

# How We Gain Knowledge

*Authority*

*Rationality (Deductive Method)*

*Intuition and Insight*

*Scientific Method*

## ***Method of Authority***

In every society, people are designated as “authorities” and we rely on them for valid information, especially when we are inexperienced.

Mom and Dad

High School Teacher

Basketball Coach

Dan Rather

*Method of Celebrity* – Oprah, Dr. Phil, Dan Rather

## Authorities are necessary, but are frequently wrong

Example: Edward Clarke, *Sex in Education; or, A Fair Chance for the Girls* (1873)

Clarke was a member of the Harvard Medical School faculty. His book was very popular, and was sold out through several reprintings. His theory of *cephalo-pelvic disproportion* stated that women who went to high school would suffer from a diverting of energy flow from the pelvis to the brain during the critical developmental years of puberty. As a result, they would end up with big heads and small pelvises, possibly dying during childbirth or becoming hysterical, with shriveled ovaries!

# **Our Parents -- The primary authority!**

A tale of two brothers

## ***Deduction and Rationality***

Many important facts can be deduced from other facts through rules of logic or mathematics.

*Example.*

1. All cats have hair.
2. Mr. Puggs is a cat.
3. Therefore, Mr. Puggs has hair.

If the first two statements above are true, then the third *must be true!*

## Logical Fallacies

Studying the rules of formal logic and mathematics can help us deduce new facts, *but also recognize fallacious arguments when we see them.*

*Example.* The fallacy of *affirming the consequent*. 1. All cats have hair. 2. Mr. Puggs has hair. 3. Therefore Mr. Puggs is a cat.

Although the fallacy of affirming the consequent is blatantly obvious in the above example, we can often be deceived by it in more complex arguments.

## ***Intuition and Insight***

Often, after laborious conscious thought and reasoning have failed to solve a problem, we shift our attention elsewhere, and suddenly an answer appears, seemingly out of nowhere.

Intuitive processes and unconscious reasoning are not well understood phenomena, but they definitely exist, and are characterized by “sudden insight.”

Of course, intuition can be terribly wrong. (Example. Ted Bundy)

# ***Scientific Method***

1. Propose hypotheses
2. Test them with data, by seeing whether the data agree with the implications of the hypotheses
3. Retain or revise hypotheses accordingly

# ***Goals of the Scientific Method***

## **Description**

Describe phenomena, carefully and objectively

## **Prediction**

Develop an ability to predict phenomena

## **Control**

Alter outcomes through knowledge

# ***Prediction vs. Explanation***

## **A Cup of Coffee After Class**

## Two Fundamental Types of Studies

$X \rightarrow Y$

X is the “independent variable”, Y the “dependent variable”

### **“Experimental” or “Manipulative”**

Manipulate X holding everything else constant, see if this causes a change in Y

### **“Observational” or “Non-Manipulative”**

Observe X and Y, seeing if there is a relationship between them

# **Anatomy of a Formal Experiment**

*Hypothesis Formulation*

*Operational Definitions*

*Experimental Design*

*Pilot Study*

*Data Gathering*

*Descriptive Statistical Analysis*

*Inferential Statistical Analysis*

*Conclusion*

## ***Some Basic Terminology***

***E = Experimenter***

***S = Subject***

# ***Controversies Over Terminology***

***“Subjects” vs. “Participants”***

***Example. X=Marijuana Usage Y=Intelligence***

The experimental hypothesis. “Marijuana usage affects intelligence negatively.”

## ***Operationalization***

Refine X and Y concepts so that they are measured in a well defined way via *operational definitions*.

Operationalization involves a tradeoff between generality and clarity.

*“Intelligence” → Score on an IQ test*

*“Marijuana Usage” → Consumption, in the lab of a standardized dose of active ingredient.*

## ***The Pilot Study***

**A “practice experiment”**

**E discovers the things that “go wrong”**

Bad lighting

Ambiguous instructions

Strange noises that distract the subjects

**E refines**

## ***Procedures and Paradigms***

***Paradigm -> A General Approach to Studying a Topic***

## ***“Paradigmatic Tunnel Vision”***

**A “good” paradigm becomes popular**

(Any paradigm involves a loss of generality)

**The good paradigm comes to dominate a field of study**

**The field of study becomes restricted to a specific “domain of content”**

## ***Key aspects of measurement –Reliability and Validity.***

### **Reliability**

Does the measure remain consistent if the quantity being measured remains consistent?

### **Validity**

Does the measure evaluate what it is supposed to?

# ***A Simple Experimental Design – Two Group Experimental-Control Design***

## **Experimental Group**

Gets marijuana

## **Control Group**

Does not get marijuana

If the experimental and control group are identical in every way *except the manipulation of X*, then if there is a difference on *Y*, we can attribute it to *X*.

# ***Threats to Validity***

**Self-Selection**

**Subject Expectancy Effects**

**Experimenter Effects**

**Order Effects**

**History**

**The File-Drawer Effect**

## Self-Selection

If we allow subjects to select which group they are in, we run a serious risk of having an Experimental and Control group that are not equal.

## Subject Expectancy Effects

If subjects know which group they are in, part of the observed difference between Experimental and Control groups may be due to *expectancies* about the treatment, i.e., in this case, marijuana.

Potential solution. *Single-blind or placebo control.*

## Experimenter Effects

If the Experimenter knows which group he/she is interacting with, then subtle differences in behavior may affect the two groups differently.

Solution. *Double Blind control.*

**Single blind.** Subjects do not know which group they are in.

**Double blind.** Neither subjects nor experimenter know which group a subject is in.

## Order Effects

Which order the treatments are administered in can be important.

In some experiments, the subjects serve as their own controls. In this case, it can be especially important to counterbalance for order.

*Example.* Studying performance on an IQ test with and without caffeine.

Time 1. Subjects take IQ test without caffeine.

Time 2. Same subjects take same IQ test with caffeine.

## History

Sometimes “things happen” outside an experiment that affect the way subjects respond.

Example. You are studying the affect of a persuasive message on people’s attitude toward President Bush. The design:

Measure Attitude → Present Message → Measure Again

Suppose that the message was presented on 09/10/01 and the followup measure was taken on 09/14/01!

## The File-Drawer Effect

Failure to understand this effect is the source of many false inferences in the behavioral sciences and elsewhere. Many studies that fail to find effects are never submitted for publication, and are never seen. We have no way of knowing how many such studies there are. So the studies we actually see may *not* be representative of the true state of the world, *even though statistical controls are supposed to keep “false positives” from being published.*

# ***An Example of the File Drawer Effect in Action***

## **The Stock-Letter Scam**

July 1, 2002.

You receive a letter from an Investment Counselor, 4-Star Investments, offering you a special rate of \$495 a year to subscribe to their investment service. The letter contains advice to buy 5 stocks. Being very disorganized, you fail to throw the letter away, and it ends up getting buried on your desk.

July 1, 2003.

You receive a second letter from 4-Star Investments. It points out to you that all 5 of the stocks have increased in value in the last year. It points out that *if* you had bought 1000 shares of each of these 5 stocks, for a total investment of \$160,000 on July 1, 2002, this portfolio would now be worth \$414,000, and you would have profited \$254,000 in one year! While rummaging around on your desk, you find the original letter. Checking out the facts online, you find that, indeed, you *would* have profited \$254,000 had you bought these stocks last year!!!

What do you do next??

(C.P.)

## ***Data Gathering***

### ***Descriptive Statistical Analysis***

**What's there?**

**What are the major trends?**

### ***Inferential Statistical Analysis***

**Is it real?**

**Or is it due to luck?**

## ***Conclusion***

Hypothesis is retained or revised. It is never proven true!

## ***A Key Point***

The outcome of an experiment is often two or more lists of numbers.

Deciding “what happened” involves looking at these lists and analyzing them with descriptive and inferential techniques. We’re going to learn a lot about such techniques.

**Remember – garbage in, garbage out.** If the experimental design is bad, it may be that no amount of fancy data analysis can rescue the experiment.