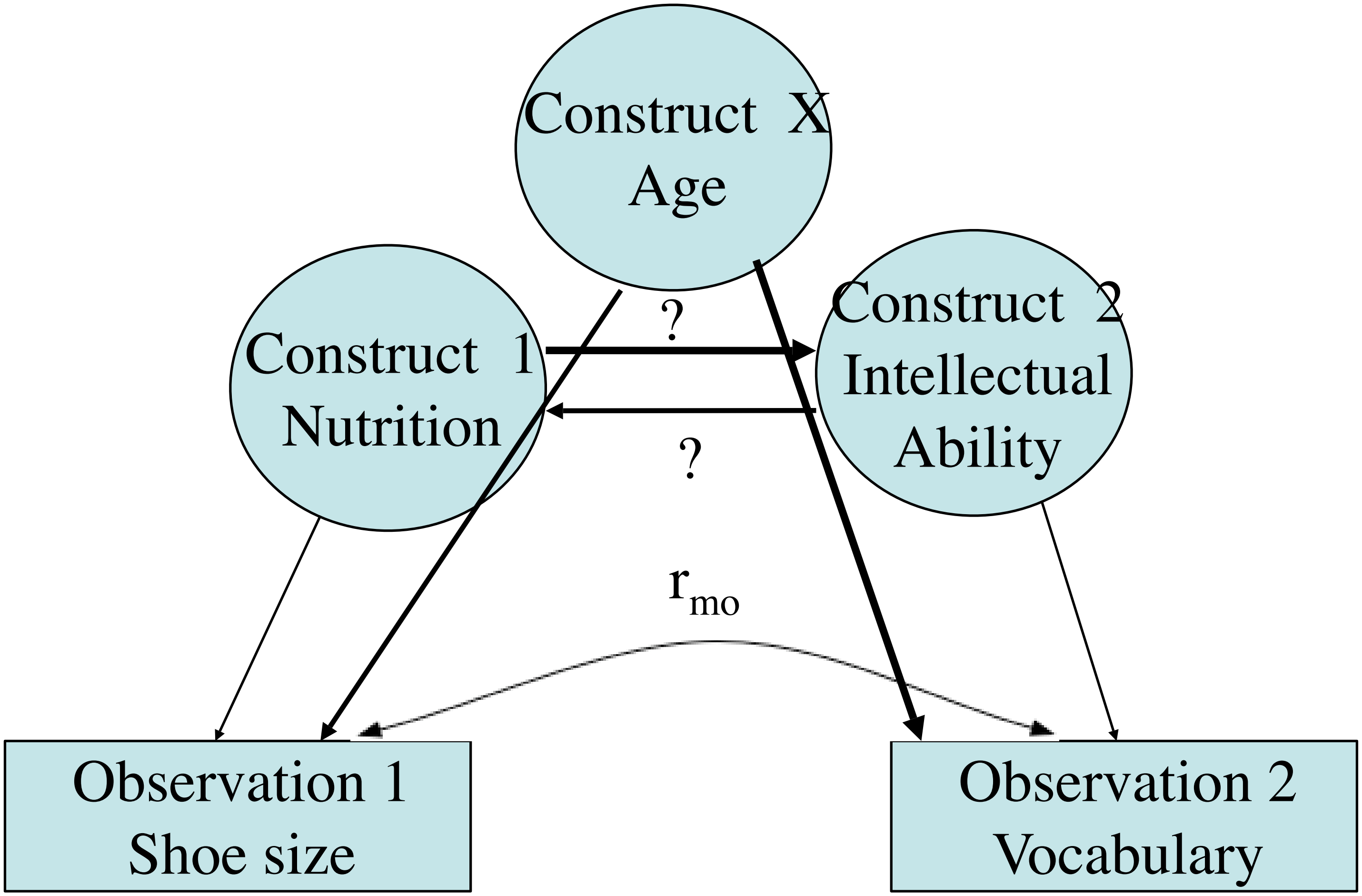
Alternative Explanatory Variables

- A developmental psychologist has noticed that children with bigger feet tend to have greater vocabularies than children with smaller feet?
- This is an example of a simple correlational design. Can you think of a powerful alternative explanation?

Theory and Theory Testing IV: Correlational inference



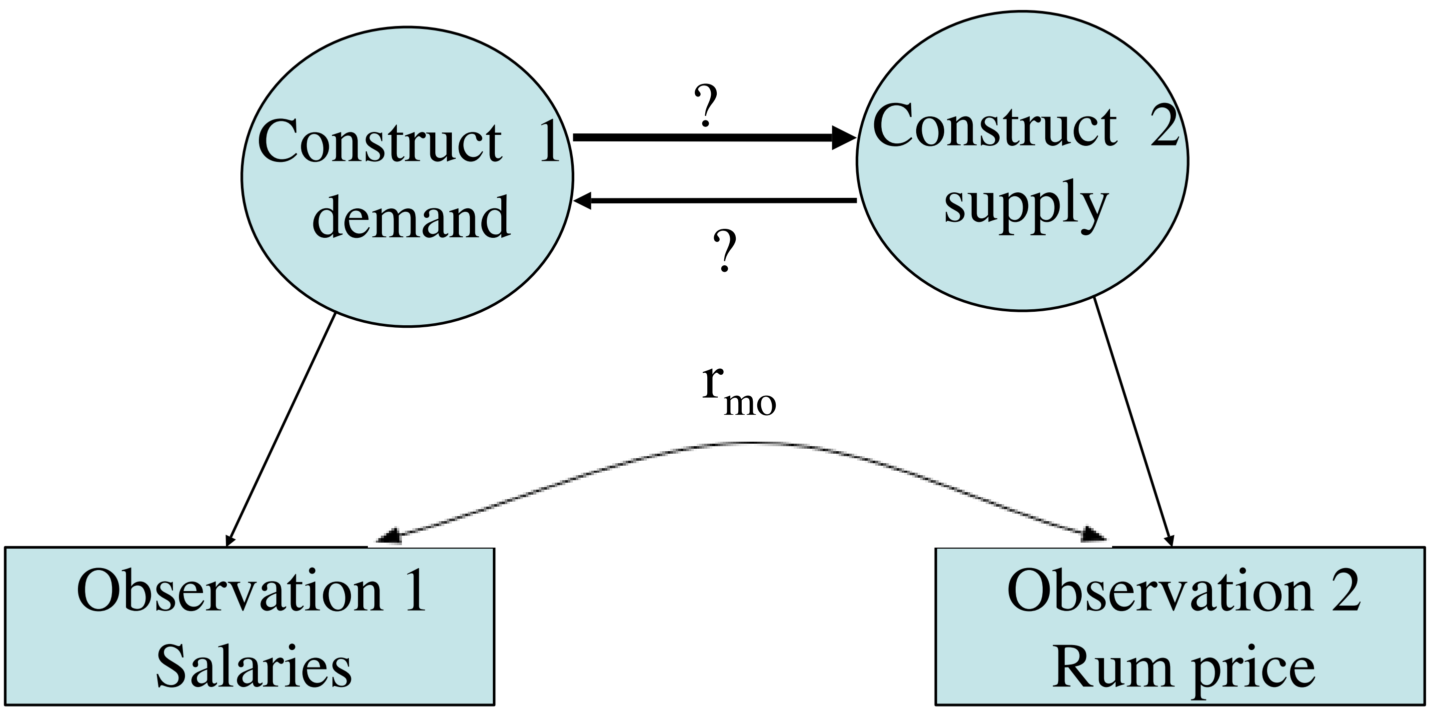
Theory and Theory Testing IV: Correlational inference



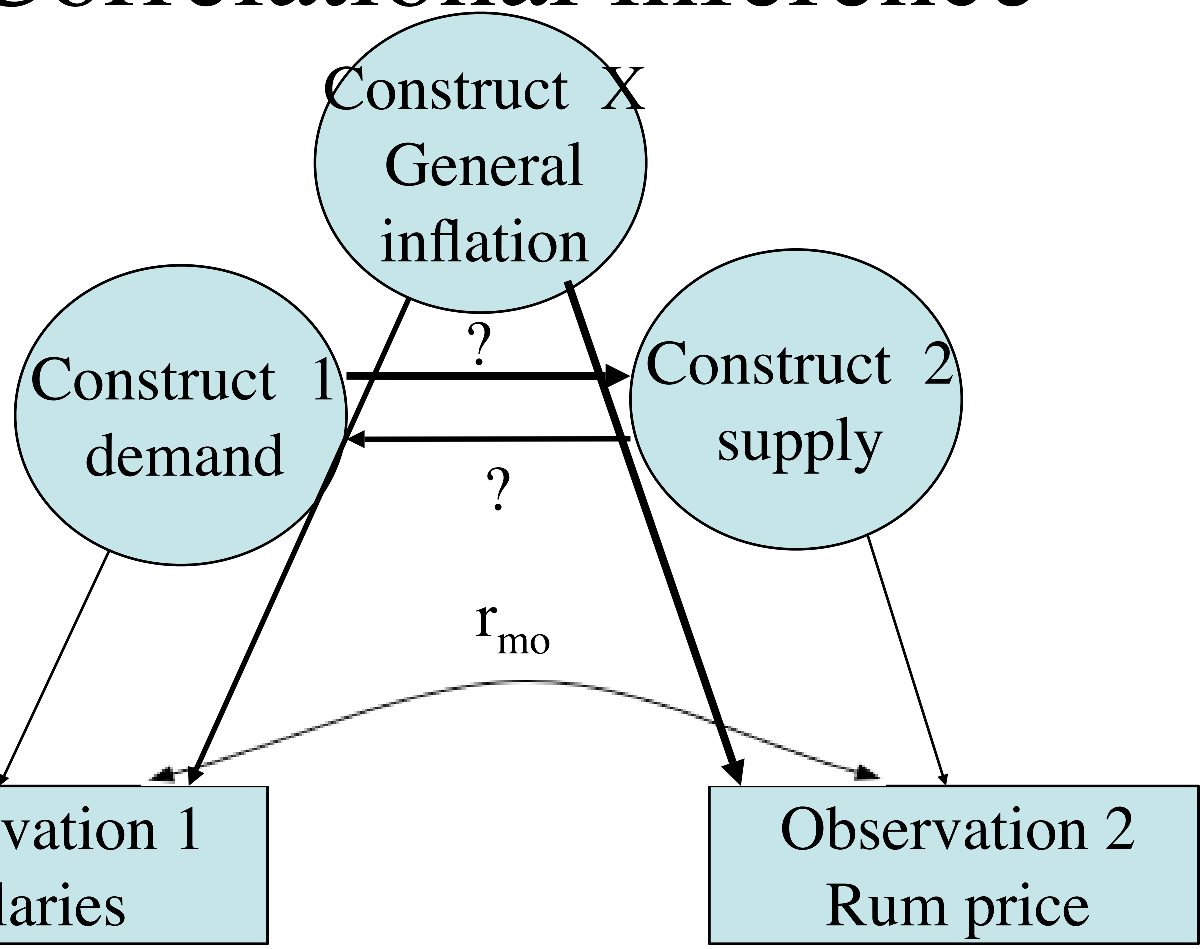
Alternative Explanatory Variables

- A Social Psychologist did an archival investigation of the relationship between rum drinking and the salaries of ministers. He has found that as the amount paid in salaries to ministers increases, that the price of Puerto Rican rum increases. He interprets this as an example of the law of supply and demand. What other variables should be included?

Theory and Theory Testing IV: Correlational inference



Theory and Theory Testing IV: Correlational inference

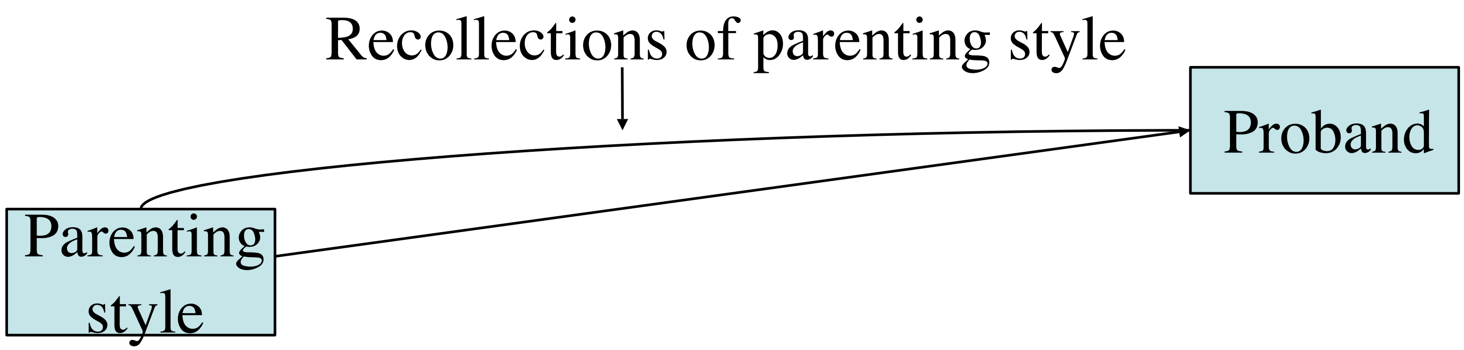


Alternative Explanatory Variables

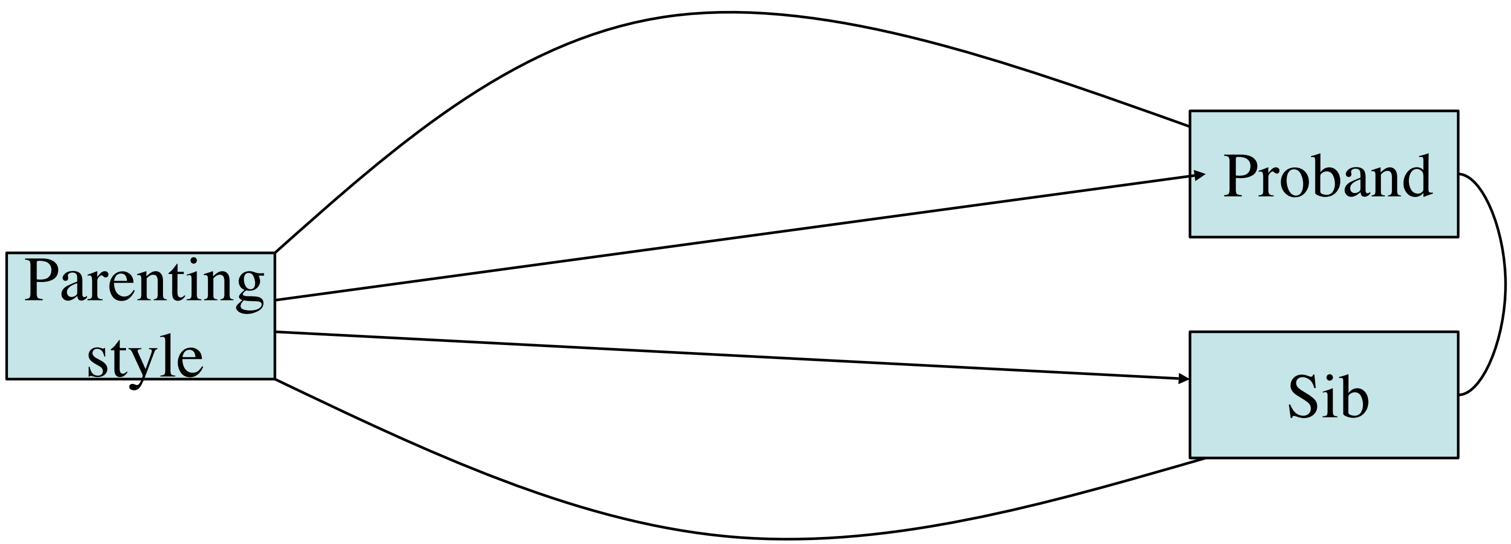
Many developmental psychopathologists claim that harsh parenting causes psychopathology in adulthood. A recent study reports evidence in favor of this hypothesis: Depressed college students report that their parents were much harsher in the way they treated them than do non-depressed students.

Consider alternative explanations

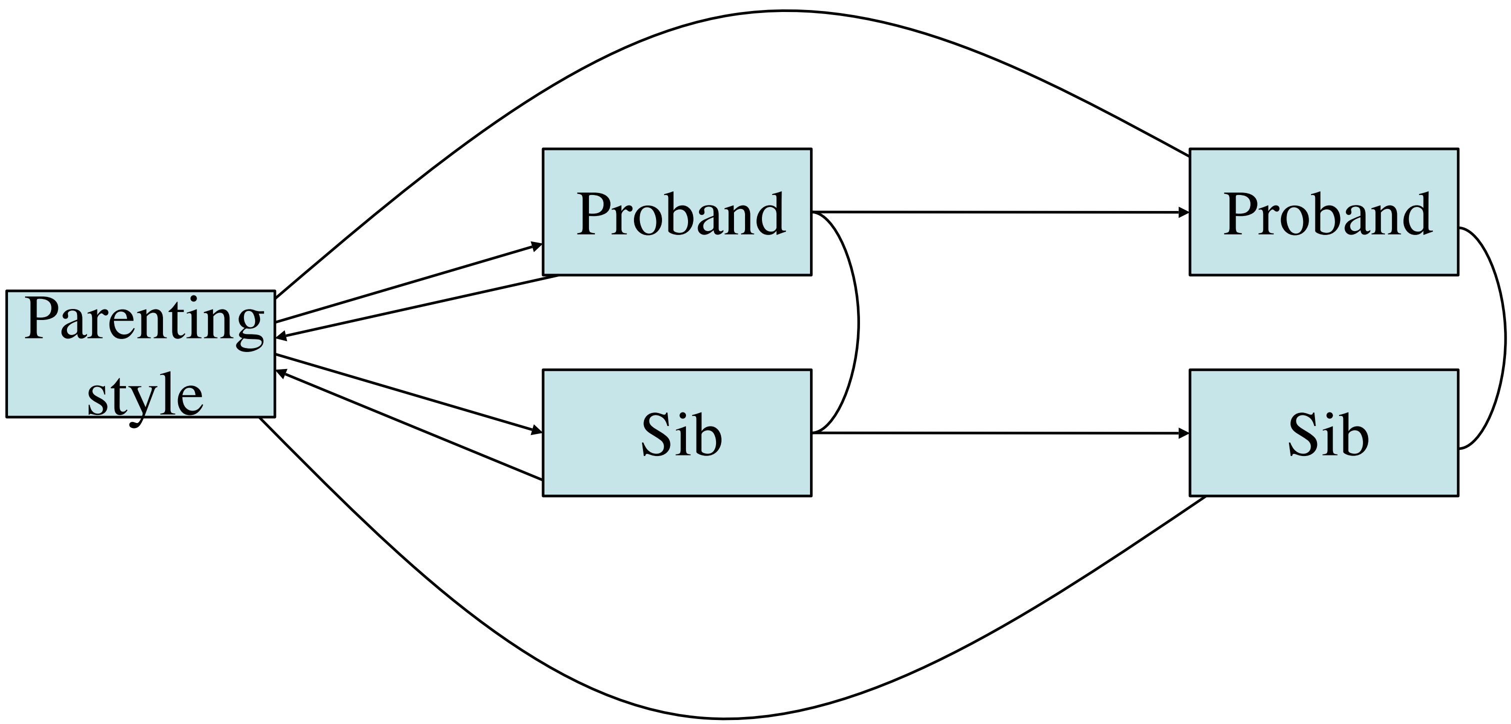
A correlational study: Depression and harsh parenting



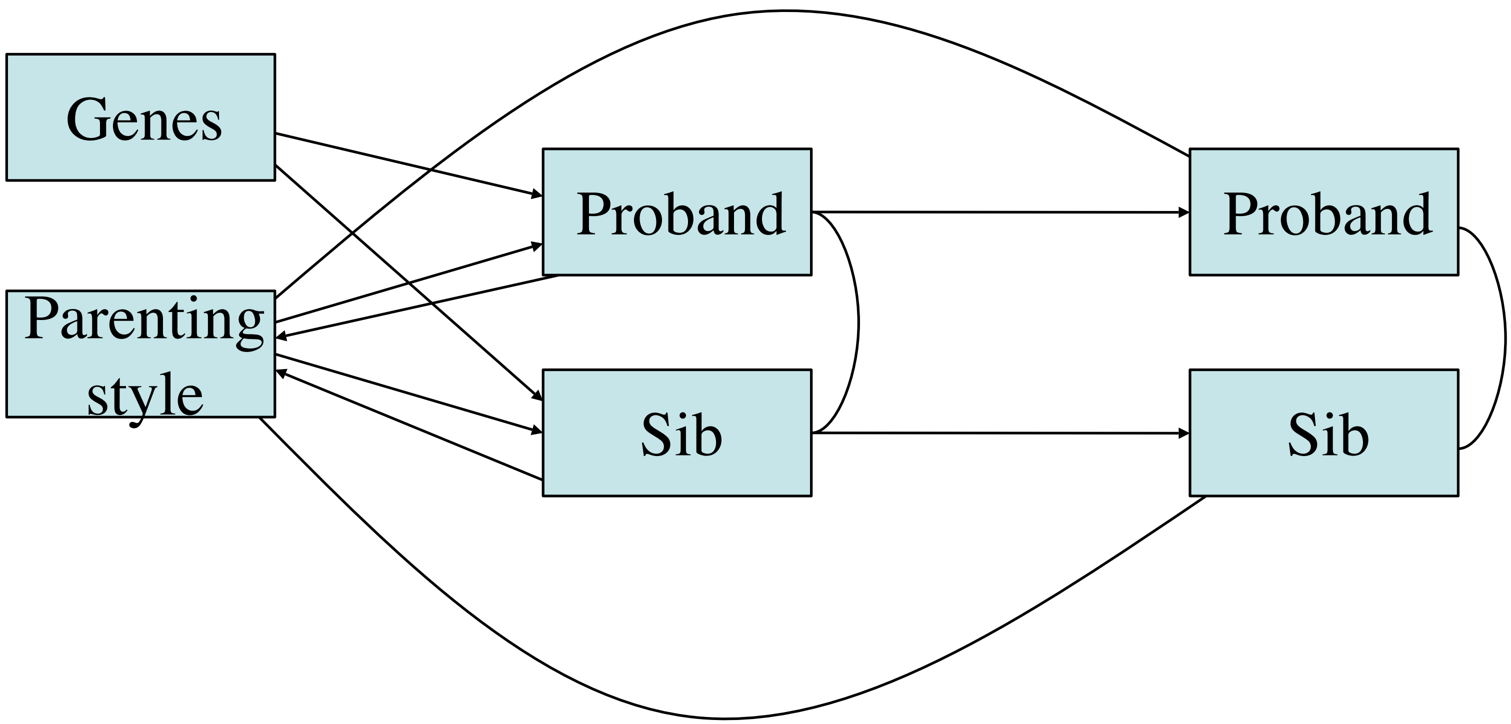
A correlational study: Depression and harsh parenting



A correlational study: Depression and harsh parenting

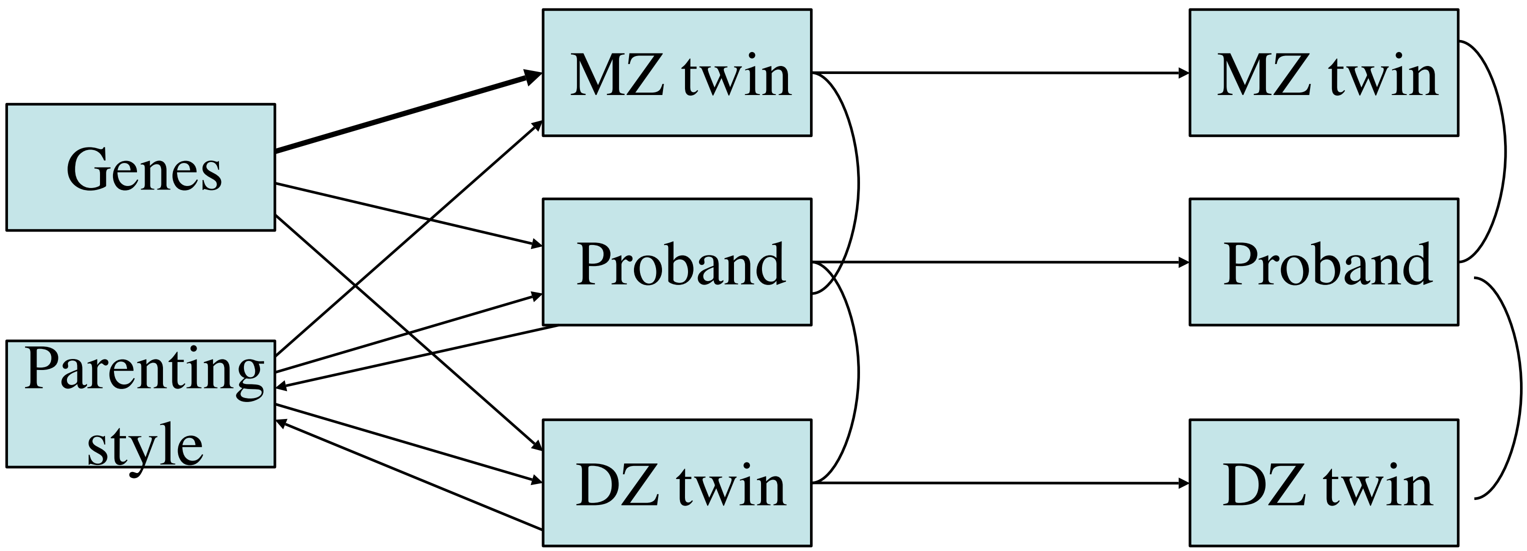


A correlational study: Depression and harsh parenting



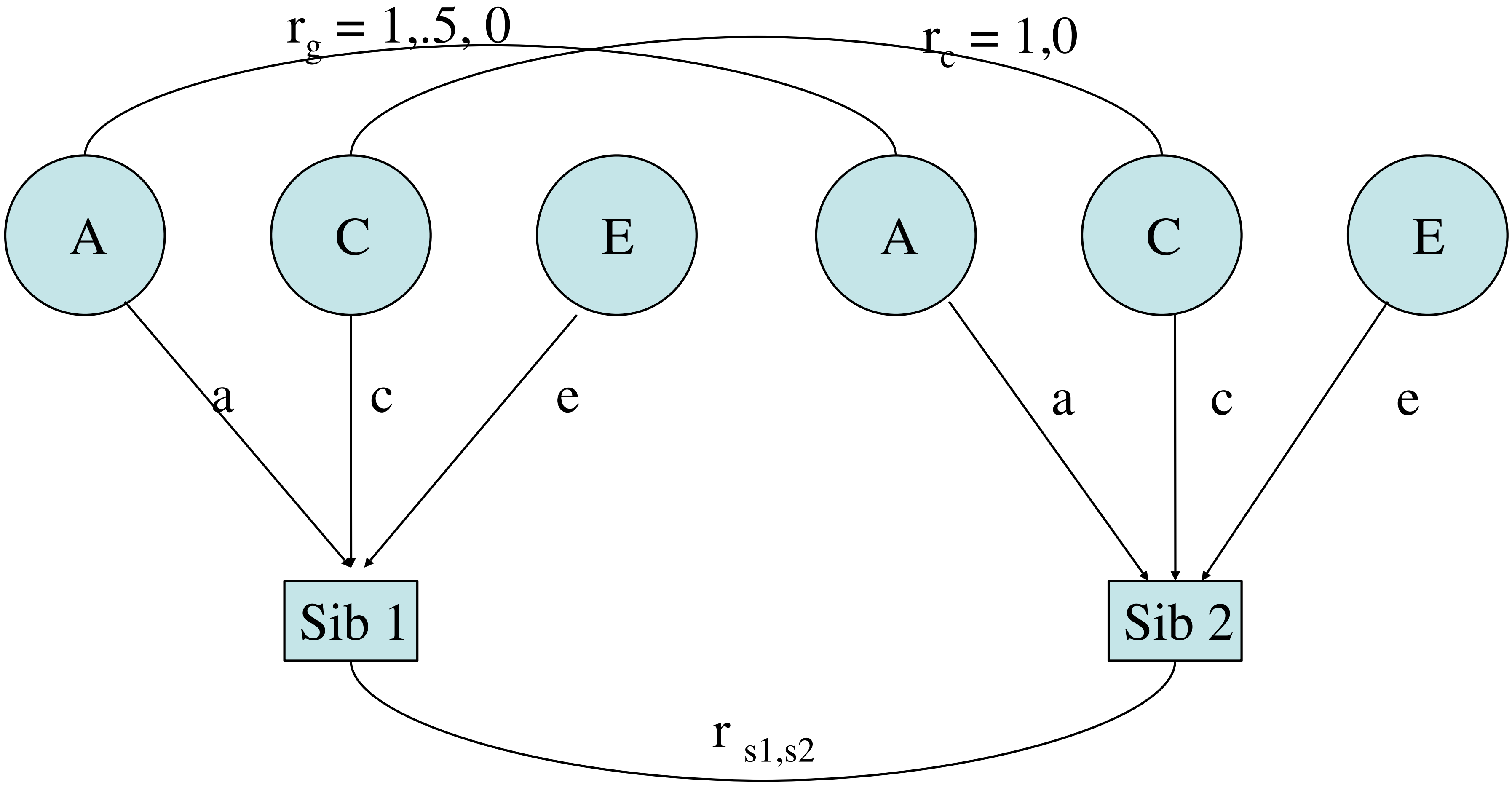
Note that Genes and family environment are confounded

A correlational study: Depression and harsh parenting



Note that Genes and family environment are confounded

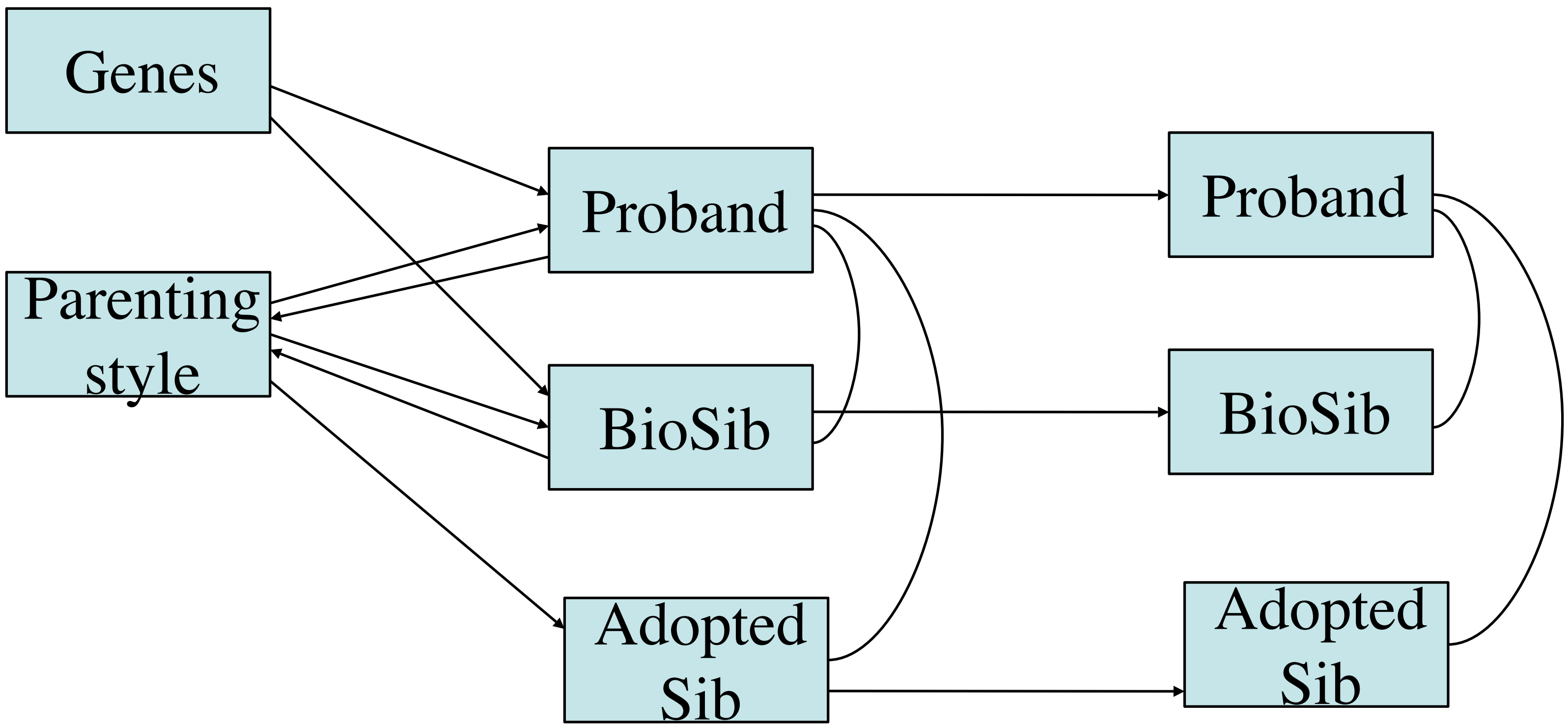
Typical Behavior Genetic Design



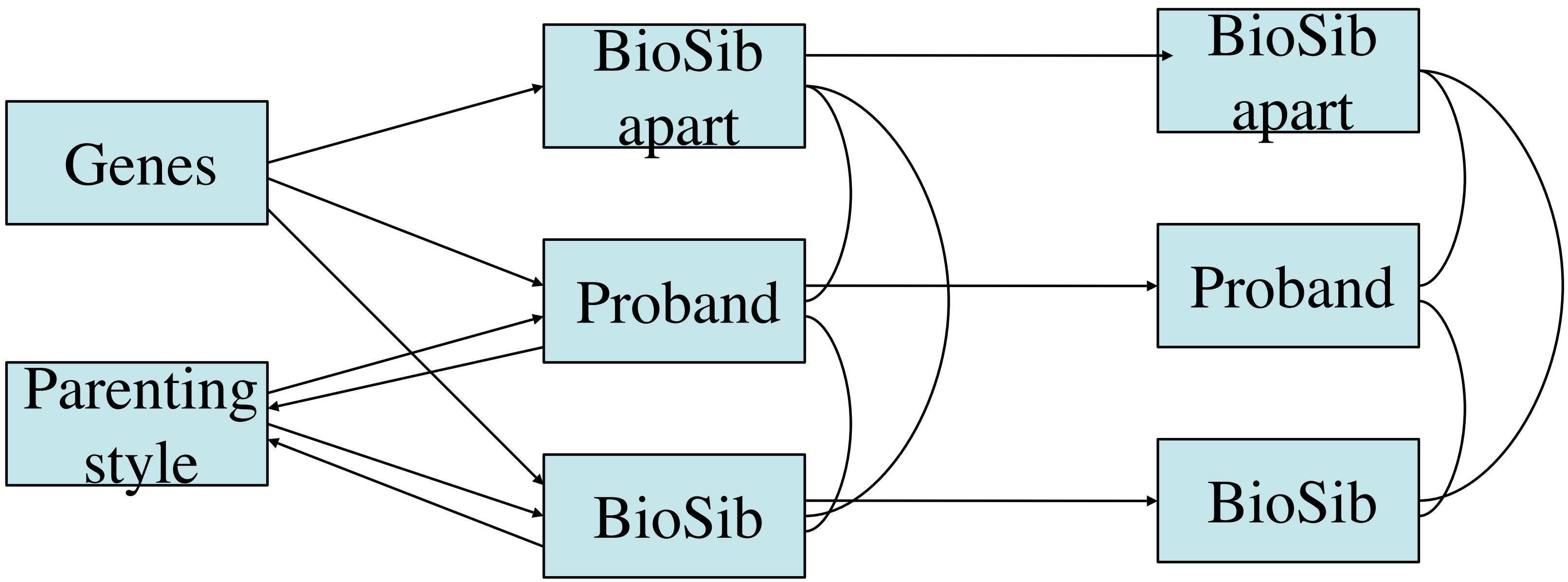
A = additive genetic variance
C = Common family environment
E = Unique environment

r_g = 1 for MZ, .5 for DZ
r_c = 1 for together, 0

A correlational study: Depression and harsh parenting



A correlational study: Depression and harsh parenting



Longitudinal environment/genetic study: