

# Epistemology and the Philosophy of Science

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## Epistemology

A branch of philosophy concerned with the  
nature and acquisition of knowledge

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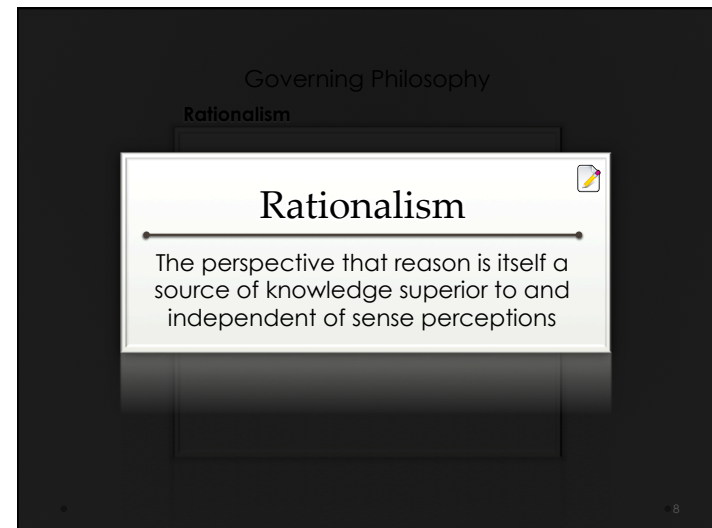
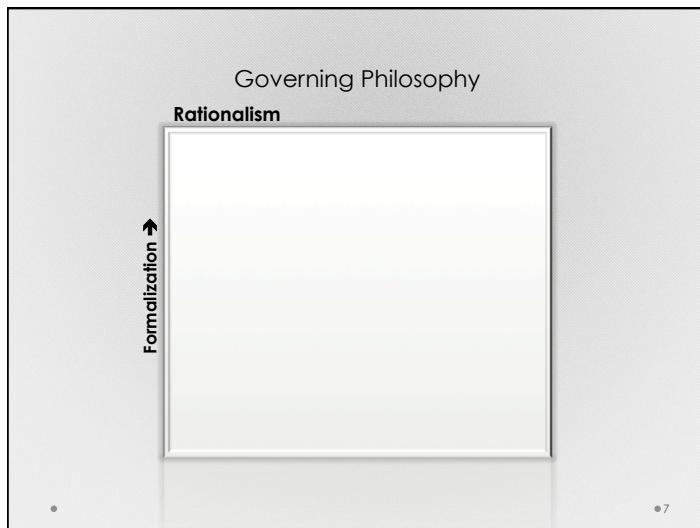
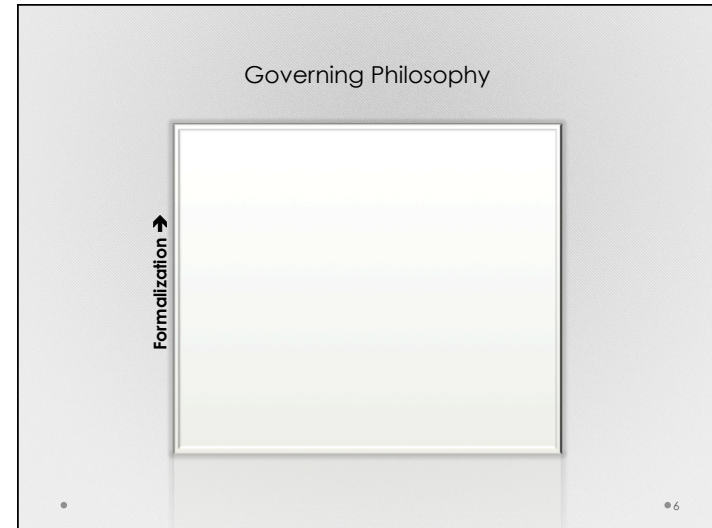
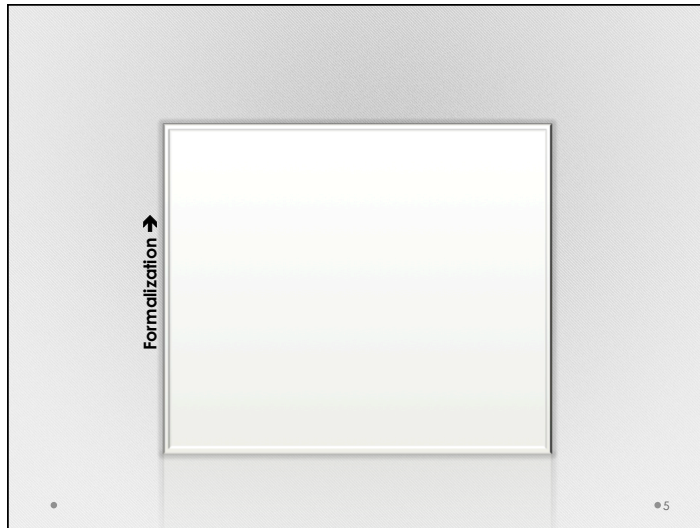
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Governing Philosophy

Rationalism

## Rationalism

The perspective that reason is itself a source of knowledge superior to and independent of sense perceptions

9

Governing Philosophy

Rationalism

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10

Governing Philosophy

Rationalism

Formalization →

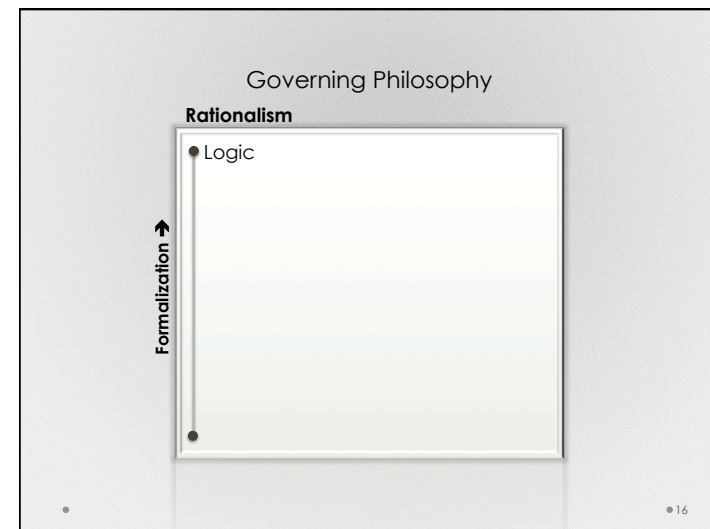
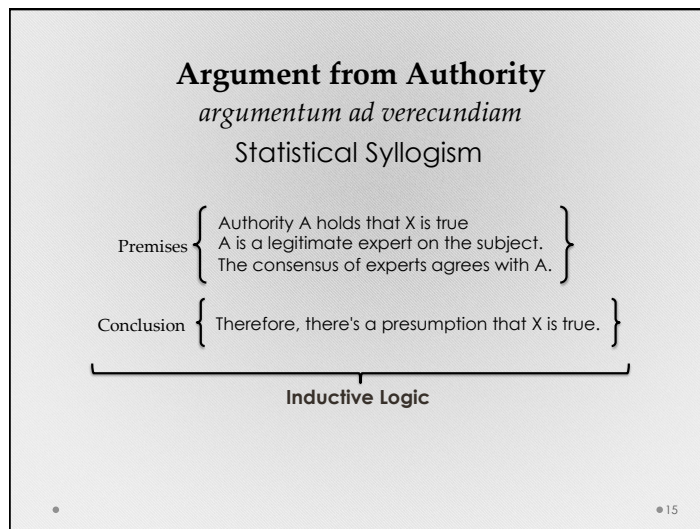
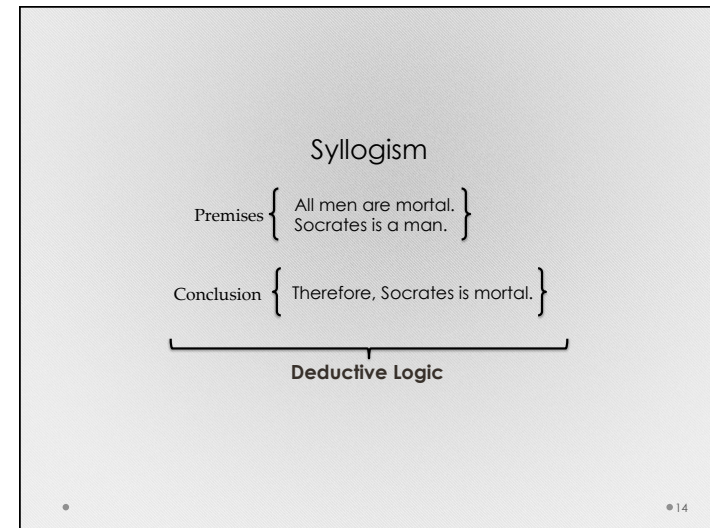
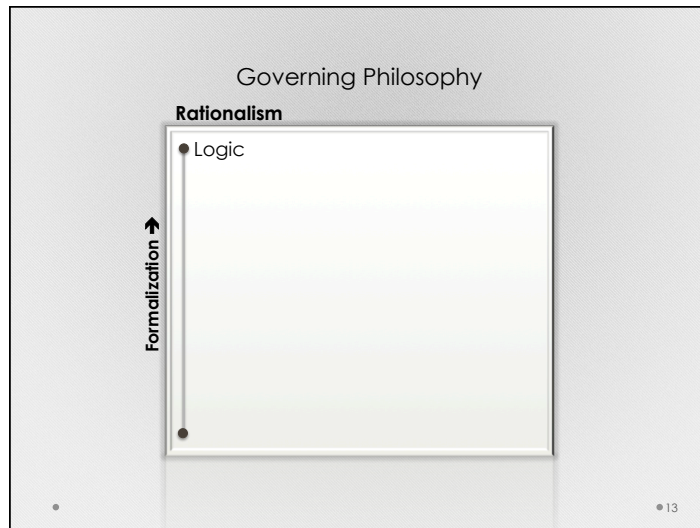
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Governing Philosophy

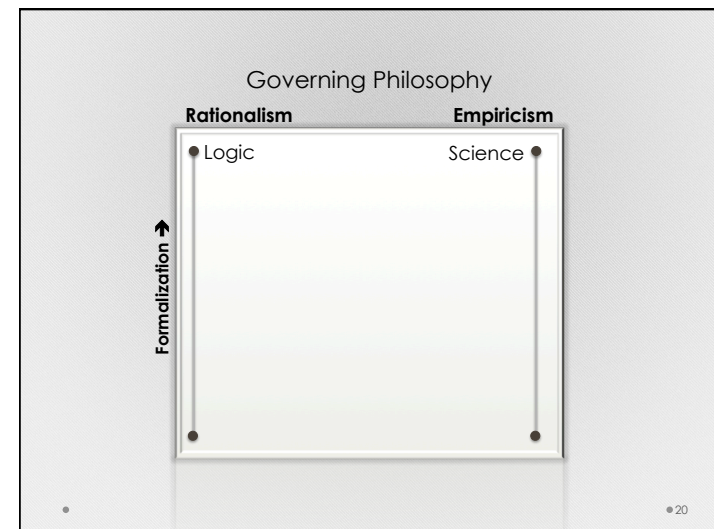
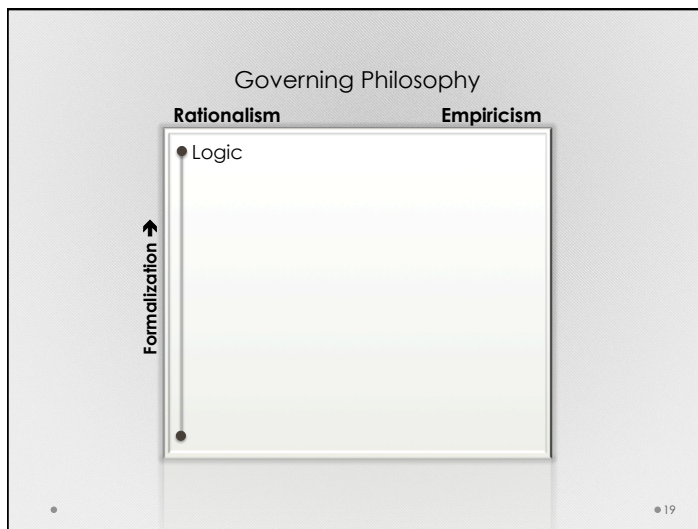
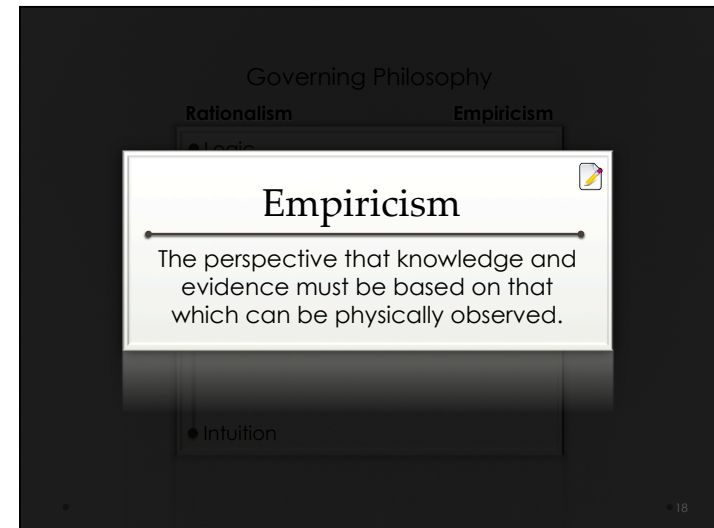
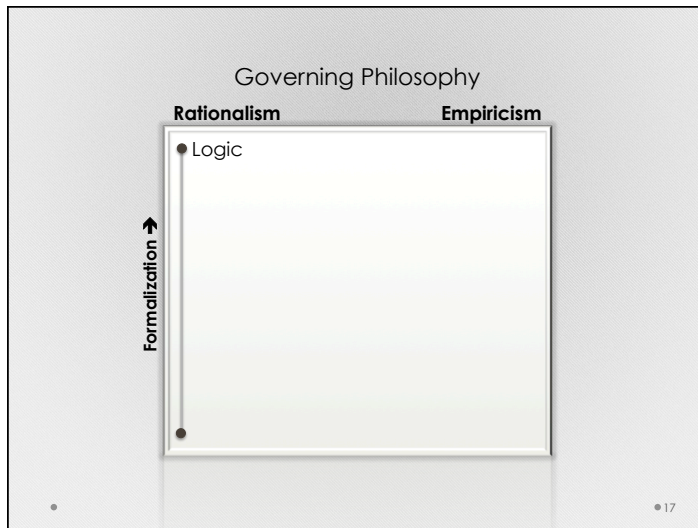
Rationalism

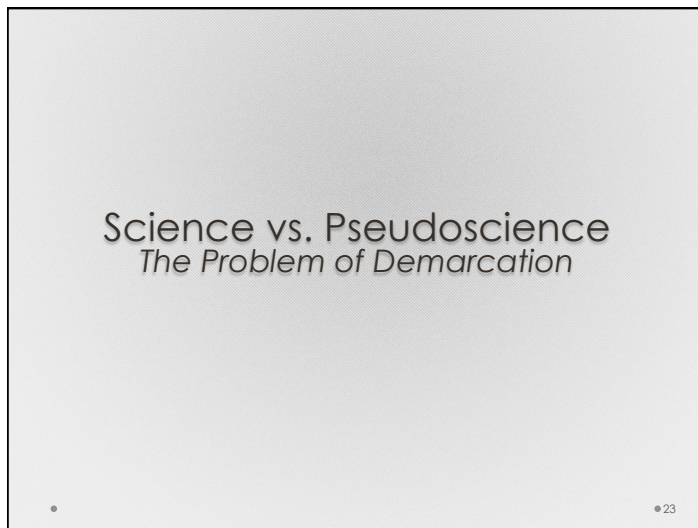
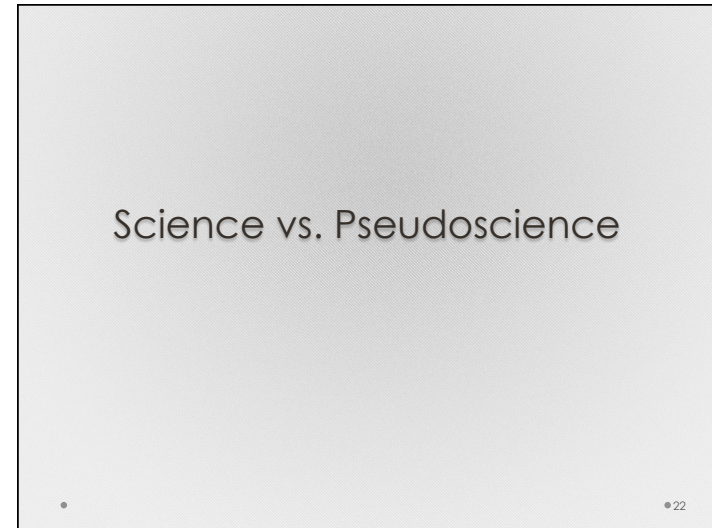
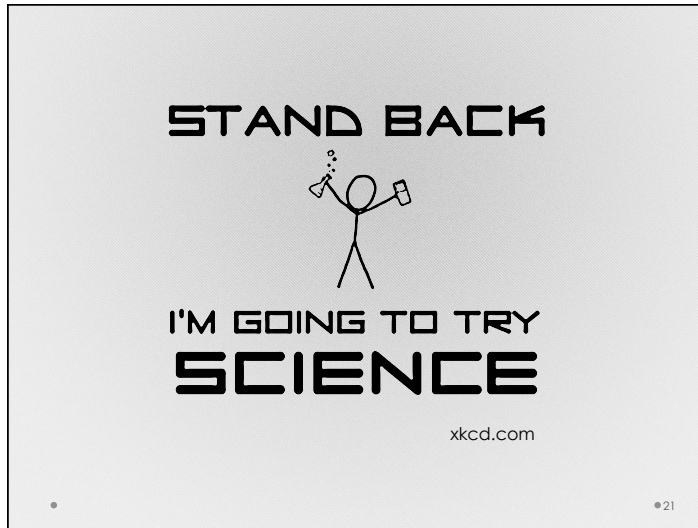
Formalization →

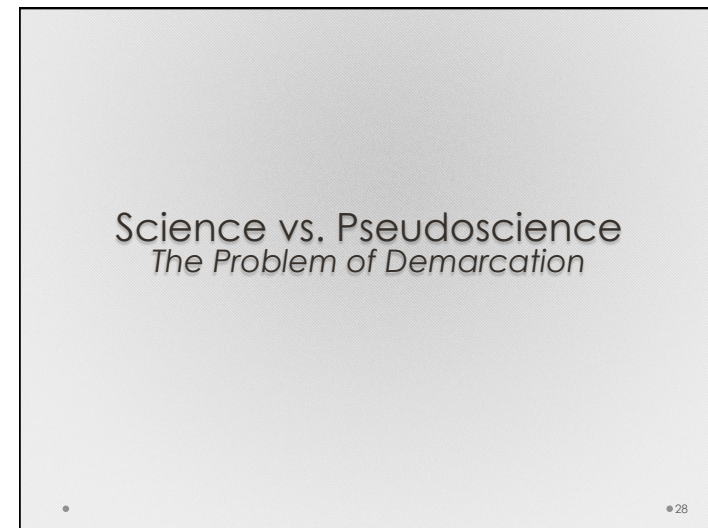
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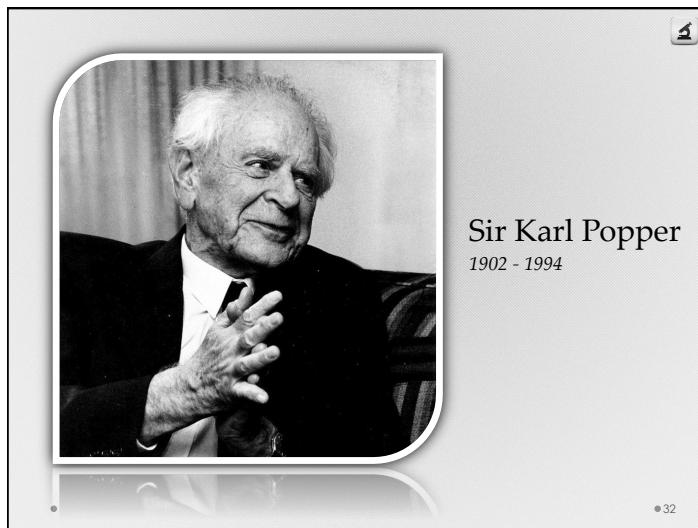
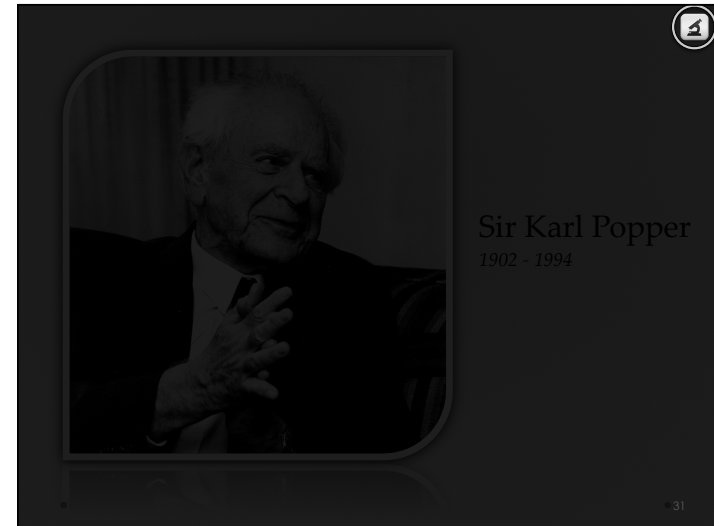
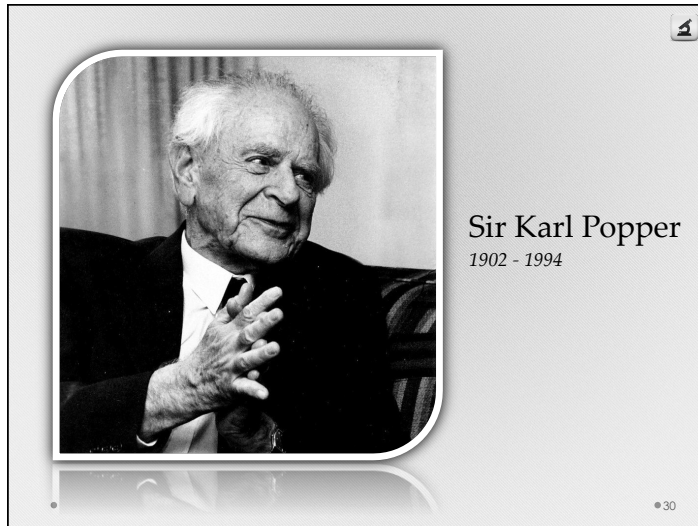












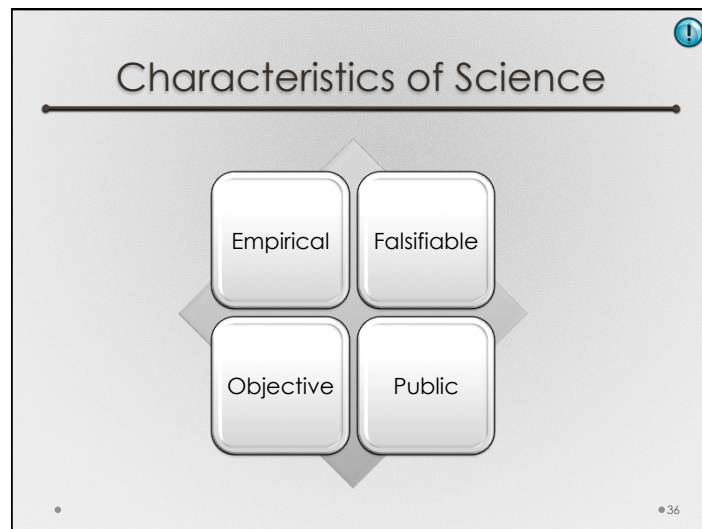
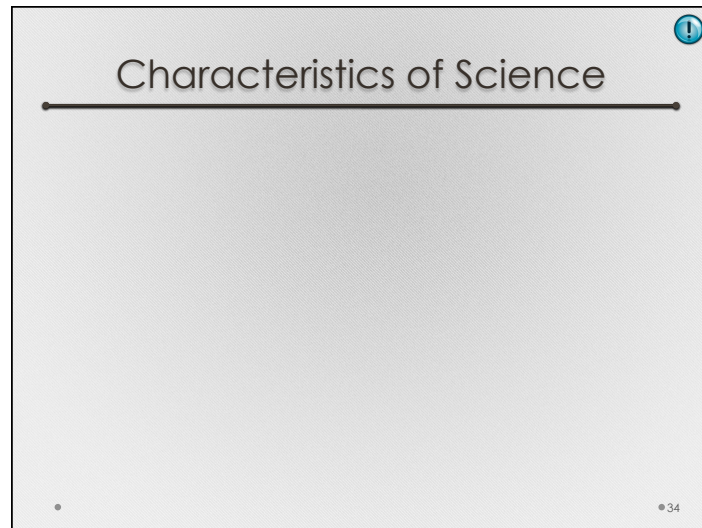
## The Criterion of Falsifiability

The perspective that for a hypothesis, theory, or enterprise to be regarded as scientific, it must be falsifiable (refutable) on the basis of some physical observation

- A necessary but not sufficient criterion of scientific knowledge

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## The Scientific Method

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Sir Francis Bacon  
1561 - 1626

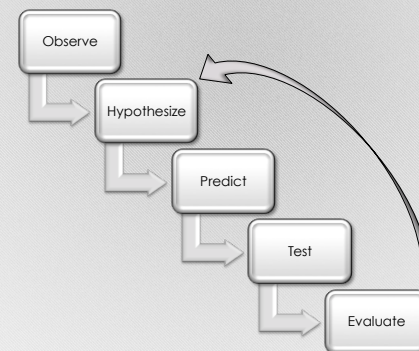
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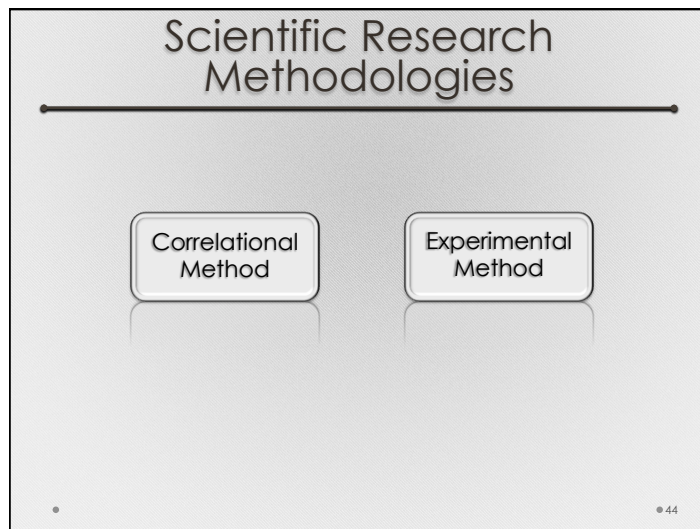
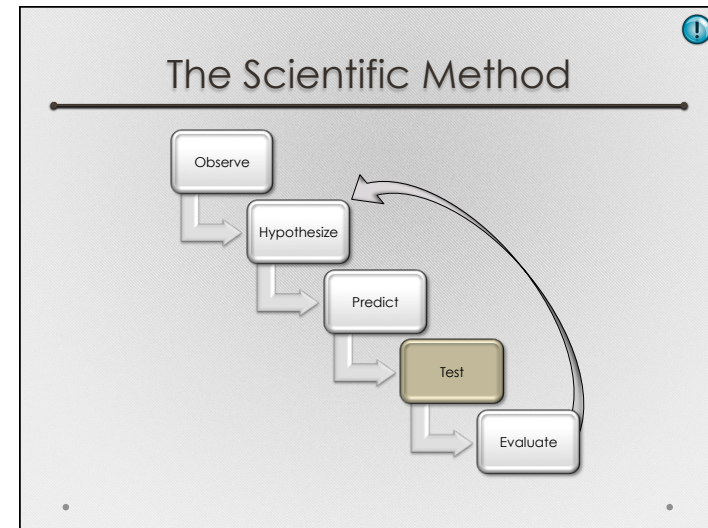
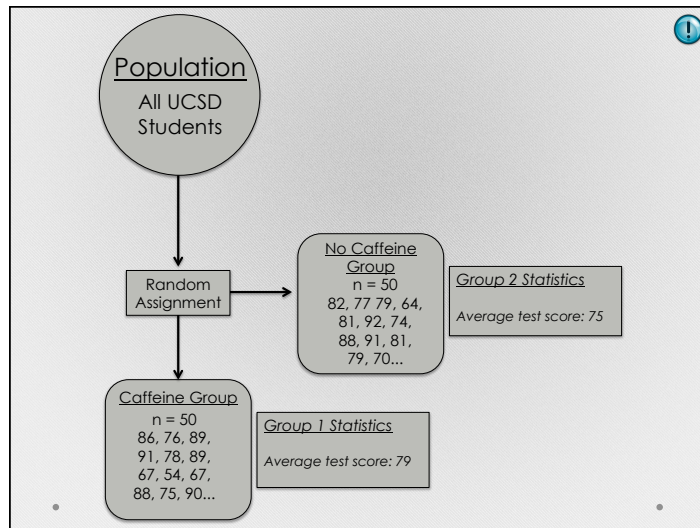
Novum Organum Scientiarum  
(new instrument of science)  
Published 1620



• 40

## The Scientific Method

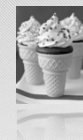
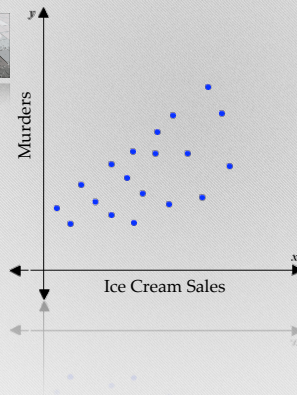
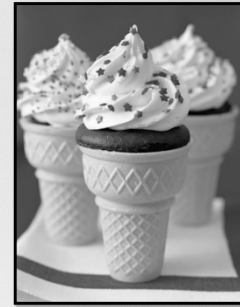






## Correlational Method

Observing two or more variables as they occur naturally to determine if there is a *relationship* between them

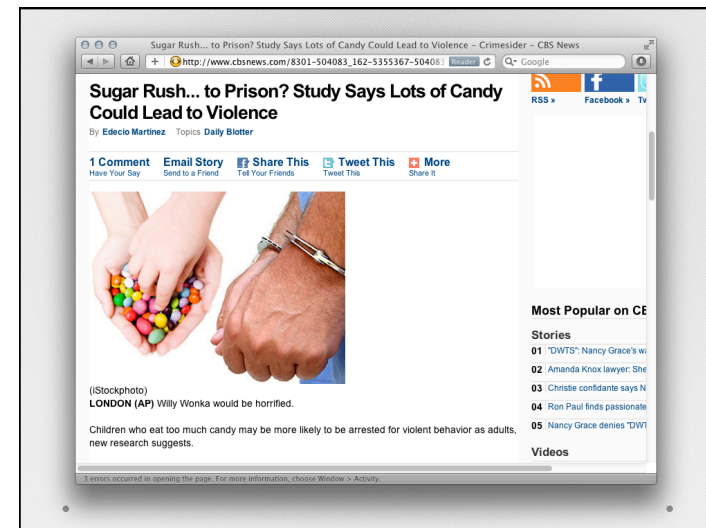




## Spurious Correlation

When an observed mathematical relationship between two variables is due to some unseen, unmeasured or unknown third variable

- Sometimes referred to as a confounding



**Does chocolate make you clever?**  
By Charlotte Pritchard  
BBC News

Eating more chocolate improves a nation's chances of producing Nobel Prize winners - or at least that's what a recent study appears to suggest. But how much chocolate do Nobel laureates eat, and how could any such link be explained?

The study's author, Franz Messert of Columbia University, started wondering about the power of chocolate after reading that cocoa was good for you.

One paper suggested regular cocoa intake led to improved mental function in elderly patients with mild cognitive impairment, a condition which is often a precursor to dementia, he recalls.

"There is data in rats showing that they live longer and have better cognitive function when they eat chocolate, and even in snails you can show that the snail memory is actually improved," he says.

So Messert took the number of Nobel Prize winners in a country as an indicator of general national intelligence and compared that with the

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Decades of Basile abuse revealed  
France confirms Mali intervention  
Dreamliner plane review ordered

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**in today's Magazine**  
The revival of an ancient whistling language  
Can you still go from burger flipper to president?  
Quiz of the week's news  
US Iranians send drugs to avert crisis

**Features & Analysis**  
Health woes  
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Who has such a snailly signature?  
Call the cops  
Did 'Gangster' Sigal rescure the club movie?

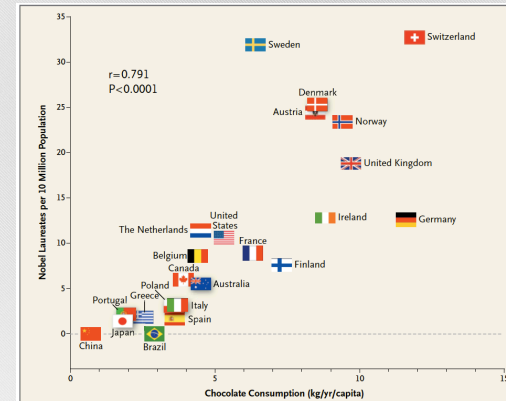


Figure 1. Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.

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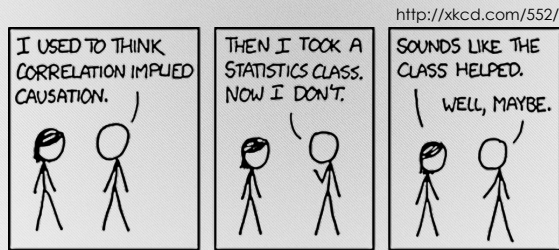
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## Causality and the Correlational Method

"Cum hoc ergo propter hoc"

"Correlation does not *imply* causation"

## Causality and the Correlational Method



Correlation doesn't imply causation, but it does waggle its eyebrows suggestively and gesture furtively while mouthing "look over there"

## Scientific Research Methodologies

Correlational Method

Experimental Method

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Correlational Method

Experimental Method

## Characteristics of a True Experiment



## Characteristics of a True Experiment

- Manipulation: the experimenter has manipulated some *independent variable* to see the effect it has on the *dependent variable*

## "Variable"

a characteristic or condition that changes or has different values for different individuals

- e.g. Age, Gender, Height, Facebook user or not, exam score

## Independent Variable

In an experiment, the independent variable (IV) is what is manipulated or changed by the experimenter

- "Levels" of the IV refers to the different types of *treatments or conditions* (e.g. *caffeine or no caffeine before an exam*)

## Dependent Variable

In an experiment, the dependent variable (DV) is what is measured



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John Stuart Mill  
1808 - 1873

## A System of Logic

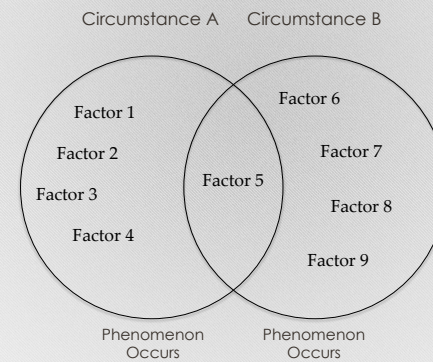
Canons of Experimental Inquiry

John Stuart Mill

### Direct method of agreement

"If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree, is the cause (or effect) of the given phenomenon."

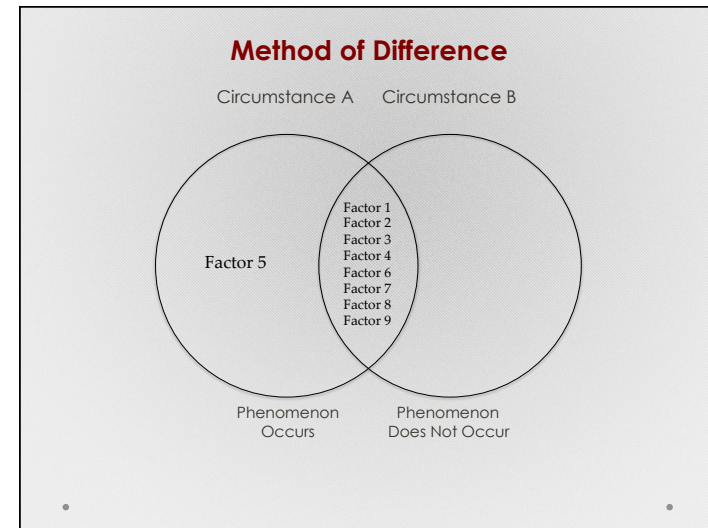
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A System of Logic  
Canons of Experimental Inquiry John Stuart Mill

**Direct method of agreement**  
"If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree, is the cause (or effect) of the given phenomenon."

**Method of difference**  
"If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former; the circumstance in which alone the two instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon."

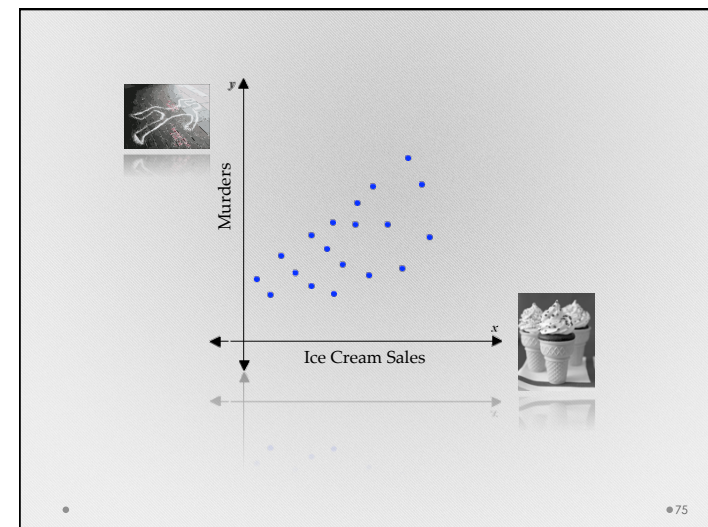


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**Method of concomitant variations**  
"Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation"



A System of Logic  
Canons of Experimental Inquiry John Stuart Mill

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## Extraneous Variable

Variables that have some relationship to the dependent variable but are not of direct interest in the experiment



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  - Random Assignment: chance alone dictates what treatment each individual receives

## Random Assignment

The process of assigning treatments (levels of the IV) to subjects so that only chance is responsible for which treatment each subject receives

- Ensures that there are no *systematic* differences across groups before treatment (groups will only differ due to chance)

## Characteristics of a True Experiment

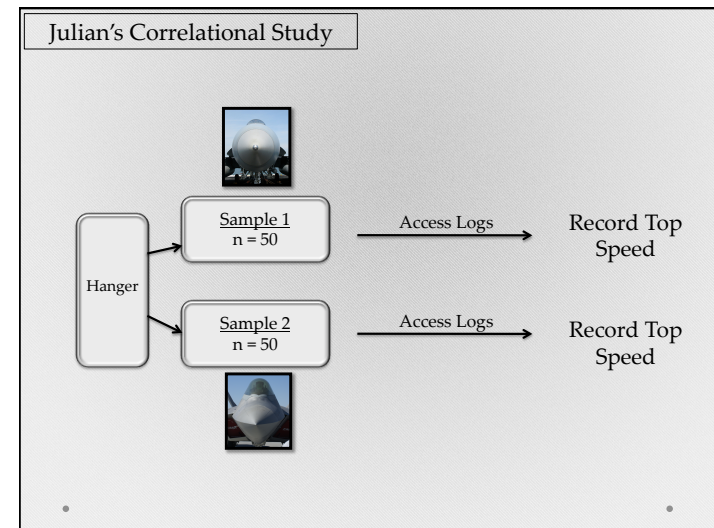
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## Characteristics of a True Experiment

Can Provide Evidence of Causality







= 1,327 miles/hour

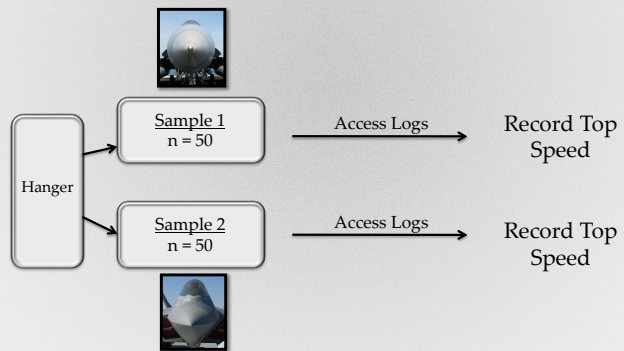


= 1,683 miles/hour

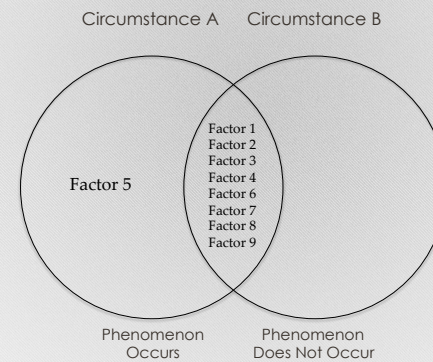
## Confounding Variable

An extraneous variable that correlates with both the dependent variable and the independent variable.

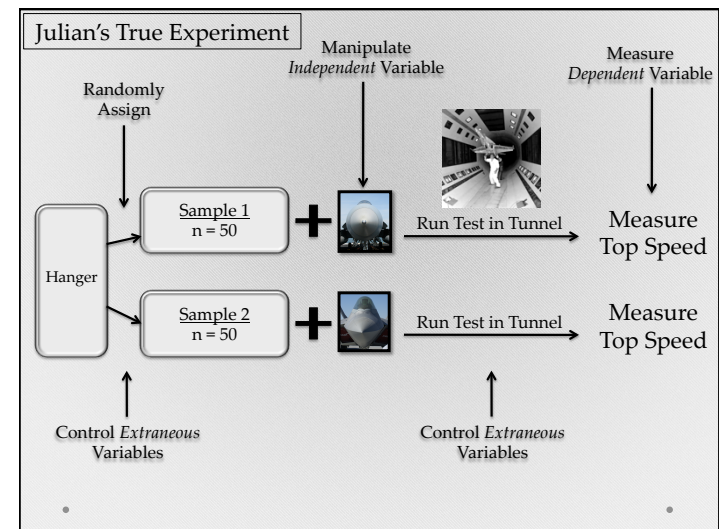
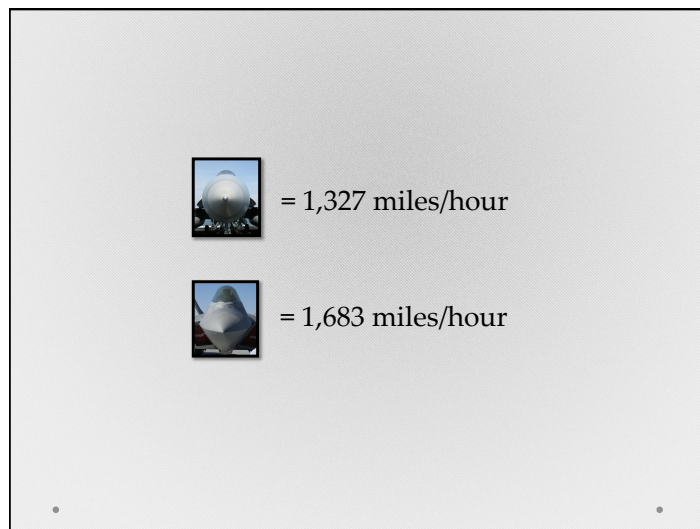
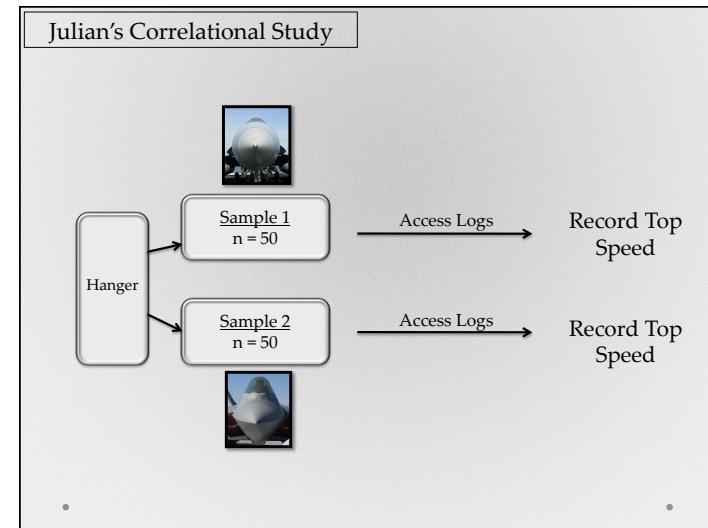
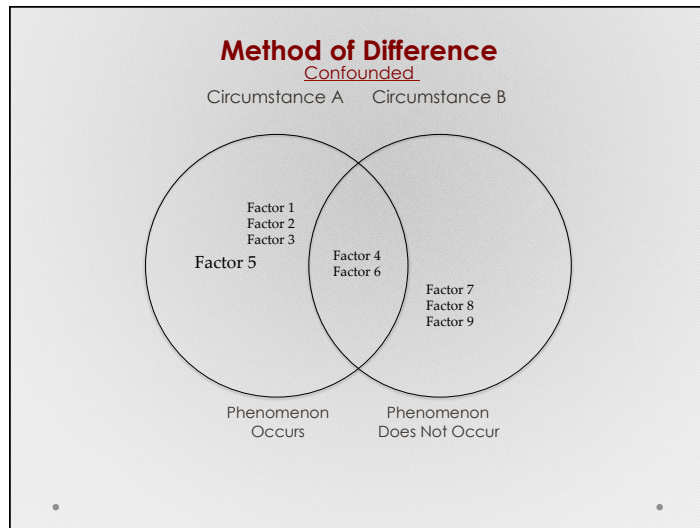
### Julian's Correlational Study



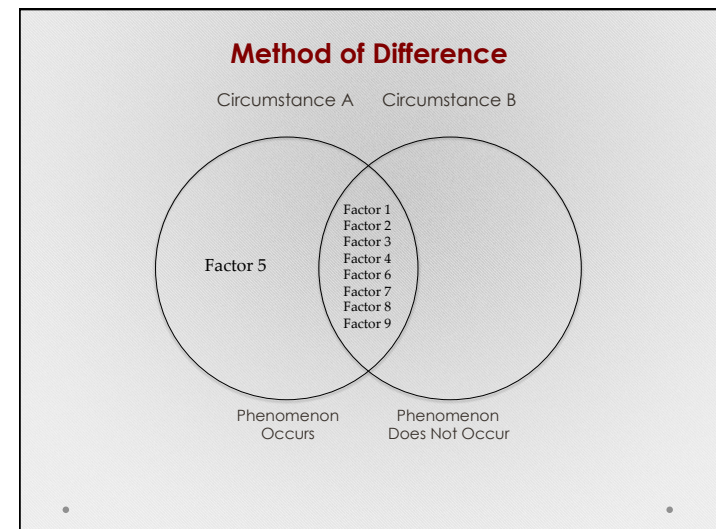
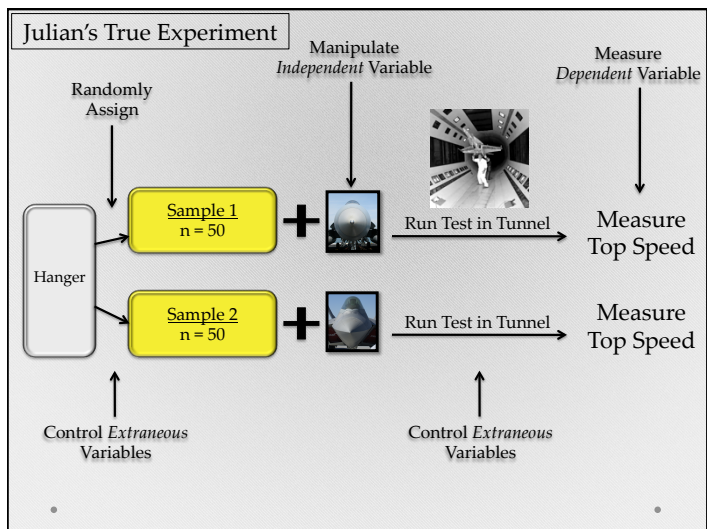
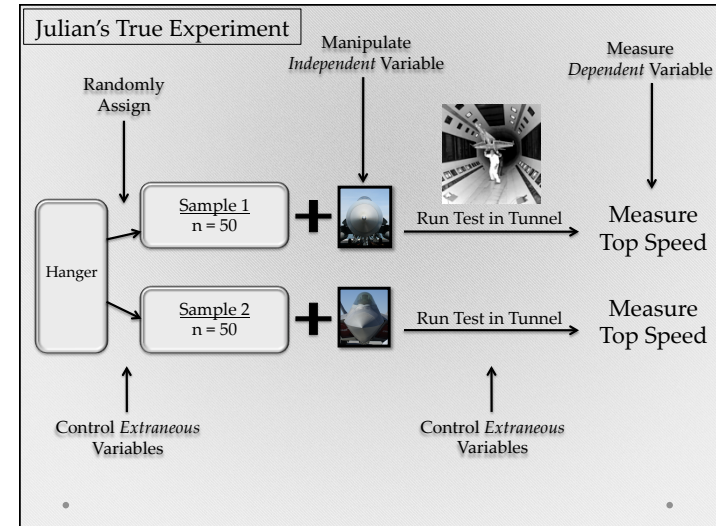
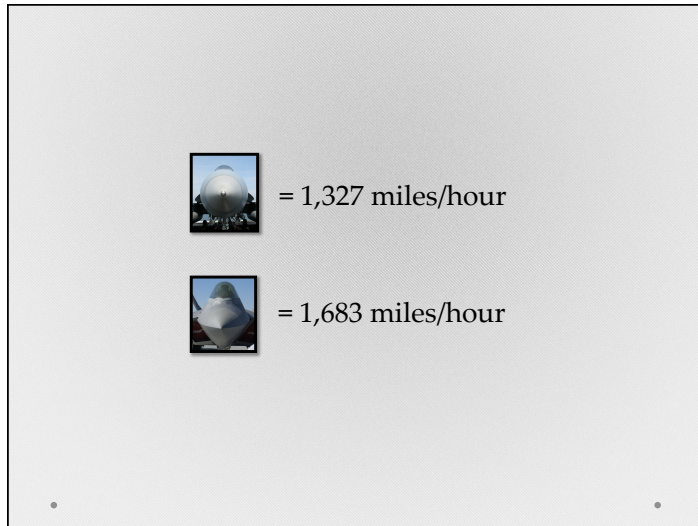
### Method of Difference

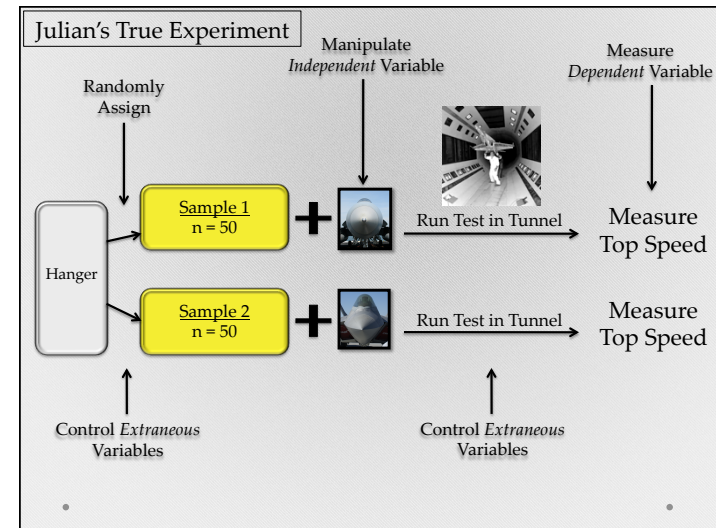
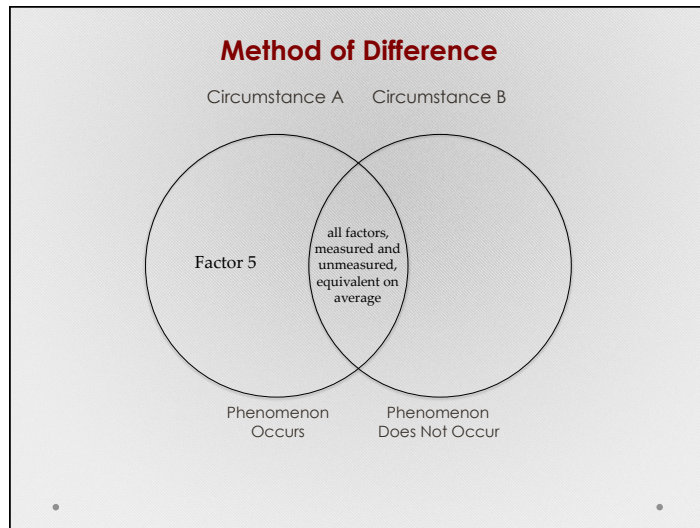












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