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Follow the Science: Does Anyone Know Where We Are Going?

(Part 1 of 2)

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Key Points

Science is one method for approaching knowledge and understanding the world around us. It is not infallible.

The scientific method is increasingly being used to support policy positions and to garner funding. It is, therefore, important to understand how to evaluate good science from bad.

Science can be influenced by politics and human error. Every step of the scientific process has the potential to be swayed by individual and social ideologies.

Summary

In the 1980s, a strange song came out called "She Blinded Me with Science." While this isn't intended as an endorsement of the song, the title certainly is an appropriate cautionary statement for our times as we daily hear admonishments by government, universities, media, and others to simply "follow the science." Increasingly, the scientific method is being used to support policy positions and to garner funding. It is, therefore, important to understand how to evaluate good science from bad so that we are not blinded from seeing the reality lurking behind what has been mistakenly termed as "science."

The purpose of this two-part series is to offer a few tools to guide our consumption of research studies and to make clear when it is appropriate to follow the science, when we should proceed with caution, or when we should run in the other direction. This first part will define science, give a brief history of the scientific method, and highlight a few areas where errors or biases can

be introduced in the research process. The second part will delve into the components of a research study and how to assess the rigor of an investigation.

A Brief History of the Scientific Method

When defining "science," it is important to recognize that the word communicates much more than just a dictionary definition. There is also an implicit definition that tacitly endears a measure of reverence, and perhaps even mysticism, from our society. Although science should enjoy a degree of respect, it is important to remember that the scientific method is just one of many approaches to knowledge, and it is not infallible.

The scientific method originated around the time of the English Enlightenment period. The philosopher and statesman Sir Francis Bacon helped bring about a shift to the way we claim we *know* or understand something in our world or universe. He recognized that human beings are flawed in our ability to accurately perceive information, but that our senses are nonetheless the necessary vehicle for understanding the world around us. To account for this innate tendency, Bacon developed the basis of the scientific method we use today.

Bacon started by setting up experiments to test his research questions and account for the conditions that might influence the study results. Some of the principles he required of scientific study were:

1) the results should be **repeatedly and systematically observed** before it is considered a solid finding,
2) results should be **considered tentative** and must be **proven** (*i.e.*, we test the hypothesis to see if it is true).

In addition to these basic principles, the scientific method also includes:

3) holding the findings loosely and allowing for the results to be **refuted**, and
4) striving for **objectivity** *(e.g.*, keeping personal investment in the research outcome in check).[1]

By the mid-1600s, these basic tenants of the scientific method gained traction in organizations in Italy and France but without much influence in their respective cultures.[2] The Royal Society in England, however, formalized the scientific method and gained much influence in Europe. In fact, the rules set out for members in the Royal Society became the foundation used in most institutionalized research today. The Society was a place for mathematicians and scientists to share their work with other members, and they were all encouraged to publish their papers. There were also stylistic rules for engaging in the Royal Society and for publication. Personal language was to be omitted, which still holds true for most scientific papers (see part two), which are typically written in the third person. The emphasis on publications was viewed as part of the Society's duty to promote science and results, which is another thread that has been maintained throughout the history of institutionalized research (see the section on peer review).

Questions to ASK about a research study from this section:

1. Has the study result been repeated and confirmed in other investigations?
2. Does the scientific community communicate the research findings in a way that lets you know that the results are tentative and open to being refuted by other studies or future investigations?
3. Are the authors transparent with their data? Are they willing to let other researchers access and re-analyze their data?

Defining Science Today

The term "science" refers to a way of *knowing* something. Importantly, the scientific method is one of many ways we can know things. The main tool of the scientific approach outlined by Francis Bacon is *observation*. The subject of our observation is simply something we want to know about. It might be a physical or a psychological phenomenon, or it could be a specimen, a human, or an animal that is our source of inquiry. When we use the term "science," we say that we are engaged in our pursuit of knowledge by systematically observing a particular phenomenon with the set of aforementioned guiding

principles, from the start of our inquiry to the conclusion of our study. In other words, we have an approach to verifying or refuting our observation.[3]

There are certainly other ways of gaining *knowledge* besides the scientific method. For example, we can know something through our personal experiences, what an authority figure (*e.g.*, a medical professional) tells us, or through our social traditions. These are a few sources that can inform our thoughts about the nature of reality or what seems to be true. Like the scientific method, all these means of making observations and *knowing* something are subject to error and/or the possibility of making faulty conclusions. The scientific method differs from and has some advantages over these other approaches to knowledge because the observation has not been conducted haphazardly or casually. However, as we will soon see, the conclusions drawn from this method are also subject to error.

With this in mind, let's turn our attention to some of the ways science can lead us to faulty conclusions.

The Challenge of Observation

As Sir Francis Bacon recognized, our senses are the instrument of observation. If observation is fundamental to the scientific method, it is important to consider how our observation can produce errors in our research findings.

First, human beings are susceptible to missing information even when it is right in front of us. Have you ever seen the awareness test commercial (click here to view)?[4] This is a great example of how we can be focused on observing one thing and miss seeing the forest from the trees. In this illustration of observation error, the commercial depicts how a person can be busy counting the number of times the basketball was passed and miss the moonwalking bear moving right through the middle of the game. The phenomenon of missing relevant findings or data points can easily occur in a study when the researcher expects to see an outcome in a certain way and subsequently is blinded to other significant factors.

"I See My Car Everywhere"

Another error that can come to bear in research is the tendency to *overgeneralize* something we observe. Have you ever spent time researching a major purchase like a car? As you go about your daily commute, you might notice your car of interest suddenly seems to be everywhere on the road. You might be tempted to conclude that the drivers in your state have a strong preference for the car you're contemplating purchasing. As the days go on and you continue to see your favored make and model on the road, you might be further tempted to conclude that there are a disproportionate number of people with an affinity for your vehicle. To go a little further, let's say you just found out that your grown child was hired as a sales manager at a dealership selling this vehicle. You might be tempted again to think that the vehicle is reputable, and therefore you should make the purchase and recommend your friends buy one, too.

The problem with the aforementioned inclination is that it is subject to all kinds of observational errors. Namely, when we look for something, we are likely to find it. While contemplating a car purchase, we likely overestimated the popularity of the vehicle. Our observation was also subject to error because we were *selectively observing* or giving most of our attention to the vehicle we were interested in purchasing. At the same time, we disregarded the other cars on the road and *overgeneralized* the degree to which a pattern may or may not have existed. The final error came when our child's income was tied to the number of vehicles on the road. The new job gave us more reasons to endorse the credibility and popularity of this vehicle. In the end, the wrong conclusion was drawn about the popularity of this vehicle.

While this example is hyperbolic, these observation errors are not uncommon. They can affect what we decide to research, how we conduct the study, and ultimately how we interpret and summarize the findings from our inquiry. In this way, study results are always subject to the influences of the instrument, the observer. The question becomes one about how aware the researcher is of other factors that can influence a study and how much care the researcher used to minimize error throughout the entire scientific process.

Figure 1. *"My Wife and My Mother-In-Law"* [5]

Let's turn now to a few examples of how our individual differences can affect what we observe. If you've ever taken an introductory psychology course, you might recall the picture named "My Wife and My Mother-In-Law." If you are seeing this picture for the first time, you might notice either a young woman or an older woman, but you will most likely not see both characters depicted at your initial viewing. Some studies have shown that the person you readily see corresponds with the character in the picture that is most closely associated with your current age.[6] If you are a younger person, you might be more apt to see the young woman in the picture and vice versa. Regardless of the reason, some people see the older woman first while others readily see the younger woman. This example is another way to demonstrate that we don't all see the same way despite observing the same exact information.

In another example, recent studies using brain imaging technology (f-MRI) have indicated that our observation can be affected by the interplay between our biological disposition and socialization. That is, we may be unconsciously assessing and perceiving the degree of danger or safety in another person based on their physical characteristics. In studies from the field of social neuroscience, it seems that we are continuously collecting data from the world around us and then forming conclusions about what we observe without our conscious awareness. Those decisions are thought to be influenced by the facial features and personal characteristics a society agrees appear to be the most safe or trustworthy (*e.g.*, upward turned lip or large eyes).[7]

The greater point here is that there are biological and social mechanisms that influence what and how we observe, which, again, can lead us to the wrong conclusion about what we think we know. To Sir Francis Bacon's original deduction, humanity as the instrument of observation is subject to error.

Things to REMEMBER and questions to ASK about a research study from this section:

1. Observation is the primary tool of science and is subject to error based on our innate characteristics.
2. Think about what other factors could be influencing the outcome of this study that weren't mentioned.

Who Are the Observers (Researchers)?

Aside from these inherent factors that challenge observation, there are also motivations that can originate with the researcher that influence both what research studies are developed and how. Although it is not always possible to gather biographical information about a researcher, when possible, it can give you a clue about the motivation behind a study. This kind of information might be available on a university or company website. Understanding an individual's background or the mission of an organization can give you some sense of why the study was introduced. For example, perhaps you want to find out how effective an intervention is for a fear of flying before you let your family member attend the treatment. As you do a search on the effectiveness of this therapy, you notice that most of the studies were performed by a group of researcher-clinicians who created the treatment or have their primary training in the same method being tested. With good reason, you question why there are few independent studies, and the ones you found don't demonstrate the same effect as the studies from those with some sort of investment in the treatment.

That said, it is not uncommon for researchers to pursue areas of study where there is personal investment. After all, interest is often what drives people to pursue a given career or an area of study. This doesn't mean that everyone who cares about an issue will produce biased or bad research; however, it does require the consumer of research to be a thoughtful reader and to assess a body of research

(multiple studies) rather than draw conclusions from scientific inquiries initiated from a homogeneous group of researchers producing studies with the same set of research methods (see methodological limitations in part two).

Questions to ASK about a research study from this section:

1. Who are the researchers or organizations involved in the study?

Processes That Can Influence Science

A segment of the philosophy of science purports that political persuasions undergird scientific inquiry and knowledge. As it has been famously said, "knowledge is power." This is one of the reasons why we see politics embedded into the production of knowledge. One of the proponents of this belief is Michael Foucault. He aptly noted that "power is rather like a colour dye diffused through the entire social structure and is embedded in daily practices."[8] Regardless of what we might think of Foucault, his remarks highlight that research does not take place void of a social and political environment. Rather, power is wielded at every stage of the scientific process. Therefore, it is important to consider the political influences that are present at every stage of a research study, including the design, approval, publication, and promotion of scientific findings or body of work research.

Questions to ASK about a research study from this section:

1. Who signed off on the research and why?

Human Subjects Committees or Institutional Review Boards

This brings us to our next point: who approves a research study? In most cases, before a study is carried out, the research methods and protocols are outlined and submitted to an ethics committee to determine if the rewards and knowledge gained by conducting a study are worth the potential risks to participants.

In order to receive the committee's review, the researcher needs to pre-determine:

1) Who will and who will not be asked to participate in the study (*e.g.*, the sample),
2) How ideas will be measured (*e.g.*, what defines remission),
3) When and how the data will be collected (*e.g.*, blood test, at one, three, and six months), and
4) How the data will be analyzed (*e.g.*, statistical methods).

The researcher also needs to explain the purpose of the study, how it can advance knowledge, any conflicts of interest, procedures for giving informed consent and protecting the identities of participants, and a plan for keeping any research data secure.

Upon review of the research protocol, the committee will determine if research participants will be treated in accordance with the three ethical principles outlined in the Belmont Report.[9] Some studies might get a clear pass, demonstrating little risk to research participants, while other studies may have to adjust the methods to put in additional safeguards to better protect participants. Within the ethics review, there are some criteria that the committee assesses based on objective standards. For example, if research participants are a part of a vulnerable population (*i.e.*, children, prisoners), additional protections are supposed to be automatic. Nonetheless, there is a great deal of latitude in how a committee interprets the risk inherent in the research methods, the application of the ethical principles, and the safety measures necessary to protect participants from harm.

Things to REMEMBER about a research study from this section:

1. Nearly every study with human subjects has gone through a review board, and someone approved the research protocols and deemed the study ethical.

Funding

Funding can also wield a great deal of influence in the scientific process. Depending on the cost of the study, outside funding may be necessary which might be sought out through grant support from private

donors, companies, and government entities. If funding is acquired, it is important to consider the nature and background of any financial supporter behind a research endeavor. In this case, it's possible that both the impetus and design of the study have been tailored to meet a request for proposals. In other words, the researcher might pose the study question and design around the grant request rather than how they might approach the inquiry without financial constraints. That said, funded studies shouldn't be discredited for this reason alone. Still, one should be aware of the possible conscious or unconscious motives that could influence the researcher(s) towards meeting the funder's desires rather than the pursuit of a clearly objective inquiry. Therefore, if possible, it is important to be aware if the research was conducted in conjunction with a funding source.

In the same vein, some organizations operate on grant funding and are required to evaluate their programs and services to maintain their support. The findings of these evaluation studies are sometimes published on the organization's website and possibly in peer-reviewed literature.

When evaluating these studies, it's important to be aware that the outcome could influence the continuity of the program's funding stream. For example, let's say an organization received a grant for a program aimed at reducing and treating opioid addiction in a certain community. It was determined that the program was successful if 20 percent of program attendees remained opioid-free for one month after leaving the program. As you interpret this program's findings, it's helpful to recognize the potential pressure on the program administers to achieve the benchmark for the purposes of funding.

One question that you can ask of these studies is if an in-house or external evaluator conducted the evaluation. Both types of evaluators have inherent benefits and risks. In general, there's likely to be less pressure on an outside evaluator than one solely salaried by the organization itself.

Questions to ASK about a research study from this section:

1. Has the study been funded, and by whom?
2. Has the study been conducted to maintain organizational operations?

Peer Review Process

One of the primary goals of most academic research is to publish the findings in a peer-reviewed journal. Peer review is a process that research study findings undergo before the report is published. Two or three peer reviewers—often academics or seasoned practitioners who have expertise in a certain area of scientific inquiry—will vet the research study findings to determine if the research is acceptable for publication and ultimately to add to the scientific discourse.

Numerous peer-reviewed journals compile research studies from just about every known discipline (*e.g.*, public health, mental health, internal medicine, etc.). Peer-reviewed journals are ranked by their impact in an area of study, and some journals are considered more prestigious than others. The level of prestige is often based on the number of times an article(s) from a given journal has been cited in other publications. The number of citations an author has is also important for academic researchers, as this metric can impact tenured status and promotions in some universities.

Being Informed Is Critical

In sum, research is a conversation about one approach to knowing and understanding the world around us. Each step of the scientific process has the potential for error and political influences. There are also spoken and unspoken rules about who gets to participate in the conversation, as well as which topics are deemed acceptable for conversation. When it comes to scholarly publication, there can be a strong bias toward accepting articles that are in line with the current accepted conversation while subsequently minimizing or rejecting studies that don't fall in line with the primary discourse. Thomas Kuhn, who wrote about the structure of a scientific revolution, talks about the challenges within the scientific community to embrace new ideas beyond the current consensus, which he referred to as *paradigm shift*.[10]

The goal of this first part in a two-part series on "following the science" was to define science and the scientific method and draw attention to the need to be an informed consumer of research. The next

installment will examine the different approaches to scientific inquiry and outline methods that will tend to produce more rigorous results.

Takeaways from Part 1:

1. Science is one way to approach knowledge.
2. The scientific method was created to optimize objectivity for a flawed observer.
3. Observation is subject to many errors, such as overgeneralization, selective observation, and observing with a desire to see a given outcome.
4. There are individual differences in how we observe the world around us.
5. The scientific method refers to four basic tenants:
    a. The results should be *repeatedly and systematically observed* before it is considered a solid finding,
    b. The results should be *held as tentative* and must be *proven* (*i.e.*, we test the hypothesis to see if it is true).
    c. The findings must be held loosely, and we must allow for the results to be *refuted*.
    d. We must strive for *objectivity* (*e.g.*, keeping personal investment in the research outcome in check).
6. Science can be influenced by politics. Every step of the scientific process has the potential to be swayed by individual and social ideologies. It's important to be aware of:
    a. The Human Subjects Committee
    b. Funding Sources
    c. Peer-Review Process

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[1] A. Rubin and E.R. Babbie, *Research Methods for Social Work, 7th Ed.* (Belmont, CA: Brooks Cole, 2010).

[2] Mark A. Runco and Robert S. Albert, *Creativity Research: A Historical View*. In In J.C. Kaufman & R.J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (Cambridge, UK: Cambridge University Press, 2010), 3–19.

[3] James Jaccard and Jacob Jacoby, *Theory Construction and Model-Building Skills: A Practical Guide for Social Scientists* (New York, NY: New Guilford Press, 2010), 34.

[4] "Test Your Awareness: Do The Test," dothetest, March 10, 2008, accessed October 15, 2021, https://www.youtube.com/watch?v=Ahg6qcgoay4.

[5] "My Wife and My Mother-In-Law," by the cartoonist W. E. Hill, 1915. This media file is in the public domain in the United States. This applies to U.S. works where the copyright has expired, often because its first publication occurred prior to January 1, 1923.

[5] Michael E.R. Nicholls, Owen Churches, and Tobias Loetscher, "Perception of an ambiguous figure is affected by own-age social biases," *Scientific Reports* 8 (2018): 1-5, accessed October 25, 2021, https://www.nature.com/articles/s41598-018-31129-7.

[6] Ibid.

[7] "Face Time: How Quickly Do You Judge A Face?," SciFri, January 29, 2015, accessed October 18, 2021, https://youtu.be/86dsCphiErA. Start at minute 3:00 and end at 4:14 for a succinct summary of how this works.

[8] Bryan Turner, 1997. "From Governmentality to Risk: Some Reflections on Foucault's Contribution to Medical Sociology," in Alan R. Petersen and Robin Bunton, *Foucault, Health and Medicine* (London; New York: Routledge, 1997), ix-xxi.

[9] "The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research," National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, April 18, 1979, https://www.hhs.gov/ohrp/sites/default/files/the-belmont-report-508c_FINAL.pdf.

[10] Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago and London: University of Chicago Press, 1970).