The Oldest Question:

Why do we behave as we do?
There are three major categories of attempts to answer such questions

- **Literary**: What is it?
- **Correlational**: What relates to what?
- **Analytic**: What causes what?
Great Literature does two things:

Entertains

And

Educates
Greek Tragedies
Who was responsible for the outcomes that befell the actors?
The Gods
Shakespearian Plays
What causes the outcomes here?
Internal Factors such as Flaws in Character
Contemporary Literature
Note Freud’s Contribution
Literature provides a description of the invented wisdom regarding behavior by which the culture was (is) managed.
Tribal elders
Philosophers
Religious leaders
What happens if someone discovers something that challenges the invented wisdom?

The keepers of the invented wisdom denounce the discoverer.

Examples:
Darwin
Semmelweis
Skinner
Who denounced Skinner?

Why?
Social Scientists...Today’s keepers of the invented wisdom.

How did this happen?
Correlation

What goes with what?

Required measurement
A Short History of Measurement in the Social Sciences
MEASUREMENT

The act of assigning numbers and UNITS to objects or events
Units of measurement in the natural sciences are

**Standard** – Everyone agrees that the unit represents the dimension; e.g., cm. for length

**Absolute** – The unit remains constant from one occasion to the next

**Universal** – The unit applies to all instances of the dimension

  e.g., the mass of any object can be expressed in grams
What about measurement in the social sciences?
A LITTLE HISTORY
Descriptive Measurement

- Descriptive measurement dates back to biblical times- King David counted his people, sheep, etc.
- Doomsday Book in England (1086). Listed landowners and their serfs and property.
- Birth and mortality records began in the 14th century.
In the 17th century, descriptive data began to be used for predictive purposes. In 1693, Halley published "An Estimate of the Degrees of Mortality of Mankind, drawn from the Curious Tables of the Births and Funerals at the city of Breslaw; with an attempt to ascertain the Price of Annuities upon Lives."

Thus was the insurance industry born and nurtured by developments in
Mathematical Statistics

- Began with the mathematics of probability applied to gambling. Pascal and Fermat around 1650.
- De Moivre developed a close approximation to the “normal law of error” in 1738 based on Pascal’s triangle.
- The non-finite mathematics of the normal law of error was worked out by Gauss and Laplace (1778), thus connecting it to Newton’s calculus.
- By 1806, “error” was being used to calculate best estimates of a physical event from a set of measures exhibiting variability.
Carl Friedrich Gauss
1777-1855
THE NORMAL CURVE
Gauss was trained as a mathematician.

He branched into physics and astronomy.

He used the method of least squares to find the best estimate among a series of astronomical observations. From this came the
Normal law of

ERROR
That set the table for....
Adolphe Quetelet

- Belgian trained as an astronomer and mathematician.
- Applied the normal law of error to all sorts of physical and social measures.
- Invented the concept of the *average man*
- Published *Sur l'homme et le développement de ses facultés, essai d'une physique sociale* in 1835.
Quetelet used variability to infer the values of natural ideals: height, weight, etc.

He also used it to estimate traits or attributes; e.g., drunkenness is revealed by frequency of being drunk.
Gustav Fechner (1801 – 1887)

Fechner defined the J.N.D. (basic unit of sensation) as the difference a subject could detect 50% of the time. Thus, he used errors in the subject’s judgment as the basis for scaling the underlying process.

Thus was born the discipline of psychophysics from whence came experimental psychology.
Quetelet also influenced

Francis Galton (1822-1911)

Cousin of Charles Darwin, Galton believed that mental abilities obeyed the Normal Law of Error.

Mapped areas under the normal curve onto a 14 unit equal interval scale which he claimed measured intelligence.

Binet (1857-1911) and Cattel (1860-1944) developed tests to measure this characteristic.
I need hardly remind the reader that the Law of Error, upon which these normal values are based, was excogitated for the use of astronomers and others who are concerned with extreme accuracy of measurement, and without the slightest idea until the time of Quetelet that they might be applicable to human measures. But Errors, Differences, Deviations, Divergencies, Dispersions, and Individual Variations. All spring from the same kind of causes...
All persons conversant with statistics are aware that this supposition brings Variability within the grasp of the laws of Chance, with the result that the relative frequency of Deviations of different amounts admits of being calculated, when these amounts are measured in terms of any self contained unit of variability. (italics mine)

Natural Inheritance, 1889. pp.54-55
The term *Vaganotic* was coined to characterize units of this type of measurement as well as the phenomena presumed to be measured by them.

Thus, IQ’s are units on a vaganotic scale used to measure the vaganotic phenomenon of intelligence.
Clearly, units thus created do not meet the standards of standard, absolute and universal that are characteristic of units in the natural sciences. Such units are said to be idemnotic.
Karl Pearson (1857-1936)

Pearson worked out the mathematics of correlation which allowed people to use Galton’s measures to predict the results of other similar measurements.

This is particularly helpful in establishing reliability and validity as those terms are used in psychology.

Thus was born educational and psychological measurement as we know it.
Individual Differences

The focus of this work was the study of individual differences, essential to any quantitative approach to the study of evolution.*

* Recall, Galton was Darwin’s cousin
The subject of individual differences was also studied about this time by another individual with a very different approach. His name was
Gregor Mendel (1822-1884)
$SSYY \times ssyy$

$Y = \text{yellow seed}$
$y = \text{green seed}$
$S = \text{round shape}$
$s = \text{wrinkly shape}$

$\rightarrow F_2$

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The diagram shows the possible genotypes and phenotypes of the $F_2$ generation for the traits of seed color and shape.
Rather than use variability to describe the phenomenon, he analysed its causes by controlling the critical variables (parental characteristics) and observing the outcomes.

This leads us to the third approach to understanding behavior:
The Analytical Approach

Seeks the **causes** of behavior through experimental analysis
Objective is to discover laws of behavior of the general form

\[ Y = f(X) \]

This is called a functional relation, sometimes read as “Y is caused by X”
\[ B = f \text{ (environment, organism, history, genetics)} \]
Strategies

1. Continuous, direct measurement
Tactics

1. Use standard, absolute, and universal units like frequency, latency, and duration.
2. Use mechanical, electronic or automatic recording devices if possible
3. Calibrate human observers
4. Avoid indirect measures such as reports
Skinner developed a means of observing frequency continuously through time.

Cumulative recorder

Cumulative records
Skinner taught us that good behavioral measurement is:

**Continuous** — Uninterrupted through time, just as behavior is

**Direct** — Record what the individual actually does

**Complete** — Get it all; avoid sampling if possible
Strategy

2. Study behavior at the single organism level, one at a time.
WATCH WHAT I CAN MAKE PAVLOV DO. AS SOON AS I DROOL, HE'LL SMILE AND WRITE IN HIS LITTLE BOOK.
Strategy

3. Gain experimental control over relevant independent variables.
Tactics

1. Hold variables constant.
2. Eliminate variables.
3. Add or remove variables, one at a time
Strategy

4. Search for and establish functional relations of the form

\[ B = f (\text{environment, organism, history, genetics}) \]

Note: Behavior is the dependent variable. We control the independent variable, not the dependent variable. Thus, we do not control behavior.
Strategy

Establish reliability and generality of a functional relation by meeting standards of **reproducibility**, not by demonstrating statistical significance.

Beware the ecological fallacy: One cannot reason from the group to the individual.
Tactics

Direct replication:
Establishes reliability

Systematic replication
Establishes generality
Behavior analysis is a natural science built on demonstrated functional relations.

Psychology is an actuarial science built on a collection of statistical inferences.
Strategy

Reject hypothetical entities as explanations of behavior
Tactics

Look for real variables controlling the effect.

Example: Why does cat come running when the can opener sounds?

Example: Yoked VI VR experiment
<table>
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<tr>
<th>Chimp A</th>
<th>Food on a VR schedule</th>
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<tbody>
<tr>
<td>Chimp B</td>
<td>Food on a VI schedule (set up by chimp A)</td>
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RESULTS

Chimp A’s frequency was 5 times that of Chimp B.
Both getting their reinforcers at about the same time.
How do we explain this? B is lazy? A is industrious? A is more motivated?
Switch the conditions. Now B is setting up the reinforcers for A.

What happens?

The frequencies reverse!
What is the responsible variable?

The **contingencies** of reinforcement.
Strategy

Theorize by induction, not deduction.
Example: Selectionism

Natural selection of species morphology as the basis of survival: Darwin

Environmental selection of behavior by contingencies of reinforcement: Skinner

Selection of cultural practices via cost benefit: Harris
Unifying Concept

The environment interacts with living forms by selection, not coercion.

The experimental science which yields this principle also makes it possible for us to pursue our mission...
The mission of the Cambridge Center is to advance the scientific study of behavior and its humane application to the solution of practical problems, including the prevention and relief of human suffering.
Thank you

I can be reached at pennypak@ufl.edu
Or Through www.behavior.org