- *Science: Observational, Experimental, Historical*
- **Raymond Siever**
- **American Scientist, Spring, 1968**
- **Link to paper**

Overview:
Siever presents his perspective on different "types" of "styles" of sciences. He concludes that there is only one science, which all strive to make generalizations about the topic of interest so that we may learn about the world and develop fundamental truths.

Major Take Aways:
- Different fields vary in their ability to make generalizations – this typically draws from the variability of the typical data within that field (i.e. physics has low variation, typically, while social science has high variability)
- Experiments are the best form of science but natural experiments are not quite the same
- "Styles" (a scientists approach to science) should not be confused with one's ability to properly conduct and progress science.

Intro:
Siever opens by proposing the questions, "*Are there different sciences is there just one science?*" and, "*Is there a scientific method, or are there many scientific methods?*" This paper

Observational vs. Experimental:
Many words are used to describe different cultures of science…

TABLE 1
WORDS THAT HAVE BEEN USED IN CHARACTERIZING DIFFERENCES AMONG THE SCIENCES

Analytical	Descriptive
Experimental	Observational
Soft	Hard
Non-mathematical	Mathematical
Good	Bad
Interesting	Dull
"Stamp collecting"	Crucial experimentation
Classical	Modern
The general equation	The encyclopaedic monograph
Rigorous	Inexact
Easy	Difficult
Exploding	Mined-out

Building on some of these terms he says…

- All sciences observe and describe
- Scientists who are involved in descriptive work tend to:
    - Do so with intent, and typically follow that description with some type of analysis
- Typically, description for descriptions sake is not considered science
    - However, many people focusing on description typically intend to do so for a temporary period in preparation for analysis

He also points out that one of the goals is to make generalized law from specific observations. Importantly, he points out that the **ability** to generalize is not equal across disciplines/subfields.

- Physics tends to generalize much easier than social sciences, for example.
    - Observations in physics return very low data variation, while social sciences return much higher variation within data.

<u>Experiments and Science</u>:

- Experiments are the most powerful tools of science
- Types of Experiments:
    - Controlled vs. uncontrolled
    - Natural vs. artificial
- Restrictions:
    - Natural Experiments:
        - The data is never perfect because the experiment is never truly controlled.
        - Perfectly controlled experiments are very hard to come by.
    - Artificial Experiments:
        - The physical size of many systems limit our ability to control them within a laboratory setting – astronomy, geology, social systems, etc.
- Simulated or "Hypothetical" Experiments:
    - Sometimes conducted in place of actual experiments when large-scale systems cannot be studied within the laboratory
    - He uses theoretical physics as an example of this but not sure exactly what he means/this looks like
    - He also says, "*But in most of the world of scientific practice, scientists use hypothetical experiments as a prelude to actual experimentation or further observation. One does not perform hypothetical experiments for their own sake.*"

General Takeaway:
Experimental science is various. The nature of the experiment is the same but the design and variables chosen will change – along with the scientists ability to control and observe parts of the experiment and subject of interest.

<u>Historical vs. Nonhistorical Sciences</u>:

The difference between historical sciences and non-historical sciences is that, very often in historical sciences, it is difficult or impossible to generalize results simply because of how the world unfolds.

- (Paraphrasing) "We don't care *when* the Grand Canyon was formed, we care *how*. Unfortunately, it's going to be a very long time until we see something like this again. The same can be said about the the oxygenation of Earth. This may only have ever happened once and, in order for it to happen again we need to witness it on another planet – or basically all be dead.

He also points out that worse than the unique experiment is a set of few experiments with high variance. For example, he highlights comparing the continents, the planets in our solar system, countries with atomic bombs, etc.

<u>Styles in Science</u>:

- Siever uses "style" to mean "the general approach in which the scientist approaches their work."
- He addresses that the word can have many meanings and thus provides examples of what he means…

> We can recognize and tag some of the more distinctive styles that are common to all fields. We recognize that some of these are cross-coupled and one may indulge in several styles at different periods or as the mood strikes:
>
> The rigorous formalist.
> The brilliant phenomenologist.
> The painstaking laboratory methodologist and his equivalent, the careful, detailed field observer.
> The quick and dirty cream skimmer.
> The niche-lover or horizontal monopolist.
> The sub-generalist or vertical monopolist.
> The dilletante and his brother, the versatile virtuoso, separated by the difference between success and failure.
> The older, wiser generalist.

He doesn't say much else about these styles other than the following points:

- People make their own value judgements about which style is best
- In reality, he thinks, that all of these styles are likely necessary for science to progress, generally, because everyone leans on everyone else.
- He worries that style will be confused with discipline and the fundamental ability for an individual to move science forward.

His final, interesting, sentence…

of the individual to make advances in science. Pluralism and diversity make for more interest in science as they do elsewhere in life. But let us have differences in style and subject and recognize that invidious distinctions between "kinds" of science serve only to build hierarchies of position and privilege.