The most dangerous profession

- Wainer (1997) reviews data from "the Swiss physician H.C. Lombard who examined 8,496 death certificates gathered over a half century in Geneva. Each certificate contained the name of the deceased, his profession, and age at death. Lombard used these data to calculate the mean longevity associated with each profession."
- Consider the following (abbreviated) table.

- H. Wainer (1997) The most dangerous profession: a note on nonsampling error. Psychological Methods, 4, 250-256.

The most dangerous profession?

(Wainer, 1997: data from Lombard, 1835)

Profession	Sample size	Age at death
Students	39	20.2
Merchant assistants	58	38.9
coachmen	12	45
Soldiers	338	48.4
Bakers	82	49.8
Butchers	77	53
Surgeons	41	54
Farmers	267	54.7
Wine merchant	120	56.3
Businessmen	7	57.5
Harness Makers	10	60.4
Lawyers	12	64.3
Apothecaries	19	64.3
School masters	18	64.4
Professors	10	66.6

Teaching effects

A teacher of statistics wanted to compare two methods of teaching introductory statistics. One method relied heavily on the teaching of the theory behind statistics (theory method). The other method was labeled the cookbook method because it consisted of teaching the students various statistical tests and informing them when to use each test.

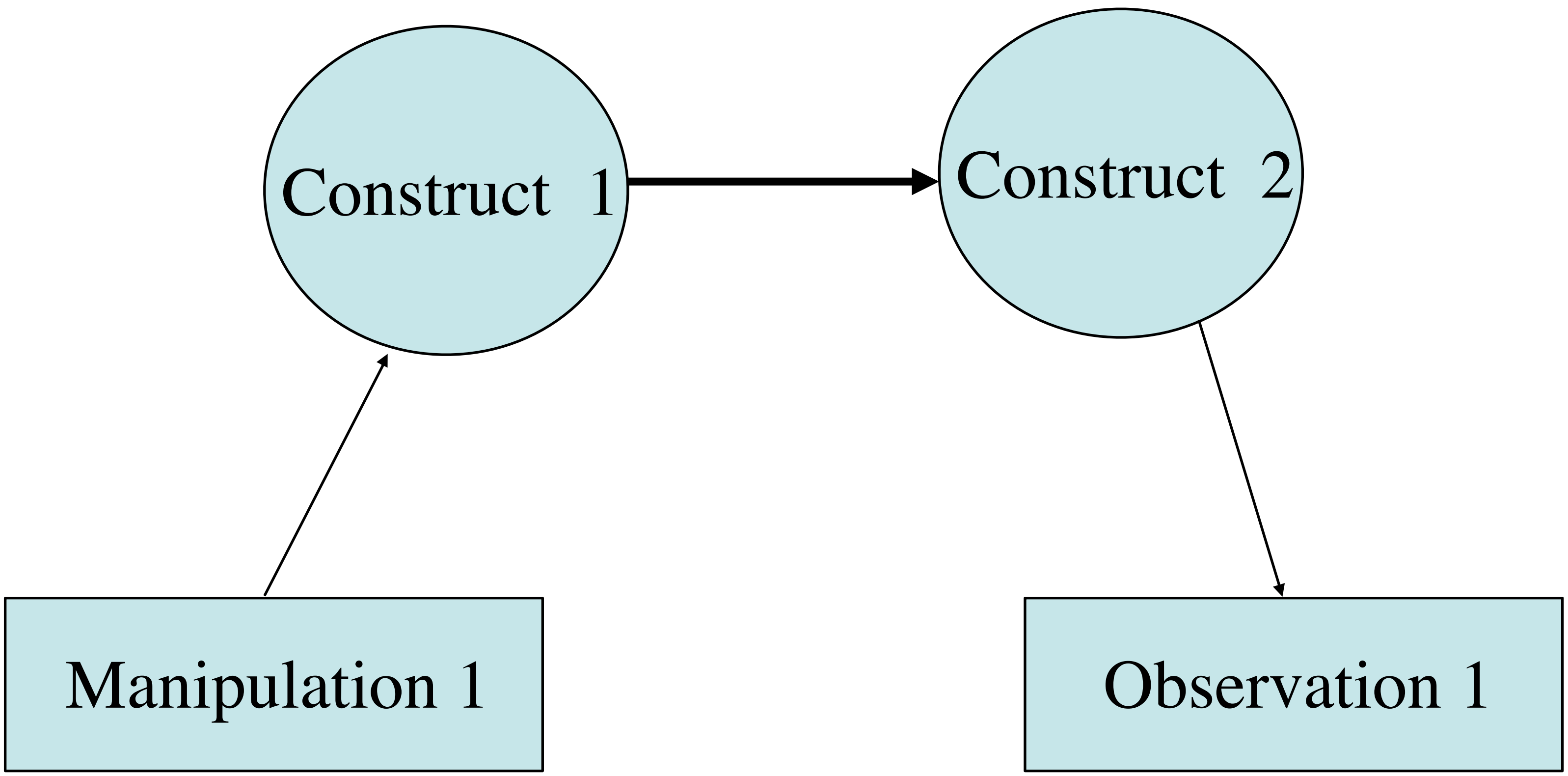
The researcher found that a leading engineering school was using the theory method in all its introductory statistics classes and that a state teachers college was using the cookbook method in all its classes.

At the end of each semester he administered a standardized test on the applications of statistics to the statistics classes of both schools. The results of this testing indicated the classes that received the theory method were far superior to the classes that received the cookbook method. The research concluded that the theory method was the superior method and should be adopted by teachers of statistics.

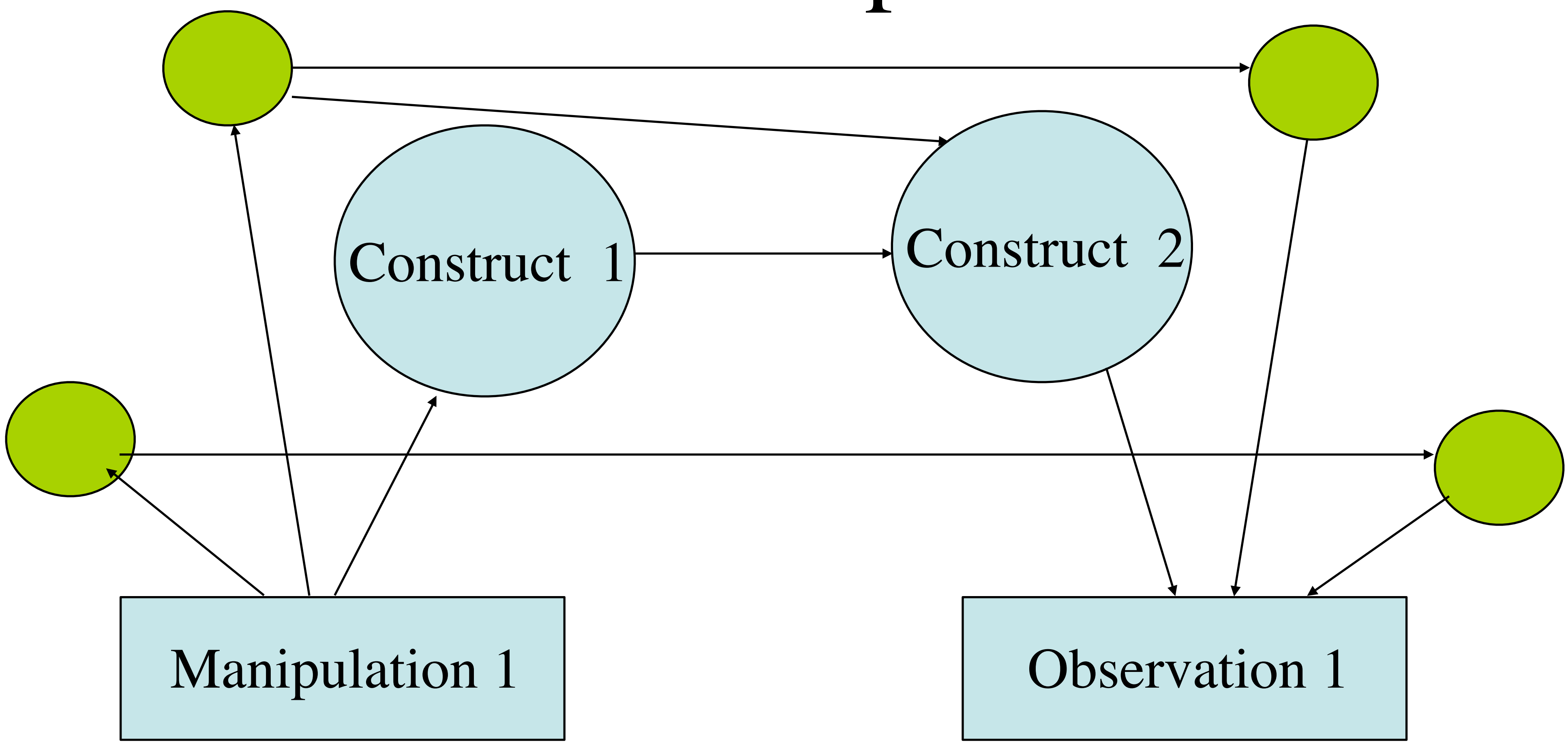
Research Designs

Between Subject Designs

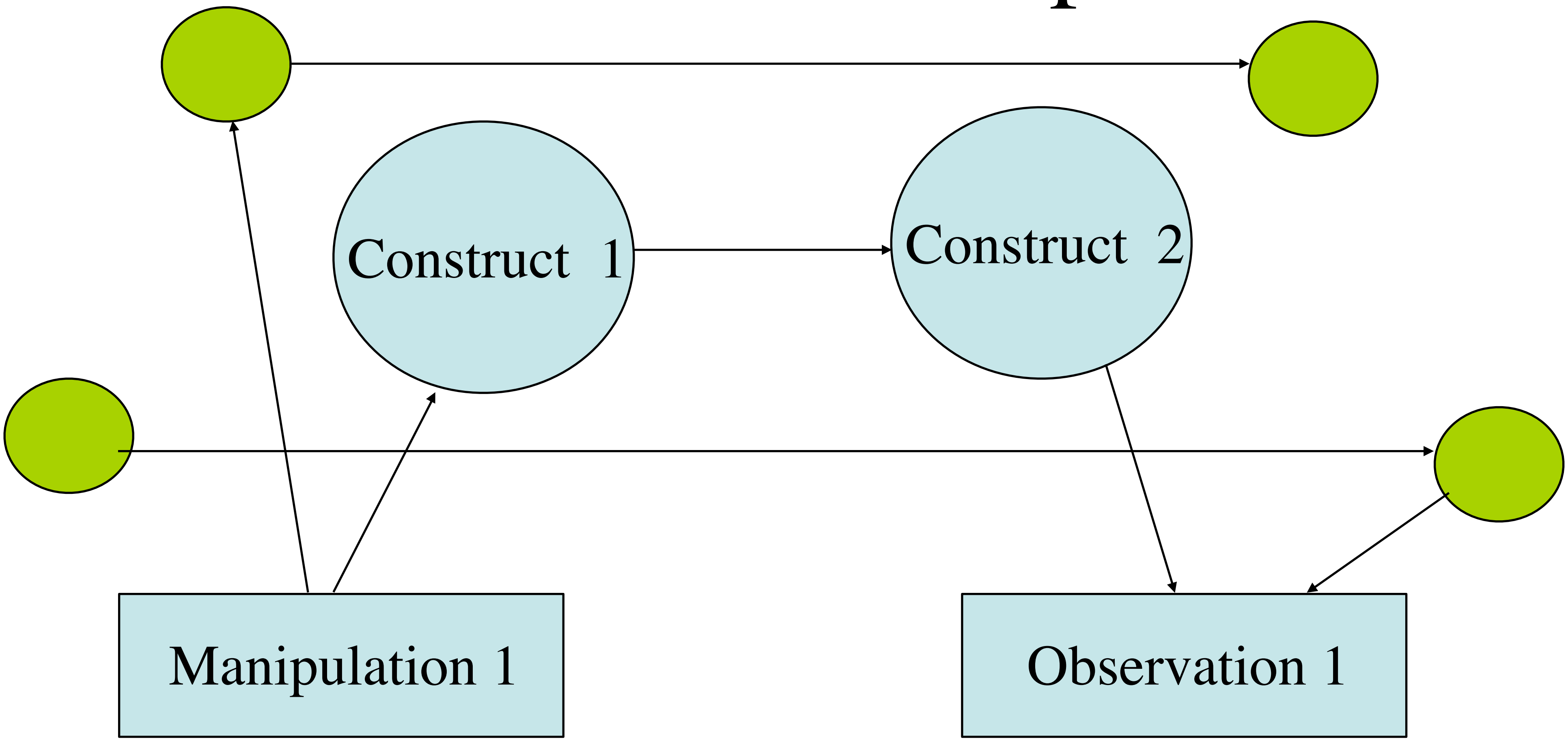
Theory and Theory Testing II: Experimental manipulation



Theory and Theory Testing III: Alternative Explanations



Theory and Theory Testing IV: Eliminate Alternative Explanations



Overview of the problem

1) Theoretical problem: understanding the relationship between latent variables (constructs)
   a) relationships among latent variables
   b) relationships between latent variables and observed variables
2) Generalization of results and threats to external validity
3) Proper design maximizes internal validity

Generalization of results and threats to external validity-I

- Limitations of generalization for subjects
- Limits of generalization for conditions -- interactions with other variables

Generalization of results and threats to external validity-I

a) limitations of generalization for subjects

(1) freshman psych students at NU

(2) students at NU

(3) college students at selective research universities

(4) college students

(5) 18-24 year olds

(6) North Americans

(7) Humans

b) limits of generalization for conditions -- interactions with other variables

Generalization of results and threats to external validity-II

b) limits of generalization for conditions -- interactions with other variables

(1) problems and benefits of interactions

(a) xy relationship depends upon z

(b) example:

i) in the morning, caffeine facilitates working memory performance

ii) in the evening, caffeine hinders working memory performance

(2) interactions limit generalization

(3) interactions test theoretical limits

Consider the following data

```
> my.data <- matrix(c(15,32,40,23),2,byrow=TRUE)
> colnames(my.data) <- c("AM","PM")
> rownames(my.data) <- c("Placebo","Caffeine")
```

No effect of time of day

```
> colMeans(my.data)
  AM   PM
27.5 27.5
```

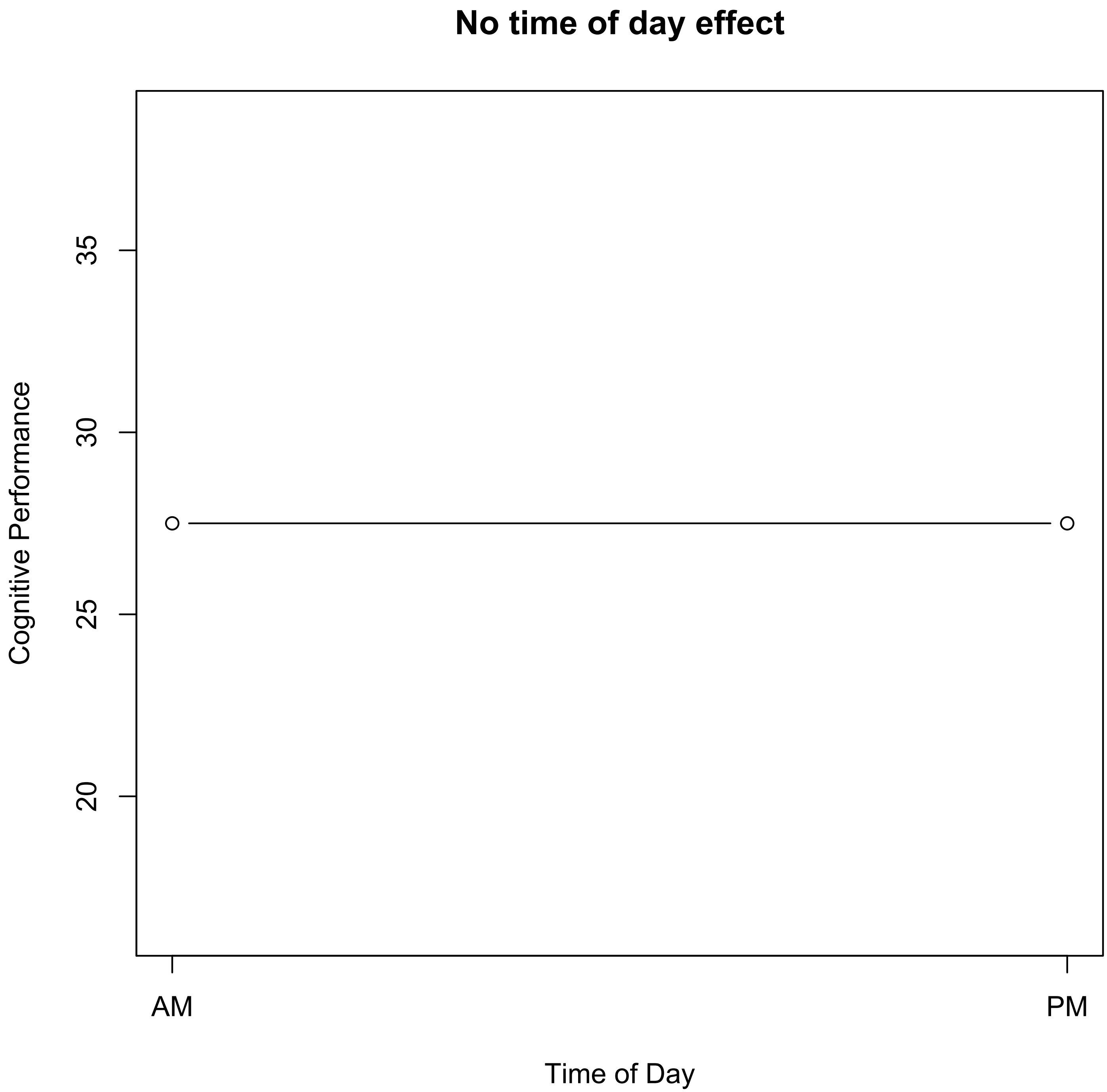
Effect of caffeine

```
> rowMeans(my.data)
 Placebo Caffeine
    23.5     31.5
```

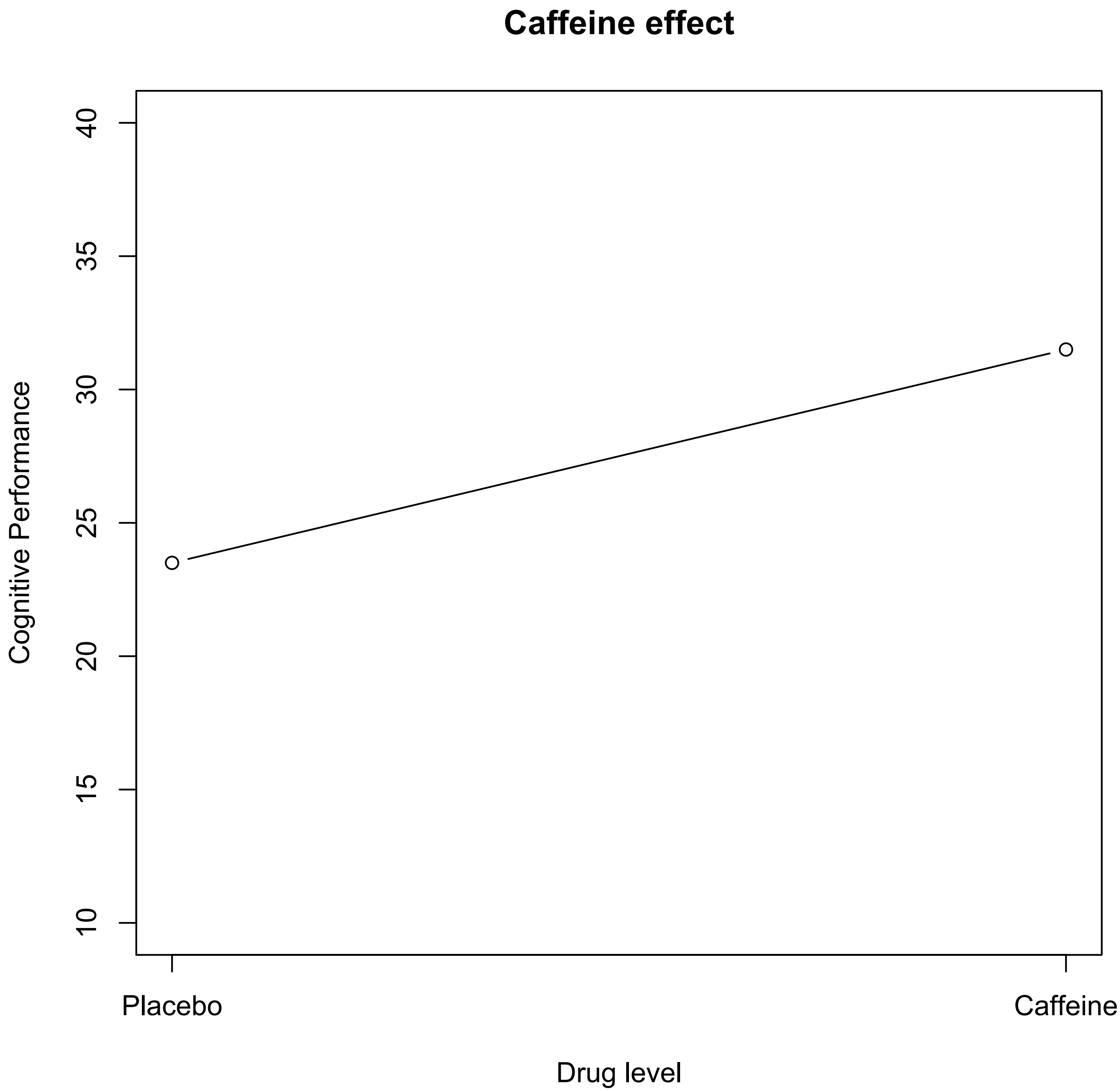
Interaction of caffeine and time of day

```
         AM PM
Placebo  15 32
Caffeine 40 23
```

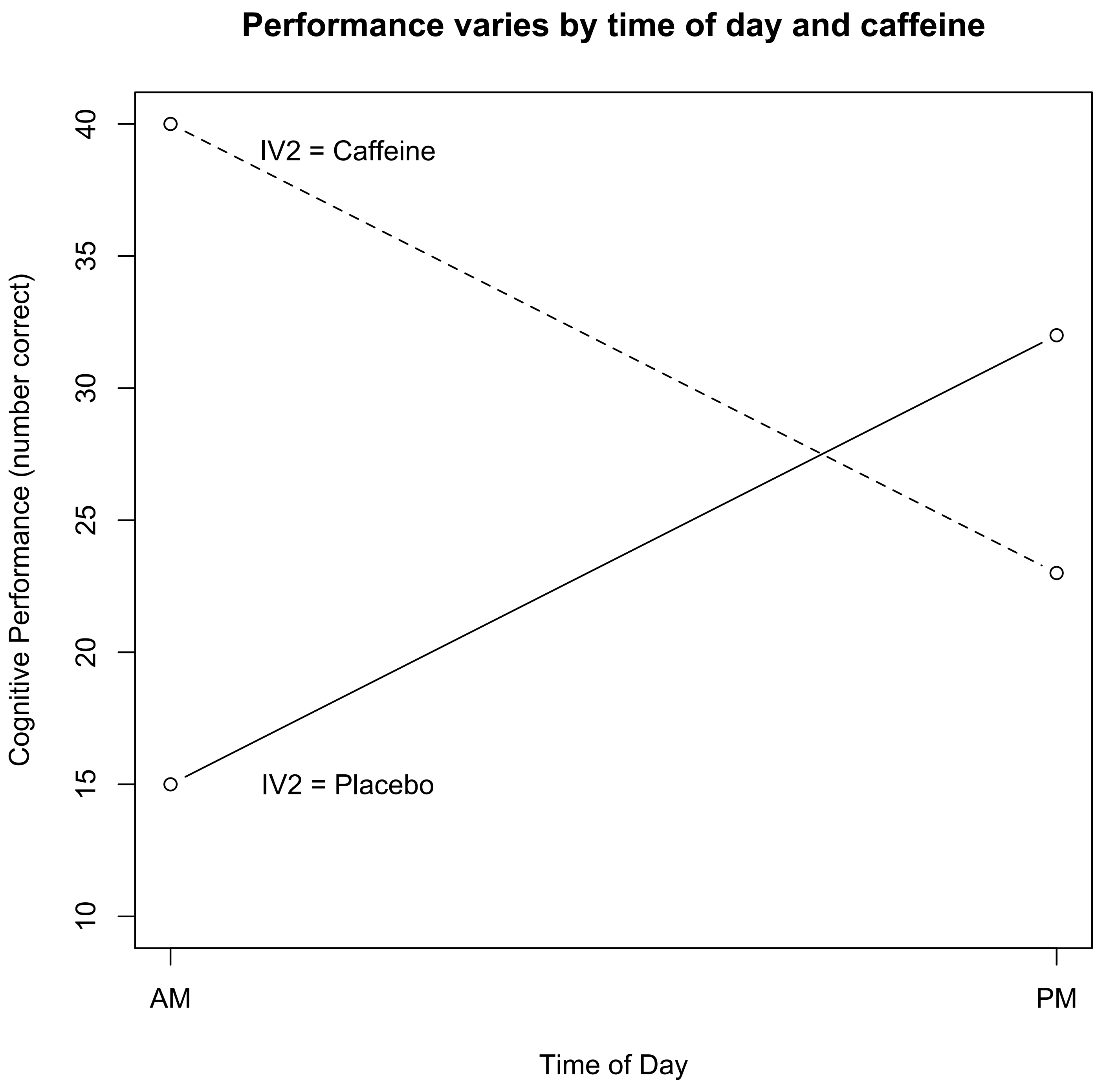
Main effect of time of day



Main effect of caffeine



Interactions



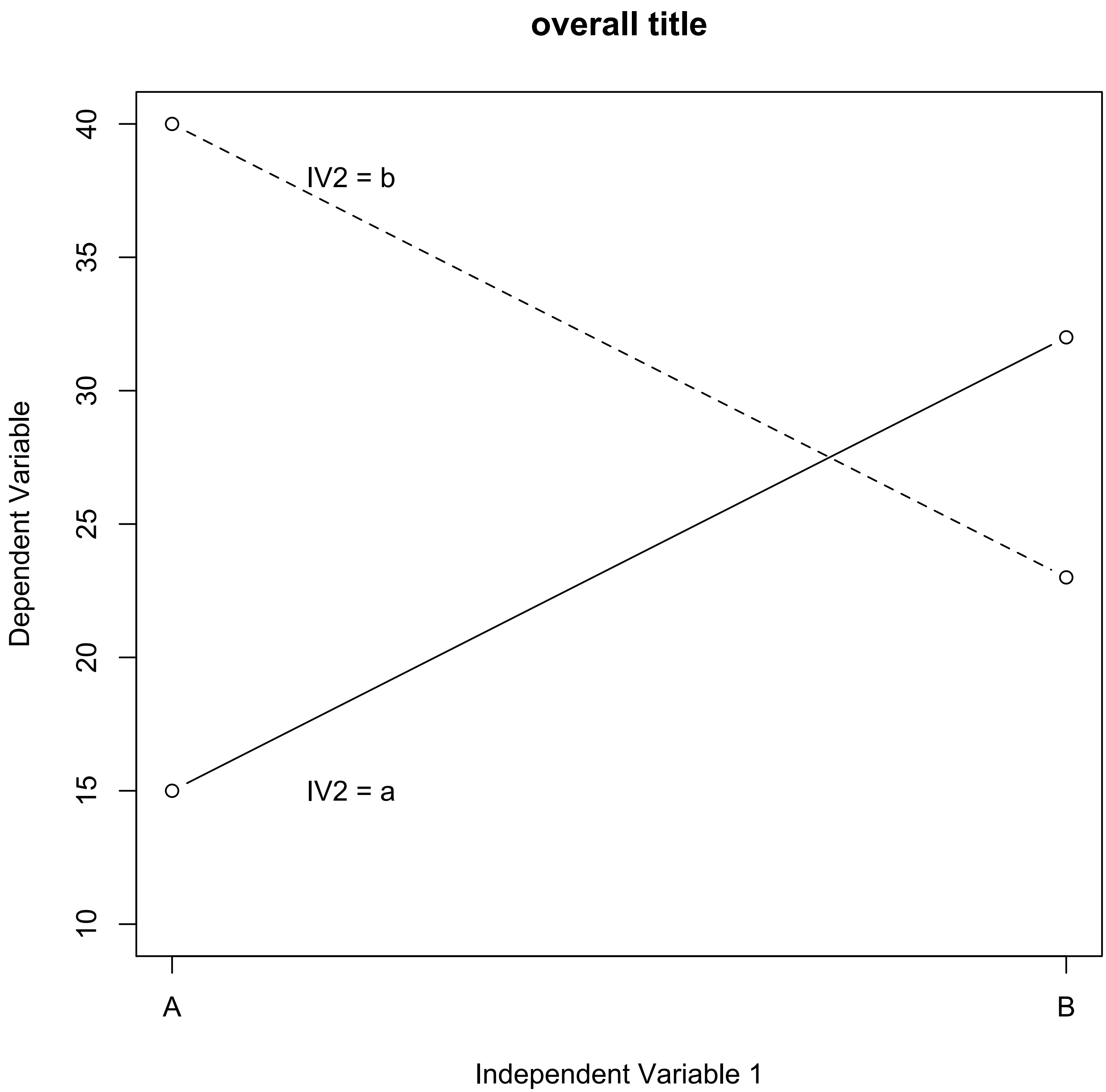
Graphing two variables

```
#specific example
colnames(my.data) <- c("AM", "PM")
rownames(my.data) <- c("Placebo", "Caffeine")
low <- 10
high <- 40
step <- 5
plot(my.data[1,],ylab= "Cognitive Performance (number correct)", xlab="Time
of Day",ylim=c(low,high),main= "Performance varies by time of day and
caffeine",typ= "b", axes=FALSE)
axis(1,c(1,2),c("AM","PM")) #x axis
axis(2,seq(low,high,step)) #y axis
box()
points(my.data[2,],typ="b",lty="dashed")
text(1.2,15,"IV2 = Placebo")
text(1.2,39,"IV2 = Caffeine")
```

Graphing two variables

```
#generic figure
colnames(my.data) <- c("A", "B")
rownames(my.data) <- c("a", "b")
low <- 10
high <- 40
step <- 5
plot(my.data[1,],ylab= "Dependent Variable", xlab="Independent Variable 1",ylim=c(low,high),main= "overall title",typ= "b", axes=FALSE)
axis(1,c(1,2),c("A","B")) #x axis
axis(2,seq(low,high,step)) #y axis
box()
points(my.data[2,],typ="b",lty="dashed")
text(1.2,15,"IV2 = a")
text(1.2,38,"IV2 = b")
```

Generic two variables



Practical problems and threats to internal validity

1 Manipulations affect more than the construct of interest

a) examples:

(1) caffeine induces alertness and motor tremor

(2) failure induces anxiety, depression, anger

(3) practice leads to motivational changes as well as changes in skill

2 Observable variables reflect more than the construct of interest

a) self report of alertness reflects base line differences

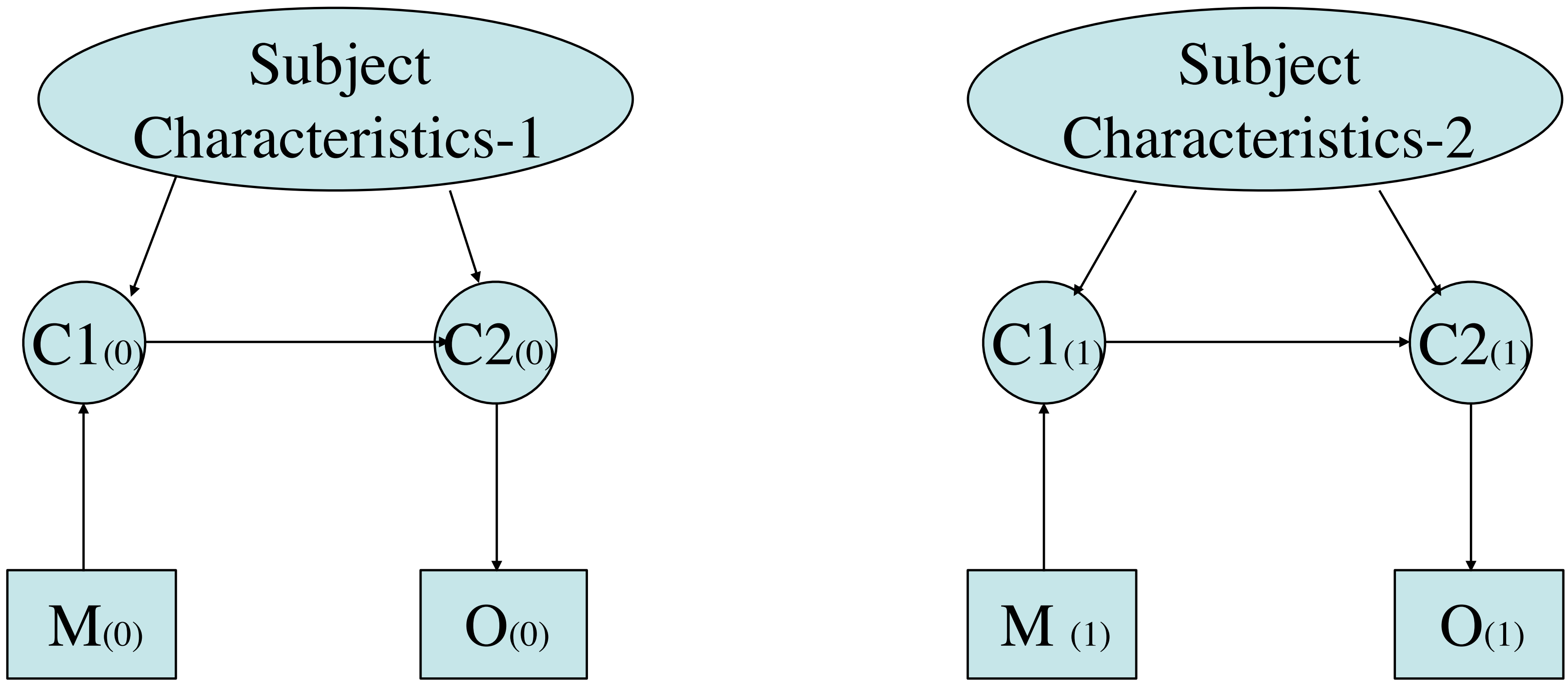
b) cognitive performance--ability, motivation, training, practice

c) slowness of responding reflects caution as well as process speed

Types of designs

- Within subject designs
  - controls for subject variability
  - confounds practice/order effects with manipulation
  - two or more conditions -- repeated many, many times
- Between subject designs
  - Subject variables as an alternative explanation of results -- threats to validity
  - Randomization as a control
- Mixed -- Within/Between

Theory and Theory Testing II: Experimental manipulation-Between Subjects



Possible confounding of subjects with conditions

Between Subject designs

- Subject variables as threat to external validity
  - Ability
  - Practice
  - Motivation
  - Interest
  - Gender
  - Age
  - Culture

Culture effects: The WEIRD subject

- Western
- Educated
- Industrialized
- Rich
- Democratic
- Joseph Henrich, Steven J. Heine and Ara Norenzayan, The weirdest people in the world (working paper 139) also BEHAVIORAL AND BRAIN SCIENCES (2010) 33, 61–135

Most subjects are American Undergrads

- 68% of subjects are from US, 96% from North America, Europe, Australia, Israel
- In JPSP 67% of American studies are undergraduates, 80% of studies from other countries

"In other words, a randomly selected American undergraduate is more than 4,000 times more likely to be a research participant than is a randomly selected person from outside of the West." (p 63)

Should it be the Journal of Social and Personality Psychology of Western subjects?

Consider Muller-Lyer illusion

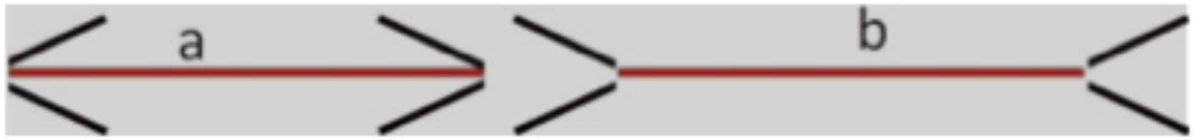
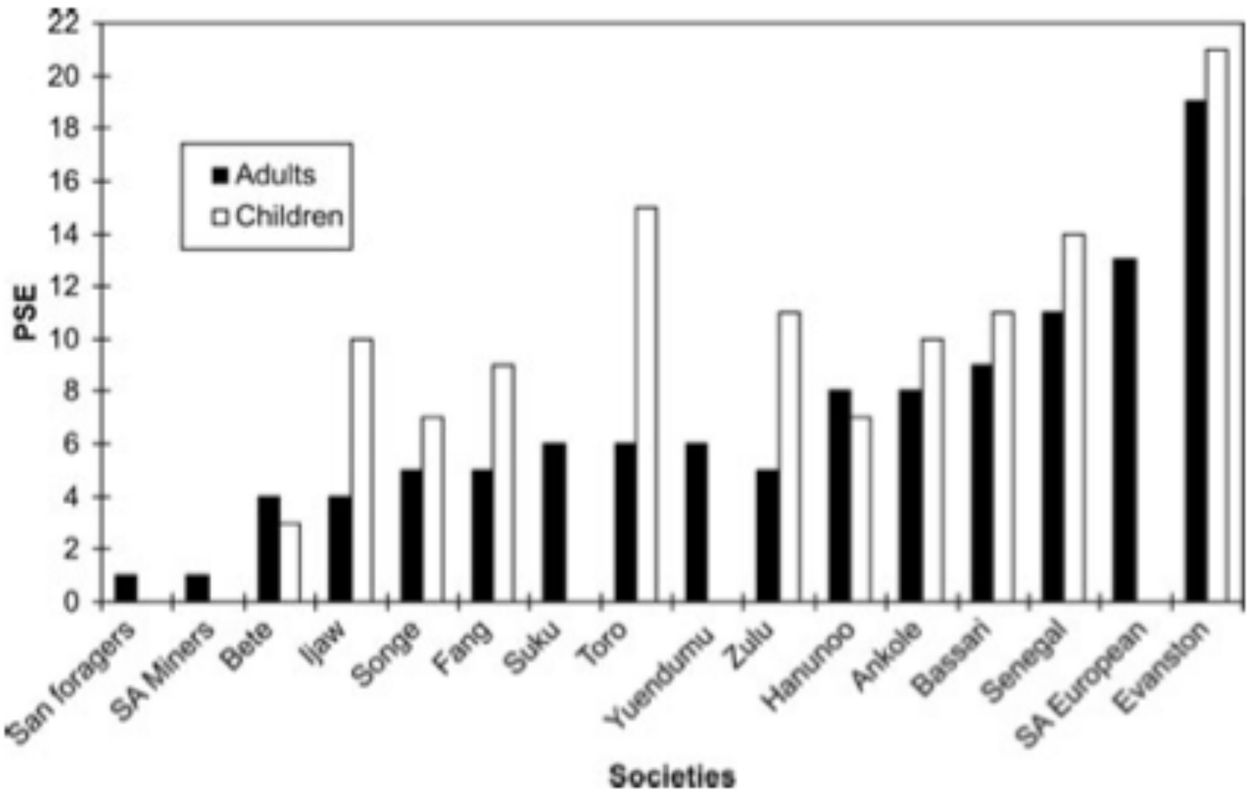


Figure 1. The Müller-Lyer illusion. The lines labeled "a" and "b" are the same length. Many subjects perceive line "b" as longer than line "a".



Between Subject designs

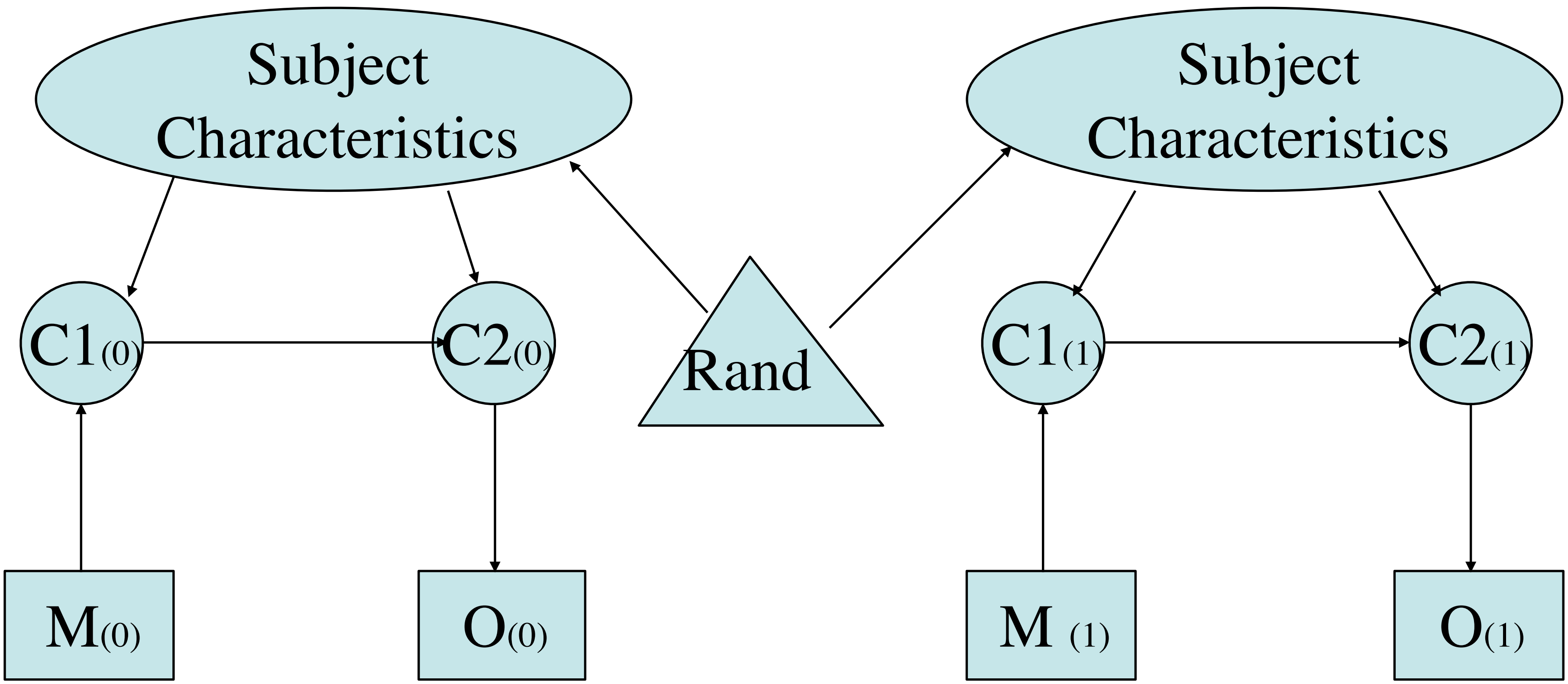
- Confounded effects that can lead to subject variability
  - Time of day
    - Naturally occurring rhythms of alertness
    - Classroom effects
    - Fatigue
  - Time of week, month, season, year
    - Class schedules
      - Mid terms
      - Papers
    - Weather
  - Volunteer effects
  - Experimenter-Subject interactions

Between Subject designs

- Subject variables as threat to external validity
- Confounded effects that can lead to subject variability
- Randomization as a control

- A YMCA official in a small town wanted some evidence to prove that his program was valuable in training future leaders. He went back to the membership records and got the names of those boys who were active members in his program 20 years before. He also took school records and got the names of boys who were not YMCA members. He compared the two groups as to present occupations, salaries, and so on, and found that the YMCA group was doing much better. He concluded that this result was due to the influence of his program.
- What were the constructs of interest?
- What are possible threats to the validity of this study?

Theory and Theory Testing II: Experimental manipulation- Between Subjects



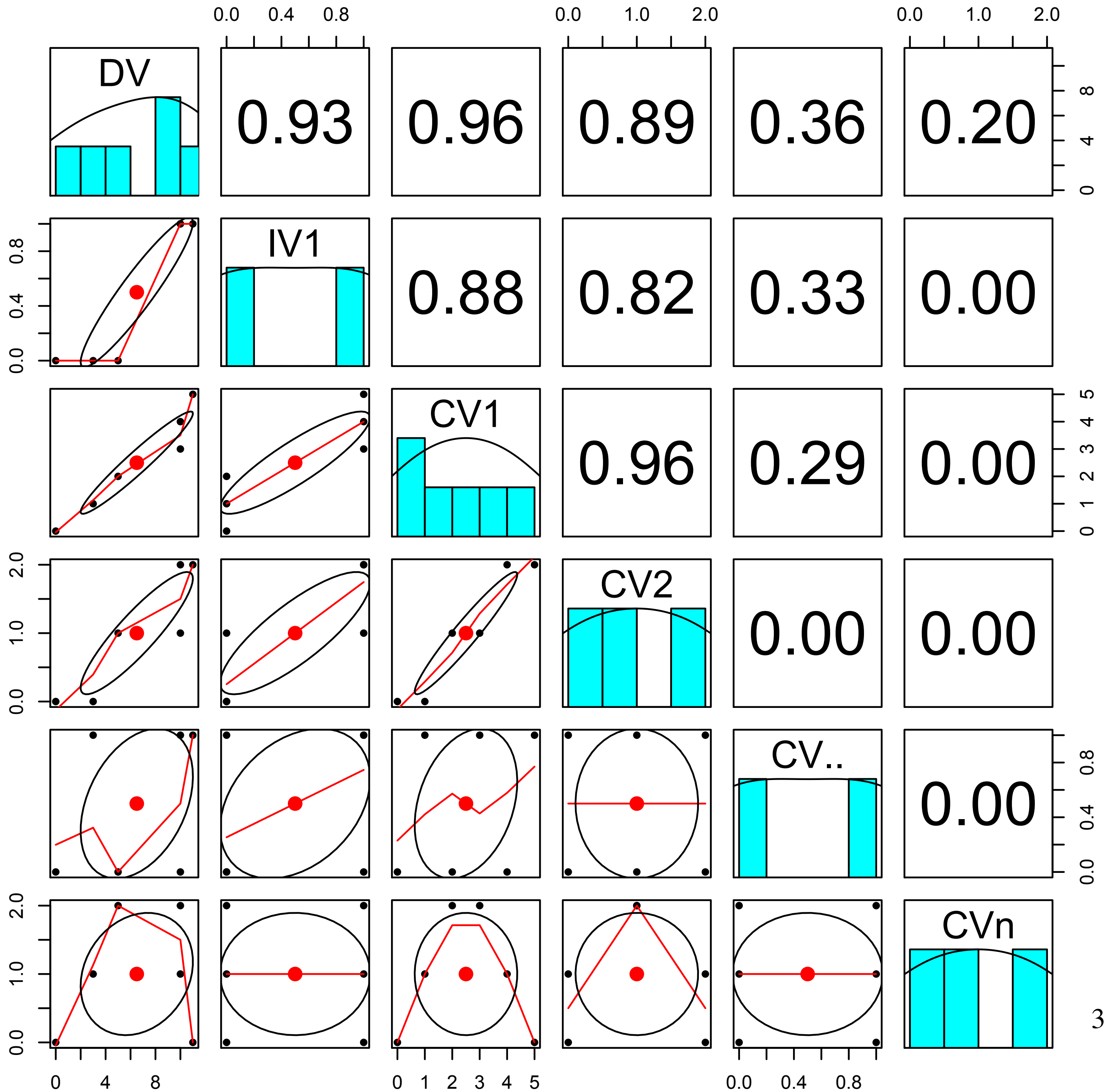
Randomization breaks the link confounding subjects and conditions

Dependent Variable = f(Independent + Confounding 1 ... N)

	DV	IV1	CV1	CV2	CV..	CVn
1	0	0	0	0	0	0
2	3	0	1	0	1	1
3	5	0	2	1	0	2
4	10	1	3	1	1	2
5	10	1	4	2	0	1
6	11	1	5	2	1	0

$DV = 3 * IV1 + \sum CV_i$

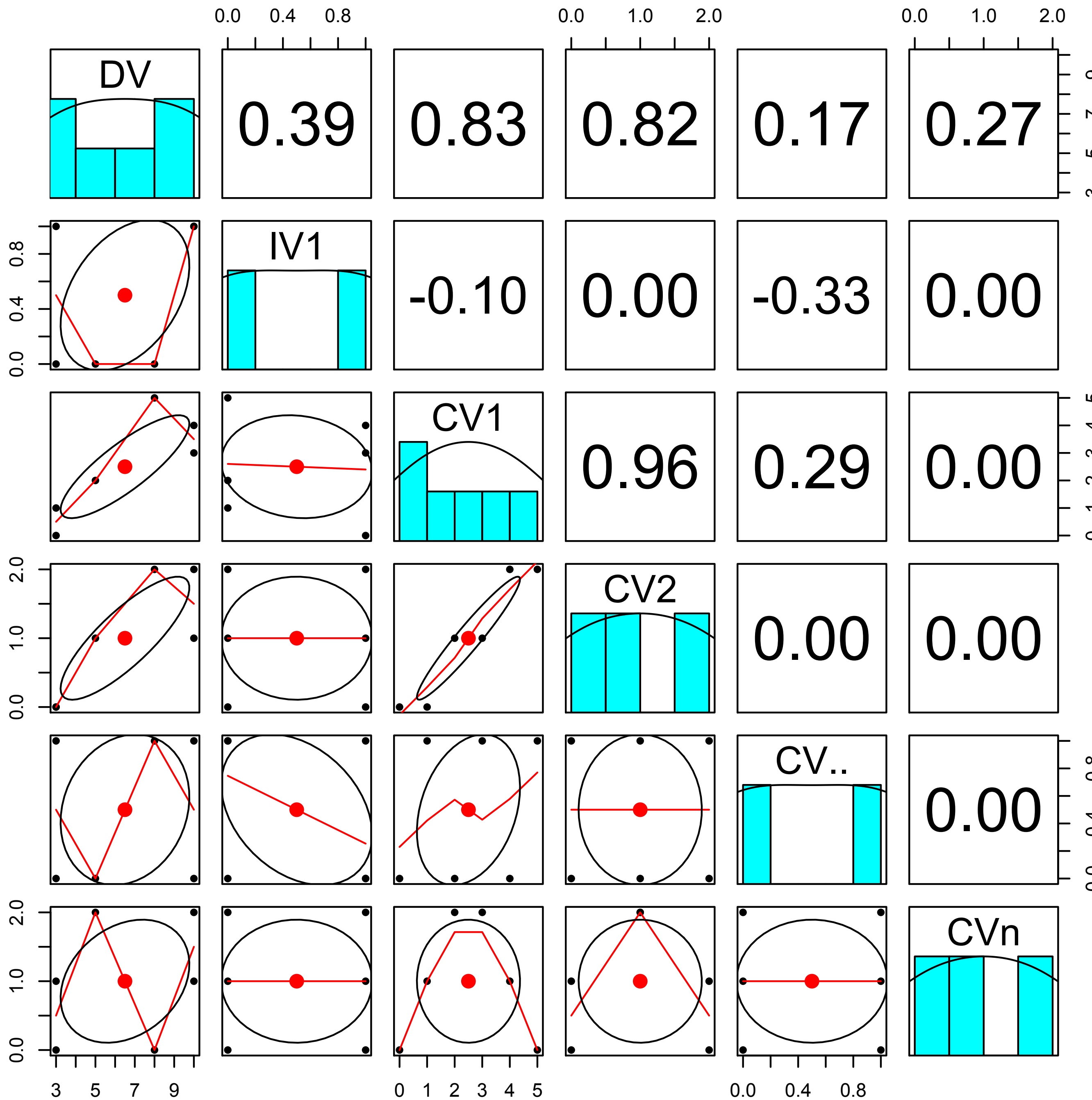
$DV = IV + \sum CV_i$


DV
IV1
CV1
CV2
CV..
CVn
0.93
0.96
0.89
0.36
0.20
0.88
0.82
0.33
0.00
0.96
0.29
0.00
0.00
0.00
0.00

Dependent Variable = f(Independent + $\sum$Confounding 1 ... N) (better)

	DV	IV1	CV1	CV2	CV..	CVn
1	3	1	0	0	0	0
2	3	0	1	0	1	1
3	5	0	2	1	0	2
4	10	1	3	1	1	2
5	10	1	4	2	0	1
6	8	0	5	2	1	0

Less confounding of IVs and CVs



Randomization

- Dependent variable is still a function of the confounding variables, but the correlation between the experimental Independent Variable with the Confounding Variables is reduced. (The expected correlation is 0, although the observed correlation will vary from sample to sample.
- We have a purer measure of the influence of the IV upon the DV independent of the effects of the Confounding Variables.

Randomization as a control

- Only the expected values of groups are equal --not the observed values
  - In any particular experiment, groups are not equivalent
  - Expected value of the (signed) group difference=0
  - Randomization does not introduce systematic bias
- Confounding variables are (on the average) not correlated with our experimental variables

Types of Randomization

- Subjects matched on variable of interest and then assigned to condition
- Blocking to control for order effects
  - Ignores stable subject effects
  - Eliminates subject effects associated with time of appearance
- Complete randomization
  - "failures" of randomization
  - Problems at the end of the experiment
    - Power is maximized with equal cell sizes
    - Randomization will tend not to produce equal size groups
- Block Randomization
  - Randomize within blocks of subjects
  - Will lead to equal cell sizes, reduces chance of end effects

Complete Random (note unequal cell size)

Random order 1

	subject	condition
1	1	1
2	2	1
3	3	1
4	4	1
5	5	2
6	6	1
7	7	1
8	8	2
9	9	2
10	10	2

Random order 2

	subject	condition
1	1	2
2	2	2
3	3	2
4	4	1
5	5	2
6	6	2
7	7	2
8	8	1
9	9	2
10	10	2

Random with end effect

	subject	condition	end.effect
1	1	2	2
2	2	2	2
3	3	2	2
4	4	1	1
5	5	2	2
6	6	2	2
7	7	2	1
8	8	1	1
9	9	2	1
10	10	2	1

Block Randomization part 1 (Creating a new R function)

```
"block.random" <-
function(n,ncond=2) {
blocks <- matrix(rep(NA,n*2),ncol=2)
colnames(blocks) <- c("blocks","condition")
rownames(blocks) <- paste("S",1:n,sep="")
for (block in 1:(n/ncond)) {
      blocks[((block-1)*ncond+1):(block*ncond),1] <- block
      blocks[((block-1)*ncond+1):(block*ncond),2] <-
sample(ncond,replace=FALSE)
}
return(blocks)
}
```

Block Randomization using the block.random function

```
> block.random(n=8,ncond=2)
   blocks condition
S1      1         2
S2      1         1
S3      2         1
S4      2         2
S5      3         2
S6      3         1
S7      4         2
S8      4         1
```

```
> block.random(n=8,ncond=2)
   blocks condition
S1      1         1
S2      1         2
S3      2         1
S4      2         2
S5      3         2
S6      3         1
S7      4         1
S8      4         2
```

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.
- Explain this effect

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.
- Explain this effect.
- How does this relate to the previous problem?

Flight instructors in the Air Force are interested in the effect of praise and blame on pilot performance. They have found that blame and criticism work much better than do praise. This is based upon the following design:

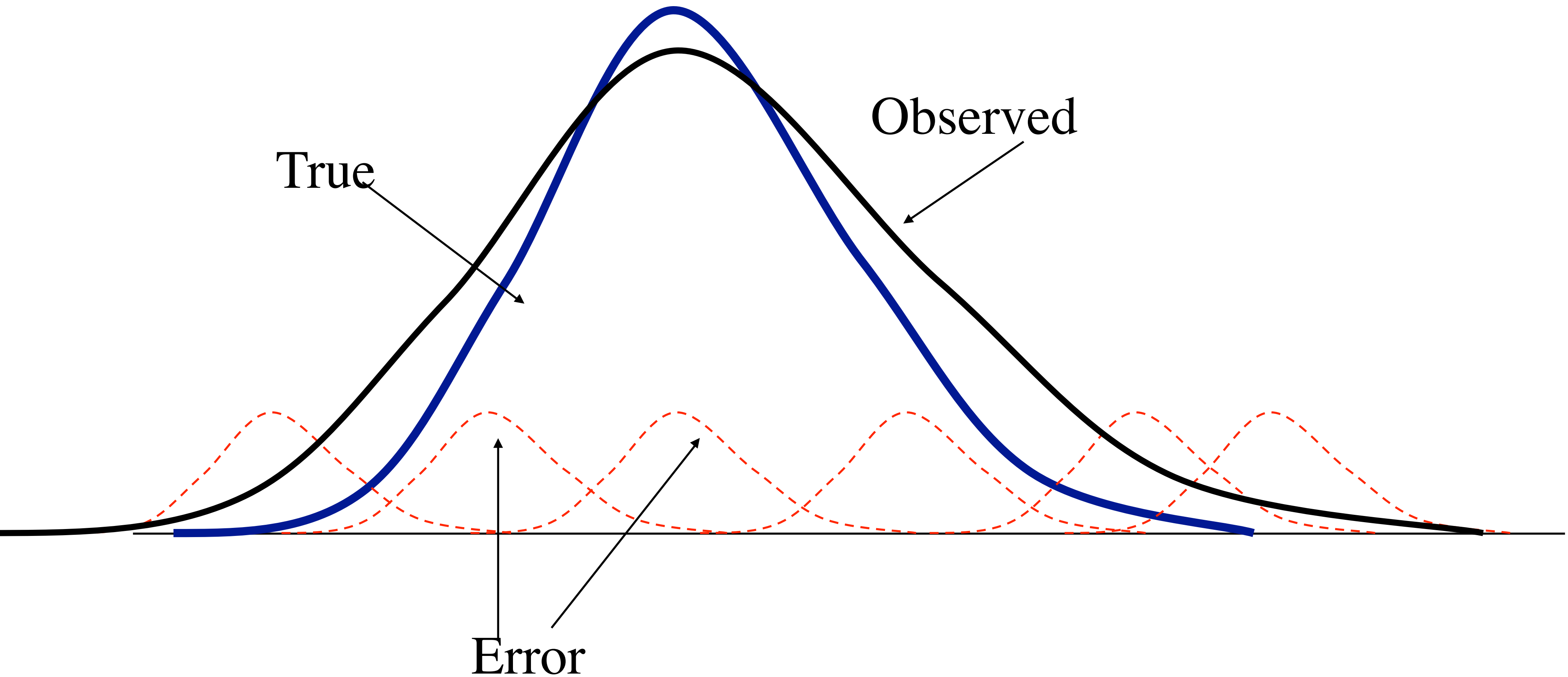
100 pilot trainees are evaluated at the end of every day of flying. Each trainee is rated in terms of their performance in taking off, executing 3 maneuvers, and then the tightness of their landing. They are rated on each activity by 3 experienced pilots on a 100 point scale. The best 50 pilots (group A) are then praised and rewarded while the worst 50 (group B) are punished by being criticized by the instructor and assigned extra duties around the base. The next day, those in group A are found to have decreased in their scores by 20 point, while those in Group B (punishment) are found to have increased by 20 points. From these results, the instructors have concluded that punishment works better than reward.

What are the constructs of interest?
What are possible alternative explanations for these effects?

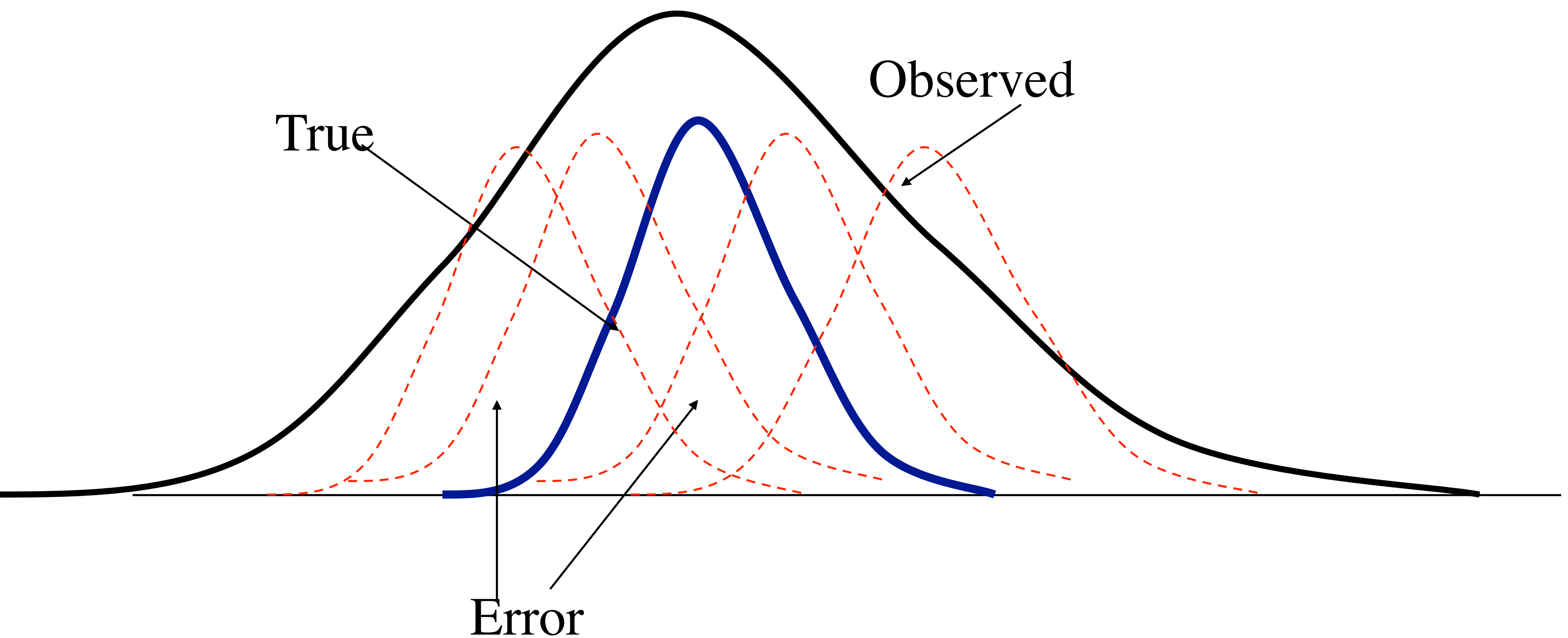
Reliability and Regression effects

- Observed score = True score + Error
- Expected score = True score
- Variance of Observed Scores > Variance True
- Choice of subjects based upon observed scores => high scores expected to decline, low scores to improve

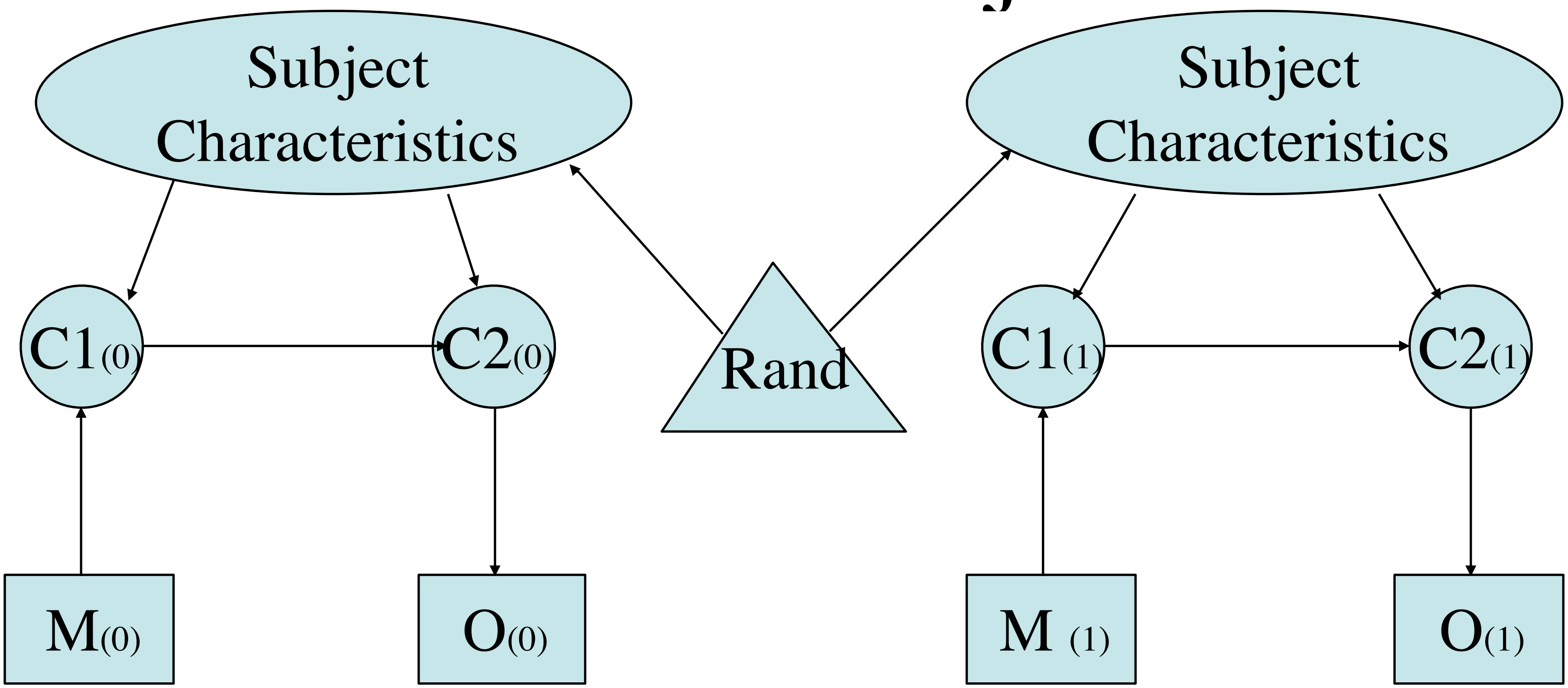
Observed= True + Error



Observed= True + Error



Theory and Theory Testing II: Experimental manipulation-Between Subjects



Randomization breaks the link confounding subjects and conditions