Psychology 205: Research Methods in Psychology

Designs: overview

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Outline

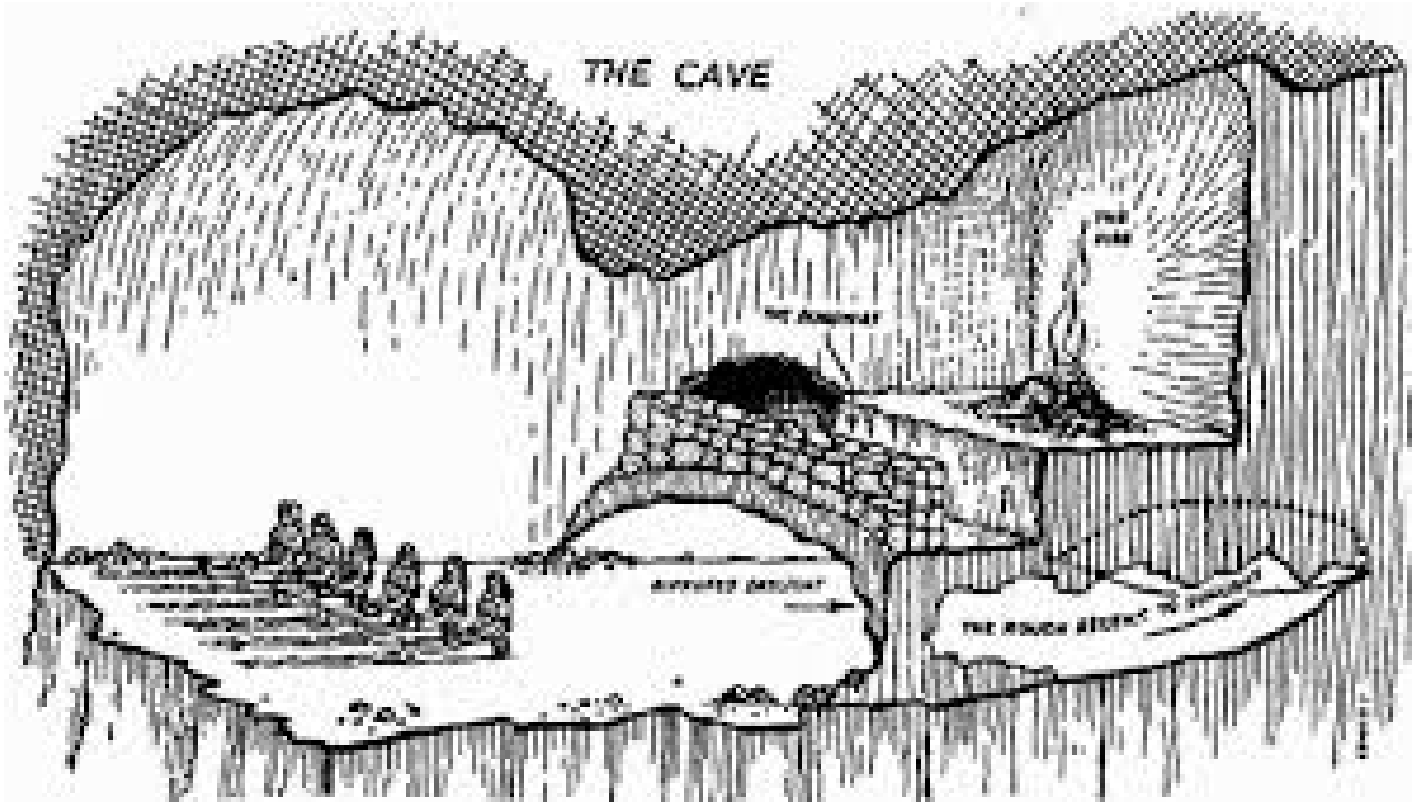
1. Some one tells you they love you. What does that mean? How do you know?
2. You think someone is intelligent. What does that mean? What do you use to make that inference?
3. Absence makes the heart grow fonder but propinquity leads to attraction. How can both of these be correct?

Theory development and testing

1. Theories as organizations of observable variables
2. Constructs, latent variables and observable variables
   - Observable variables: What can you actually see and measure
     - Multiple levels of description and abstraction
     - Multiple levels of inference about observable variables
   - Latent Variables (unobservable, but inferred)
     - Latent variables as the common theme of a set of observations
     - Central tendency across time, space, people, situations
     - Constructs as organizations of latent variables and observed variables

Plato's allegory of the cave

(The Republic VII 514-517)

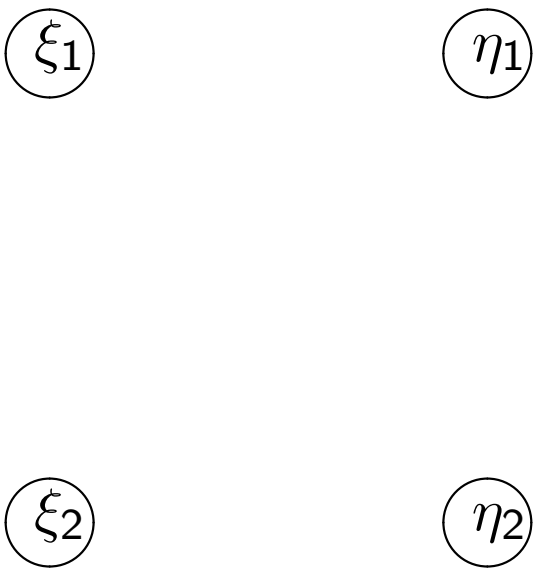


Latent and Observed variables

- The distinction between what we see (observe) versus what is *really* there goes back at least to Plato in the *Allegory of the Cave*.
  - Prisoners in a cave observe shadows on the walls of the cave.
  - These are caused by people and objects behind them, but in front of a fire.
  - Movements of the shadows are caused by, but not the same as the movements of the people and objects.
- In psychology we sometimes make the distinction between *surface* traits and *source* traits.
- A major breakthrough in psychological theorizing was the willingness to consider latent constructs.
  - Operational definitions are associated with the observed (surface) measures.
  - Unobserved, latent constructs are now part of our theoretical armamentarium.

Latent Variables

ξ η



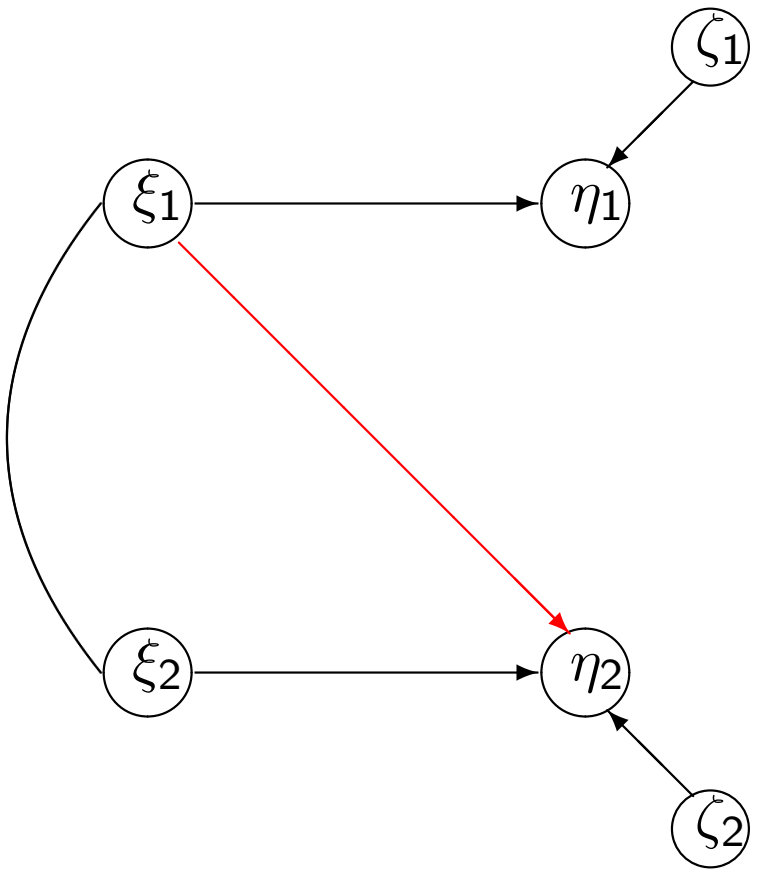
Examples of psychological constructs:

The problem is how to operationalize them as observations

1. Anxiety
   - Trait
   - State
2. Conformity
3. Intelligence
4. Intuition
5. Learning and memory
   - Procedural - memory for how
   - Episodic – memory for what
     - Implicit
     - explicit
6. Love

Theory: The relationships (a model) of latent variables

ξ η



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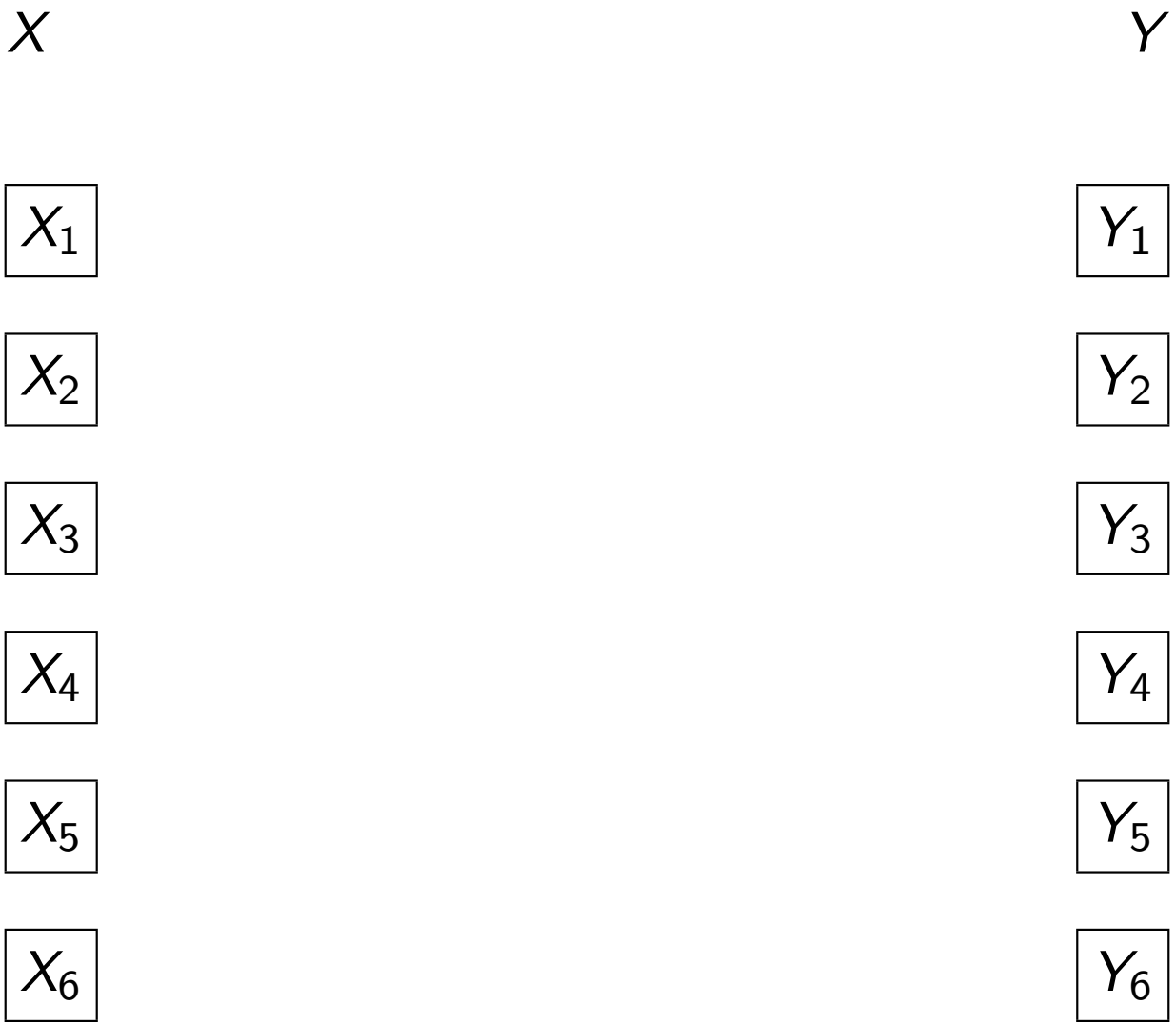
Observed Variables



Latent Variables

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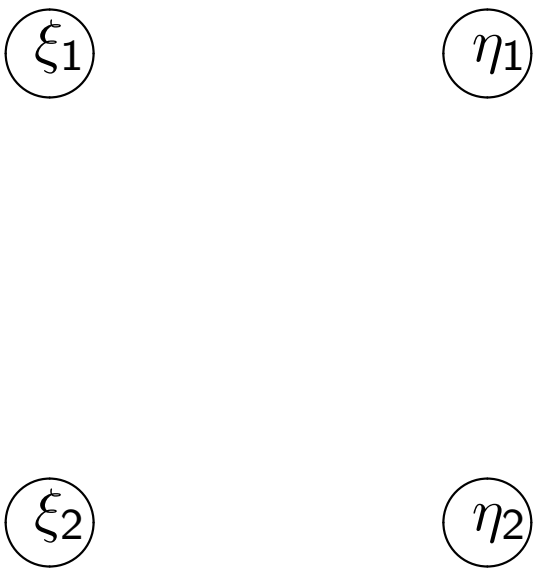
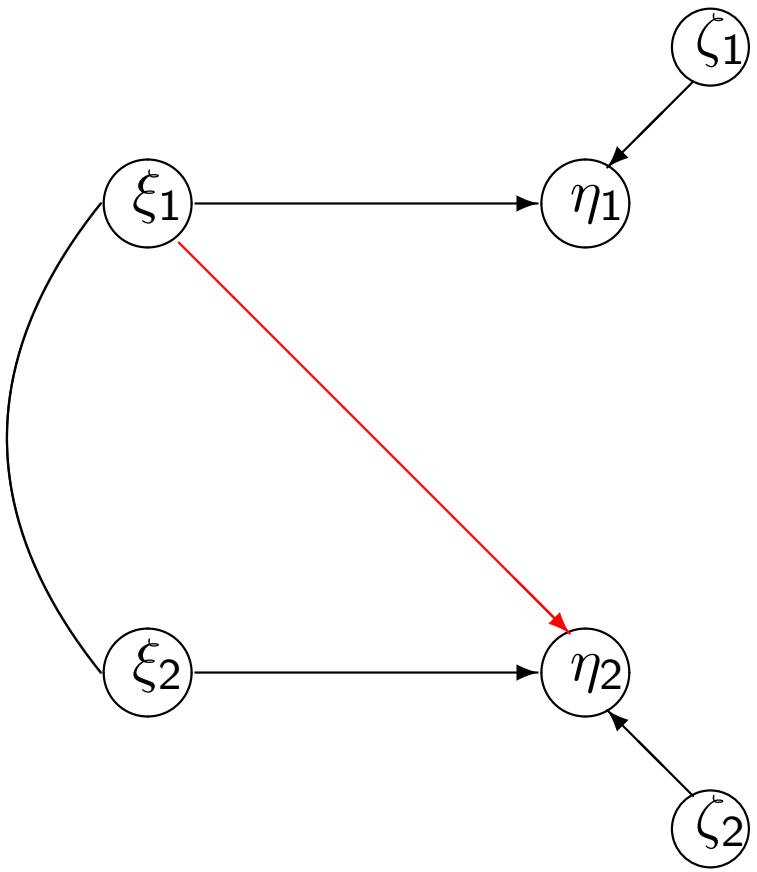


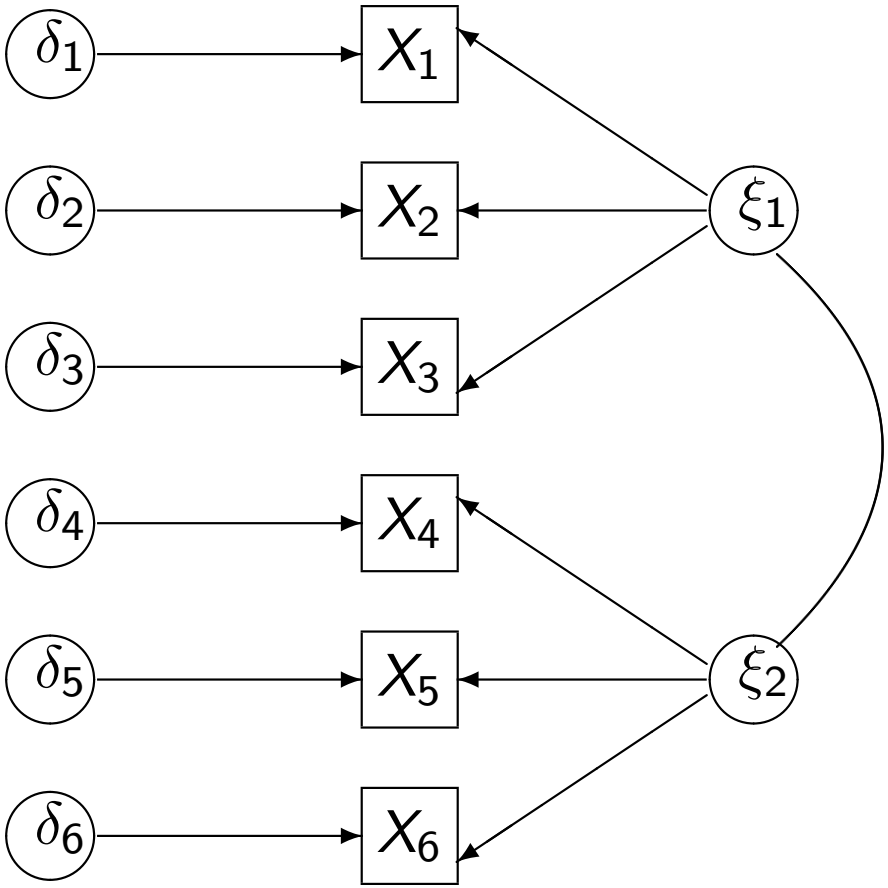
Theory: A regression model of latent variables

ξ η

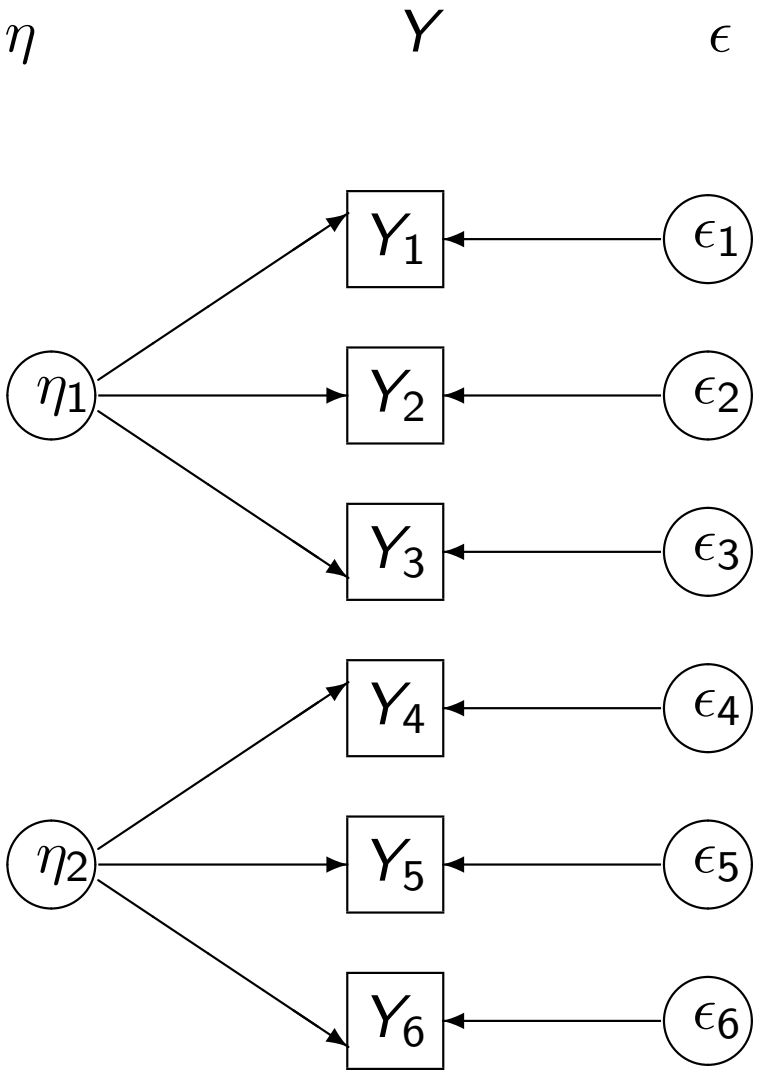


A measurement model for X

δ X ξ

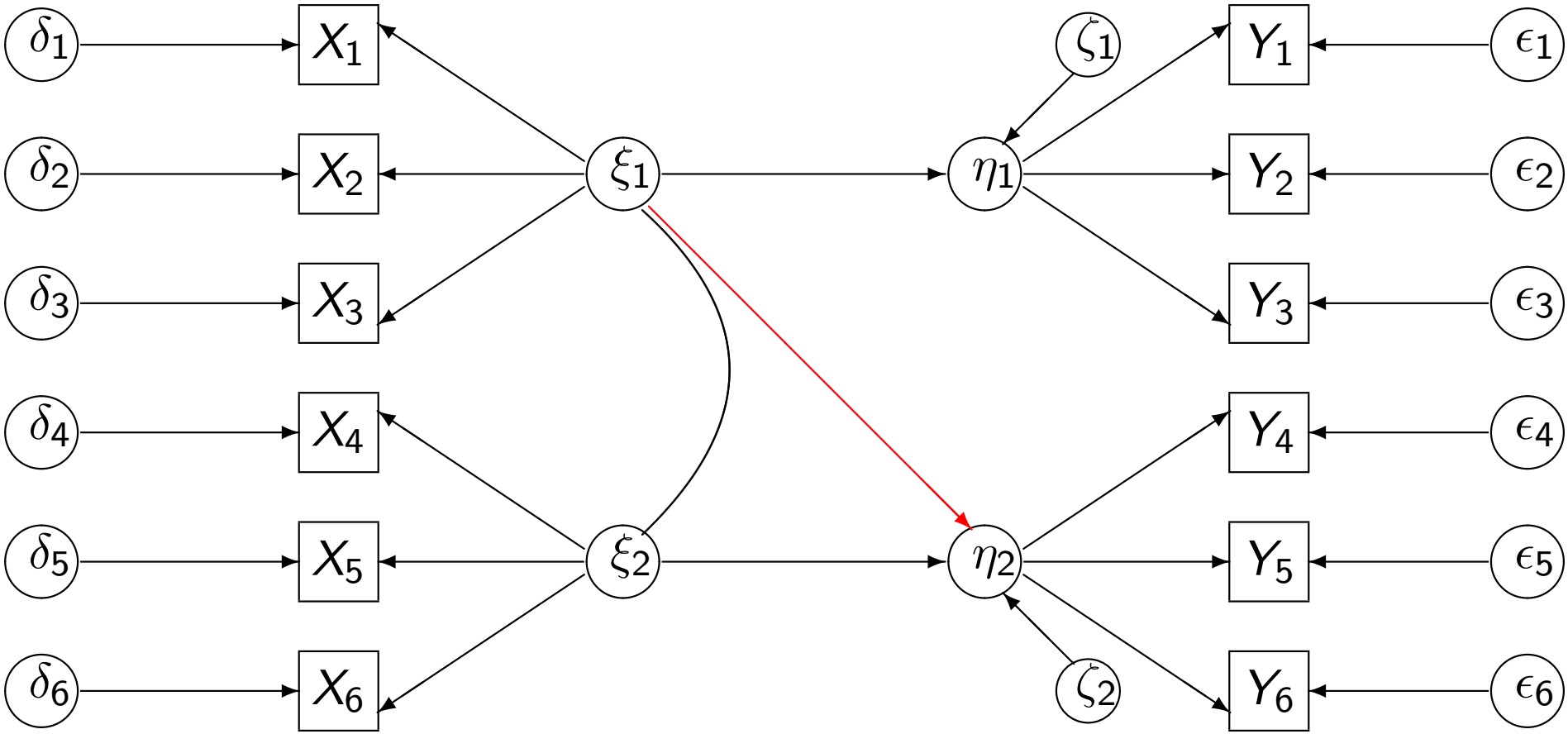


A measurement model for Y



Psychological Theory = Latent Variable Modeling of Observed Data

δ X ξ η Y ϵ



Psychological Theory = Latent Variable Modeling of Observed Data

1. Requires measuring observed variables
   - Requires defining what is relevant and irrelevant to our theory.
   - Issues in quality of scale information, levels of measurement.
2. Formulating a measurement model of the data: estimating latent constructs
   - Perhaps based upon exploratory and then confirmatory factor analysis, definitely based upon theory.
   - Includes understanding the reliability of the measures.
3. Modeling the structure of the constructs
   - This is a combination of theory and fitting. Do the data fit the theory.
   - Comparison of models. Does one model fit better than alternative models?

The most basic of all theory: Construct 1 -> Construct 2

ξ η

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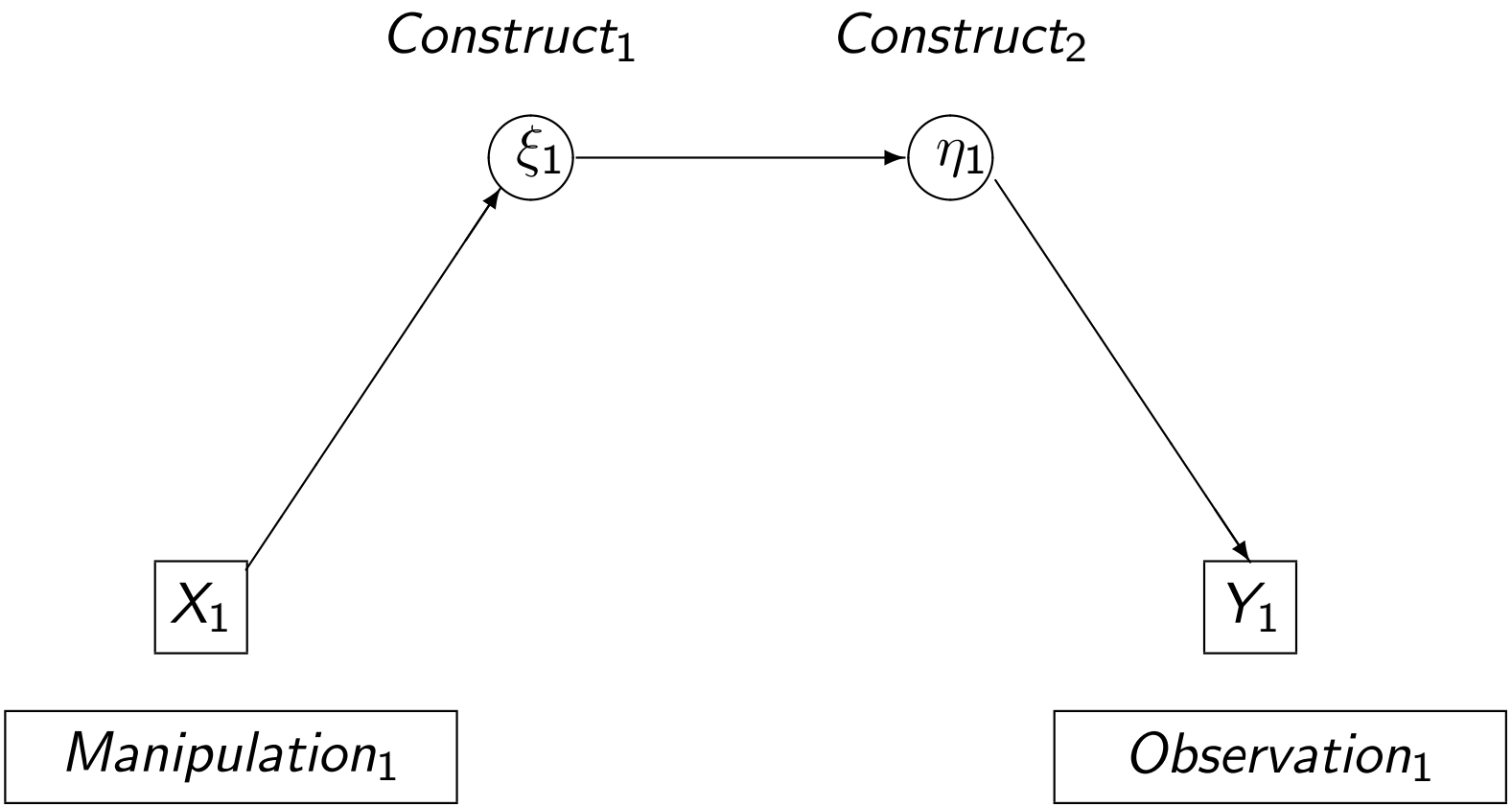
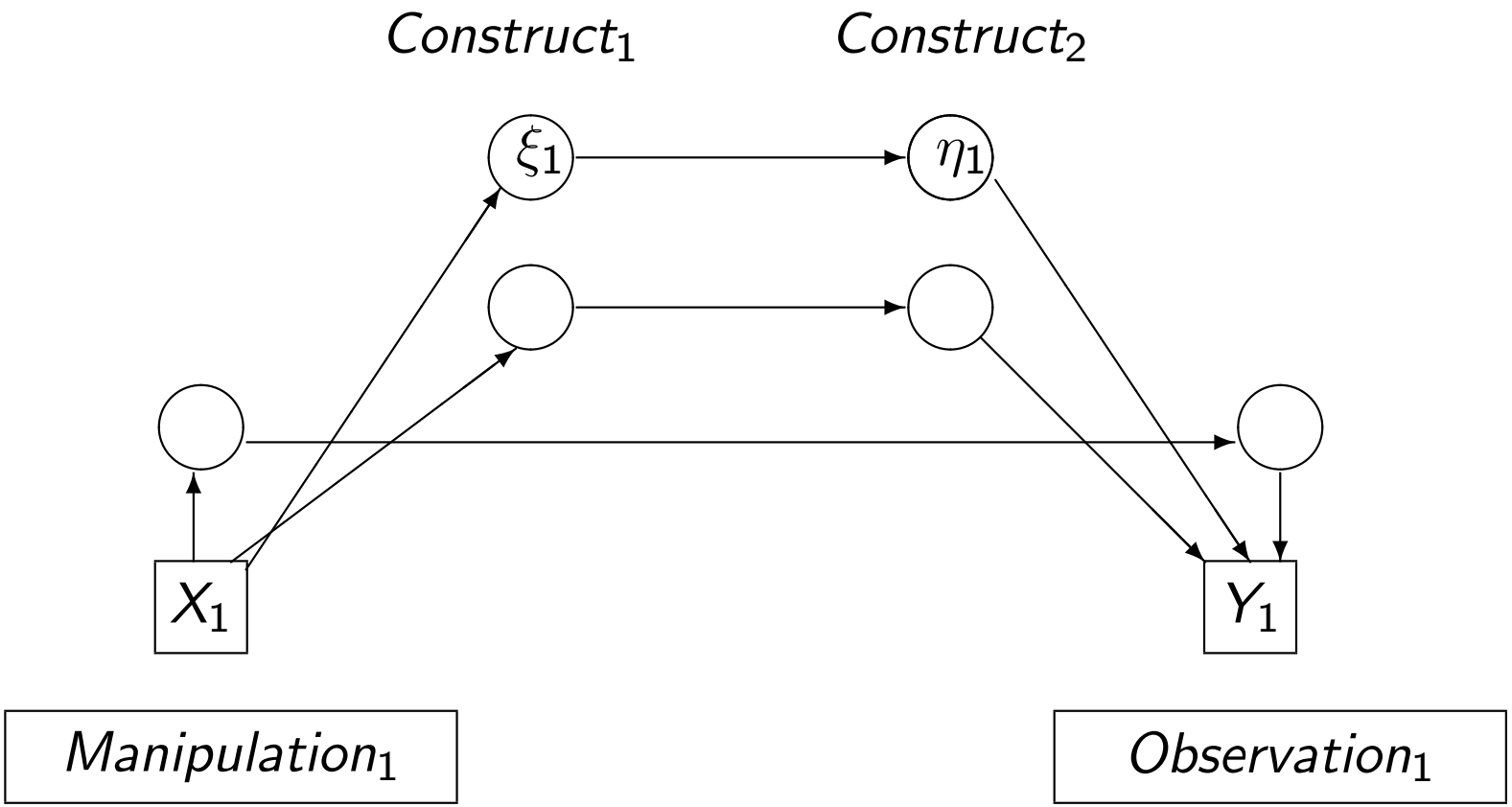
X ξ η Y



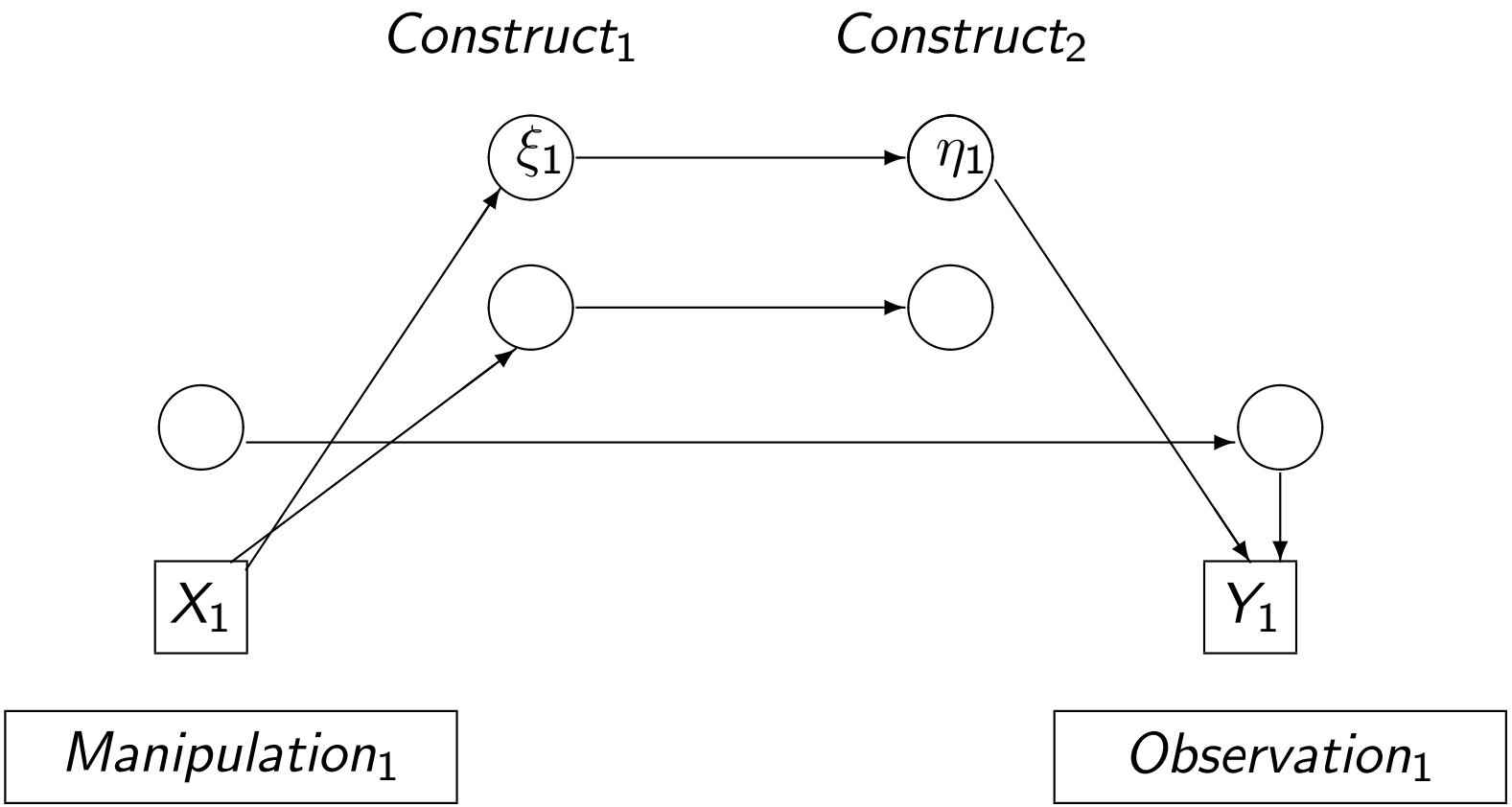
But all manipulations and observations have multiple effects and causes

X ξ η Y



Design eliminates extraneous paths

X ξ η Y



Multiple ways of asking theoretical questions

1. Observational-correlational
   - Correlations across people
   - Correlations across time
2. Experimental
   - Within Subjects
   - Between Subjects
   - Mixed
3. Quasi-experimental and field studies

The process of science

Prologue: two broad themes to be discussed and interwoven

1. The two disciplines of scientific psychology
   - Two broad cultures of intellectual activity (Snow, 1959)
   - Two broad cultures of psychology (Kimble, 1984)
   - Two disciplines within scientific psychology (Cronbach, 1957, 1975) and (Eysenck, 1966, 1987a, 1997).
2. The process of theory construction and validation
   - Science from hunch to law (Eysenck, 1976, 1985)
   - Good theories as alive and generative: the example of theories of Extraversion.

I tend to emphasize the power of integrating psychometric and experimental techniques in a programmatic study of personality and individual differences, but other examples will be used when appropriate.

The two cultures of intellectual inquiry

C.P. Snow (1959) considered two cultures of intellectual inquiry:

> *"I believe the intellectual life of the whole of western society is increasingly being split into two polar groups."*
> *.. "I felt I was moving among two groups–comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all, who in intellectual, moral and psychological climate had so little in common ... one might have crossed an ocean."*

Kimble and the two cultures of psychology

Just as Snow considered the scientific versus humanistic cultures of English and American society, so did Kimble (1984) consider two cultures of psychology: the scientific and the humanistic.

> *"The remaining points of disagreement involve the items asking about most important values (scientific vs. human), source of basic knowledge (objectivism vs. intuitionism), and generality of laws (nomothetic vs. idiographic).*

Two competing tribes/paradigms within scientific psychology

But even within the culture of scientific psychology, we have two competing tribes who differ in their basic paradigmatic view of how to do science: the correlational vs. experimental paradigms discussed by Cronbach (1957, 1975) and Eysenck (1966, 1987a, 1997). Both pleaded for an integration of the two tribes. Neither was overly successful.
Others who have tried to reconcile these differences include Vale & Vale (1969), and Underwood (1975).

The conventional dichotomy of research paradigms in psychology ala Cronbach (1957, 1975) and Eysenck (1966, 1987a, 1997)

Correlational

1. Influential founders
   - Galton (1886)
   - Pearson (1896)
   - Spearman (1904)
2. Measurement of variances and covariances
   - bivariate r, ϕ, $Yule_Q$
   - multivariate R, factor analysis, principal components
   - General Linear Model and its extension to multi-level modeling
3. Addresses threats to validity by statistical "control"

Experimental

1. Influential founders
   - Wundt (1904)
   - Gossett (Student, 1908)
   - Fisher (1925)
2. Measurement of central tendencies
   - bivariate t and F
   - multivariate MANOVA
   - General Linear Model and its extension to multi-level modeling
3. Addresses threats to validity by randomization

Two disciplines: two viewpoints

Table: The naive perspective from both sides–the other side is easy, why don't they just do it right? Our variables are complicated, well articulated, theirs are simple, just use any one.

Individual Differences	Experimental
Personality Ability	Task Performance

The experimentalist's challenge: what to measure

Measures

1. Giant 3
   - EPI
   - EPQ
2. Big 5
   - NEO-PI-R
   - IPIP B5
   - IPIP NEO
   - BFI
   - TIPI
3. Beyond the Big 5
   - HEXACO
   - IPIP HEXACO
   - BFAS
   - SAPA 3-6-12
   - ICAR-IQ
   - ...

Constructs

1. Extraversion
   - but which one? Costa vs. Goldberg
2. Neuroticism
3. Agreeableness
4. Conscientiousness
5. Openness-Intellect
   - but is it openness or is it intellect?
6. Honesty/Humility
7. Impulsivity
8. Sociability
9. Trust
10. ...

The challenge for individual difference researchers: what constructs to measure

Memory

1. Working memory
2. Iconic memory
3. Short Term memory
4. Long Term memory
5. Semantic memory
6. Episodic memory
7. Procedural memory
8. Autobiographical memory
9. False memory
10. Recall
11. Recognition

Attention

1. Sustained Attention
2. Allocation of Attention
3. Capturing Attention
4. Breadth of Attention
5. Local/Global Attention
6. Paying Attention

The experimentalist's challenge: how to analyze, what to report

Analysis

1. Dimension Reduction
   - Principal Components
   - EFA
   - CFA
2. Structure
   - Path Analysis
   - SEM
   - Latent Growth Curves
3. Reliability analysis
   - Internal Consistency
   - Alternate Form
   - Test-Retest
4. Item Response Theory

Statistics

1. Measures of association
   - Pearson r, Spearman ρ
   - ϕ or $Yule_Q$
   - $r_{tetrachoric}$, $r_{polychoric}$
2. Goodness of fit
   - χ^2 or χ^2 difference
   - RMSEA or RMSR
   - Tucker-Lewis
   - BIC or AIC
3. Reliability
   - α
   - β
   - ω_h
   - ω_t

The challenge for individual difference researchers: which paradigm to use

Memory

1. Reaction time
   - Sternberg Memory Scanning
   - Ratcliff choice
   - Jacoby identification
2. Accuracy
3. Serial anticipation
4. Free recall
5. Cued recognition

Attention

1. Posner letter search
2. Erickson flanker task
3. Vigilance
4. dot probe
5. emotional "Stroop"
6. Eye tracking
7. Reaction Time

The extra subtleties of design

Personality

1. Item wording
2. Response alternatives
3. Appropriate sample size
4. Subject selection
   - restriction of range
5. generalization of subject characteristics

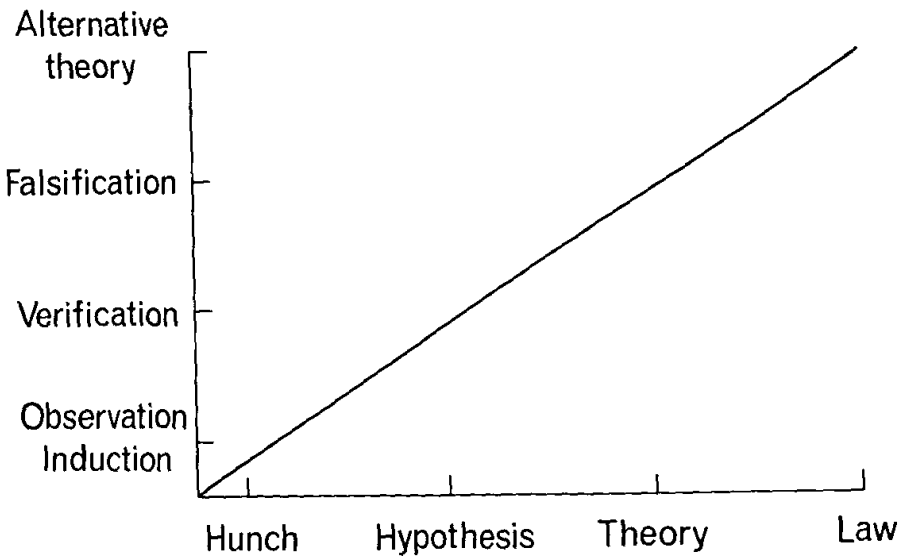
Experimental

1. number of practice trials
2. Inter Stimulus Interval
3. Stimulus Onset Asychrony
4. Type of randomization/counterbalancing
   - block randomization
   - complete randomization
   - counterbalancing
5. Data trimming procedures
6. Power/p-hacking

Scientific progress and levels of theory

Eysenck (1976, 1985); Eysenck & Eysenck (1985)

1. Hunch
   - observations
   - deduction
2. Hypothesis
   - hypothesis development
   - hypothesis verification
3. Theory
   - Weak theory – confirmation studies
   - Strong theory –disconfirmation studies
4. Law



Eysenck, Lakatos, Popper and Kuhn

Eysenck (1983, 1985, 1987b, 1988); Eysenck & Eysenck (1985) followed Lakatos (1968) in suggesting that disconfirmation studies did not lead to theory rejection until a better theory was supplied.

> *"Purely negative, destructive criticism, like 'refutation' or demonstration of an inconsistency does not eliminate a programme. Criticism of a programme is a long and often frustrating process and one must treat budding programmes leniently. One can, of course, undermine a research-programme but only with dogged patience. It is usually only constructive criticism which, with the help of rival research programmes can achieve major successes; but even so, dramatic, spectacular results become visible only with hindsight and rational reconstruction."*
> *(Lakatos, 1968, p 183)*

Types of experimental designs

1. Within subject designs
   - controls for subject variability
   - two or more conditions
   - repeated many, many times
   - confounds practice/order effects with manipulation
2. Between subject designs
   - Subject variables as an alternative explanation of results
   - threats to validity
   - Randomization as a control
3. Mixed – Within/Between
   - Some variables studied between subjects
   - Some variables studied within subjects

Questions for evaluating research

1. What are the basic constructs being studied?
2. What are the particular operationalizations (observations) associated with the constructs?
3. How much of the variability in a construct is due to the (experimental manipulation) independent variable?
4. What are possible alternative sources of variation?

Examples of logical design

1. Madsen and McGaugh
    - Electroconvulsive shock in rats
2. Roediger and McDermott
    - False learnings in humans

Roediger and McDermott

Meta-theoretical question

1. memory as photograph versus memory as reconstruction (memory as photo vs. photoshop)
2. "recovered" childhood memories of trauma versus ?false? memories
3. legal testimony of accuracy of memory

Roediger and McDermott- background

Prior work

1. memory distortions over time – Bartlett
2. reconstructive memory – Loftus
3. low error rates in recognition memory – Underwood
4. intrusions in free recall – Deese

Loftus and Palmer (1974)

1. The participants were 45 students of the University of Washington. They were each shown seven film-clips of traffic accidents. The clips were short excerpts from safety films made for driver education. The clips ranged from 5 to 30 seconds long.
2. Following each clip, the students were asked to write an account of the accident they had just seen. They were also asked to answer some specific questions but the critical question was to do with the speed of the vehicles involved in the collision.
3. There were five conditions in the experiment (each with nine participants) and the independent variable was manipulated by means of the wording of the questions. For example:
   - Condition 1: 'About how fast were the cars going when they smashed into each other?'
   - Condition 2: 'About how fast were the cars going when they collided into each other?'
   - Condition 3: 'About how fast were the cars going when they bumped into each other?'
   - Condition 4: 'About how fast were the cars going when they hit each other?
   - Condition 5: 'About how fast were the cars going when they contacted each other?'

Loftus and Palmer (1974)

- Condition 1: 'About how fast were the cars going when they smashed into each other?'
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The basic question was therefore 'About how fast were the cars going when they ***** each other?'. In each condition, a different word or phrase was used to fill in the blank. These words were; smashed, collided, bumped, hit, contacted.

From http://www.holah.co.uk/study/loftus/

Underwood, 1965

1. A master of verbal learning (before the cognitive revolution)
2. Varied word type in a running recognition task.
   - Stimulus words (Bottom, give, day, man, ... butter, crumb, ... bed, dream, ...
   - Antonyms (Top, take, night, ... ? Associates (bread, .. sleep, ...
3. Varied number of repetitions of each cued word.
4. Low but reliable number of false recognitions
5. Increased effect for words that were repeated three times

Deese, 1959

1. Another verbal learning master
2. Lists consisting of 12 words each were presented to 50 Ss for a test of immediate recall. In the recall of these lists, particular words occurred as intrusions which varied in frequency from 0% for one list to 44% for another.
3. Data gathered on word- association frequencies clearly showed that the probability of a particular word occurring in recall as an intrusion was determined by the average frequency with which that word occurs as an association to words on the list.

Roediger and McDermott

1. Alternative explanations for memory effects
   - (1) connection strength models of memory
   - (2) network models of association
2. Theoretical statement
   - not testing theory but rather testing phenomenon
   - need to get a robust measure of false memory in order to study it

Roediger and McDermott Study 1

1. Materials
   - (a) 6 lists of 12 words with high associates of 6 target lures
   - (b) recognition list
   - 12 studied words ii) 6 target lures
   - 12 weakly related iv) 12 unrelated
2. Procedure
   - (a) verbal presentation of each list
   - (b) free recall after each list
   - (c) recognition 2 minutes after all lists had been presented
3. Results
   - (a) recall shows serial position effects
   - (b) intrusion errors almost as strong as low point of serial position
   - (c) recognition errors are frequent

Roediger and McDermott Study 2

1. Materials
    - (a) 16 lists
2. procedure
3. results

Our replication and extension

1. A conceptual replication of R & M
2. Same basic paradigm, same word lists, slight differences in timing
3. But added the variable of seeing versus hearing
4. Two primary Independent Variables:
   - Mode of presentation (Oral versus Visual) ?
   - Recall vs. math
5. Based upon prior work in 205, observed lower rates of subsequent false recognition than R & M. Was this due to modality of presentation
6. Within subject study (why?)

The basic design

1. Independent Variables
   - Mode of presentation
   - Recall vs. math
2. Dependent variables
   - Recall per list (examine order effects)
   - Recognition of
     - real words (varying by position)
     - false words
     - control words
3. Design mixed within (mode and recall) with order (between)

Within subject threats to validity

1. Order effects
    - Learning
    - Fatigue
    - Materials
2. Confounding of Independent variables
    - We want to have no correlation between independent variables

Cronbach, L. J. (1957). The two disciplines of scientific psychology. *American Psychologist*, *12*, 671–684.

Cronbach, L. J. (1975). Beyond the two disciplines of scientific psychology. *American Psychologist*, *30*, 116–127.

Eysenck, H. (1983). Is there a paradigm in personality research? *Journal of Research in Personality*, *17*(4), 369 – 397.

Eysenck, H. J. (1966). Personality and experimental psychology. *Bulletin of the British Psychological Society*, *19*, 1–28.

Eysenck, H. J. (1976). *The Measurement of personality*. Lancaster: MTP.

Eysenck, H. J. (1985). The place of theory in a world of facts. In *Annals of theoretical psychology*, volume 3 (pp. 17–72). Plenum Press.

Eysenck, H. J. (1987a). The growth of unified scientific psychology: Ordeal by quackery. In A. W. Staats & L. P. Mos (Eds.), *Annals of Theoretical Psychology*, volume 5 chapter 3, (pp. 91–113). Plenum Press.

Eysenck, H. J. (1987b). "there is nothing more practical than a good theory" (kurt lewin) –true or false? In W. J. Baker, M. E. Hyland, H. V. Rappard, & A. W. Staats (Eds.), *Current Issues in Theoretical Psychology*, volume 40 (pp. 49–63). North Holland.

Eysenck, H. J. (1988). The growth of a unified scientific psychology. In A. Staats & L. Mos (Eds.), *Annals of Theoretical Psychology*, volume 5 of *Annals of Theoretical Psychology* (pp. 91–113). Springer US.

Eysenck, H. J. (1997). Personality and experimental psychology: The unification of psychology and the possibility of a paradigm. *Journal of Personality and Social Psychology*, *73*(6), 1224–1237.

Eysenck, H. J. & Eysenck, M. W. (1985). *Personality and Individual Differences: A natural science approach*. New York: Plenum.

Fisher, R. A. (1925). *Statistical methods for research workers*. Edinburgh: Oliver and Boyd.

Galton, F. (1886). Regression towards mediocrity in hereditary stature. *Journal of the Anthropological Institute of Great Britain and Ireland*, *15*, 246–263.

Gray, J. A. (1981). A critique of Eysenck's theory of personality. In H. J. Eysenck (Ed.), *A Model for Personality* (pp. 246–277). Berlin: Springer.

Kimble, G. A. (1984). Psychology's two cultures. *American Psychologist*, *39*(8), 833 – 839.

Lakatos, I. (1968). Criticism and the methodology of scientific research programmes. *Proceedings of the Aristotelian Society*, *69*, pp. 149–186.

Pearson, K. P. (1896). Mathematical contributions to the theory of evolution. iii. regression, heredity, and panmixia. *Philisopical Transactions of the Royal Society of London. Series A*, *187*, 254–318.

Revelle, W. & Oehlberg, K. (2008). Integrating experimental and

observational personality research – the contributions of Hans Eysenck. *Journal of Personality*, *76*(6), 1387–1414.

Snow, C. P. (1959). "the rede lecture, 1959". In *The Two Cultures: and a Second Look* (pp. 1–21). Cambridge University Press.

Spearman, C. (1904). The proof and measurement of association between two things. *The American Journal of Psychology*, *15*(1), 72–101.

Student (1908). The probable error of a mean. *Biometrika*, *6*(1), 1–25.

Underwood, B. J. (1975). Individual differences as a crucible in theory construction. *American Psychologist*, *30*, 128–134.

Vale, J. & Vale, C. (1969). Individual differences and general laws in psychology: a reconciliation. *American Psychologist*, *24*(12), 1093–1108.

Wundt, W. (1904). *Principles of Physiological Psychology* (Translated from the Fifth German Edition (1902) ed.). London: Swan Sonnenschein.