Science of Mind

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Abstract

As time has passed, as science has increasingly become the preferred method for sorting out reality, the field of psychology seems to have become stuck, unable to move forward as other fields have done. To analyze psychology's difficulties, this article explains how science is defined, what it requires, and what obstacles stand in the way of a science of mind.

Contents

1 Science

1.1 Definition

To fully appreciate modern science's power and effectiveness, we need to understand its properties, its essentials. Among these are:

1. The goal of explaining, not merely describing, aspects of nature, through the shaping and testing of theories.
2. A requirement for empirical evidence to support or refute theories.
3. A property of theories that they may be perpetually modified or falsified by new empirical evidence.
4. A property of theories that they may be proven false, but cannot be proven true.
5. A property of theories that they predict phenomena not yet observed, phenomena whose existence supports the theory's claims.
6. A quality criterion by which theories are judged and compared, in which the best theories explain much of nature with few axioms and claims.
7. A posture of skepticism toward claims unaccompanied by evidence, and the presumption that an unsupported claim is false.

1.2 Genesis

The structural basis for modern science was outlined in, among other early works, Francis Bacon's[1] seminal text Novum Organum (New Method)[2] (1620), a philosophical framework that eventually replaced its predecessor Aristotelianism[3], ideas that originated with Aristotle[4] and dominated medieval thinking. Novum Organum sets out a strategy for processing observations of nature in which inductive reasoning[5] plays a central role, and in which the goal is an explanation, a theory, about what has been observed.

At some risk of oversimplification, Bacon's scheme, now called the Baconian Method[6], placed a greater emphasis than did its predecessor Aristotelianism on empirical evidence and the validation or falsification of proposed explanations through empirical observation – direct observations of nature. In his writing Bacon lists various ways by which observers may be misled in their efforts to objectively view nature, ways that will sound familiar to modern scientists:

- Idols of the Tribe (*Idola tribus*): The tendency to see patterns that don't really exist, thought to arise from preconceived ideas about nature.
- Idols of the Cave (*Idola specus*): The distorting effect of personal beliefs and preferences.
- Idols of the Marketplace (*Idola fori*): The misleading effect of ambiguous word definitions and other communication breakdowns.
- Idols of the Theatre (*Idola theatri*): An overreliance on figures with authority and status over direct observation of nature.

This classic list is easily translated into modern terms, and each of its points can be located in a modern compilation of logical errors.

1.3 Theory

The Baconian Method emphasized the shaping and testing of theories – explanations – of what has been observed. Theories serve multiple purposes in science – they provide a way to either validate or refute an idea by attempting to apply it to more phenomena, they provide a way to make a testable general statement based on specific observations, they increase the practical value of an idea by asserting a greater sphere of applicability, and they suggest new areas for research that might broaden our understanding of nature.

Using the above reasoning, observations that don't lead to testable theories aren't science, they can only be a preliminary step toward science. Here's an example – if I sit under a clear nighttime sky, then report that I saw many tiny points of light, I've made an observation of very little scientific usefulness, and one that can't meaningfully be falsified by repeated observation. But if I claim those points of light are actually distant thermonuclear furnaces like our sun, my assertion can be tested and possibly falsified. By moving beyond observation, by offering a tentative explanation, I've crossed the threshold of science.

1.4 Skepticism

A scientist's default posture toward an idea unaccompanied by evidence is that it's false. At first hearing, this precept might seem pointlessly skeptical, but on reflection its value becomes obvious. This precept has a formal definition in science – the *null hypothesis*[7], an evidentiary standard by which observations are assessed. Using the null hypothesis, a set of observations is compared to the presumption that there is no effect, in order to see whether the observations have sufficient weight to refute the default presumption.

To understand the value of the null hypothesis, imagine assuming its opposite, known as the *alternative hypothesis*[8] – the assumption that a given claim is true and relying on observational evidence to support or falsify the claim. Under the alternative hypothesis and using my favorite example, Bigfoot is presumed to exist and observational evidence bears the burden of *disproving* or falsifying his existence. But this represents an impossible evidentiary burden – Bigfoot might be hiding under some rock on a faraway planet, and conclusive disproof would require surveying every location in the universe. Technically, this standard of proof is called *proof of a negative*[9] or evidence of absence, and in general it's regarded as a logical impossibility.

To summarize the above point, scientists honor the null hypothesis, the default scientific precept, which presumes that a claim is false and tests observational evidence's ability to contradict that outlook. Its opposite, the alternative hypothesis, is the default *pseudoscientific*[10] precept, which presumes that a claim is *true* and tests observational evidence's ability to contradict that outlook.

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An interesting article[11] from Scientific American aptly summarizes these opposing outlooks. Quoting science philosopher Karl Popper, the article says, "The big difference Popper identifies between science and pseudo-science is a difference in attitude. While a pseudo-science is set up to look for evidence that supports its claims, Popper says, a science is set up to challenge its claims and look for evidence that might prove it false. In other words, *pseudo-science seeks confirmations and science seeks falsifications.*" This way of expressing it corresponds well with the definitions of the null and alternative hypotheses provided above.

The article emphasizes another distinction between science and pseudoscience – scientific claims are empirically testable and falsifiable, pseudoscientific claims aren't.

2 Psychology

2.1 Overview

First, to avoid unnecessary complexity, when I use the term "psychology" I refer to both psychiatry[12] and psychology. Both fields study the mind, both believe themselves to be sciences, and if they actually were sciences, they would be seen as branches of a science of mind, in the same way that cosmology and particle physics, very different activities, are seen as branches of the science of physics.

The American Psychological Association[13] defines psychology as "the study of the mind and behavior"[14]. The cited definition goes on to say that "'the understanding of behavior' is the enterprise of psychologists."

The Wikipedia[15] entry defines psychology as "the scientific study of mental functions and behaviors". This language is stronger than that quoted above, more insistent that psychology is a science. The Wikipedia definition was recently changed – it once read more like that at the APA site, until I and others pointed out the contrast between Wikipedia's earlier definition of psychology ("study of the mind, partly through the study of behavior") and that of neuroscience[16] ("the scientific study of the nervous system.").

But how one describes a field can have no bearing on whether it's actually scientific – were this not so, Christian Science would become science on the strength of its name. Consistent with the spirit of science itself, establishing whether a field is scientific must rely on evidence, not opinion.

2.2 Demarcation Problem

In online debates, people sometimes argue that science is subjective, like art, a matter of personal taste. But this isn't true, and the Demarcation Problem[17], the division between what is and is not science, is relatively easy to solve. And it's not a trivial issue – if people could define science as they please, then Creationists would be allowed to present religious beliefs as science in public school classrooms.

Creationists cannot do that, because courts have ruled that Creationism isn't science. Such rulings require courts to define their terms, to say what science is and is not, but that's not difficult. Here is how one court defined science[18]:

1. It is guided by natural law;
2. It has to be explanatory by reference to natural law;
3. It is testable against the empirical world[19];
4. Its conclusions are tentative, i.e. are not necessarily the final word; and
5. It is falsifiable[20].

Legal decisions like the above are now commonplace, and science's basic requirements are no longer a matter of debate. In consequence, because psychology studies the mind, because the mind is not part of the physical world nor open to empirical investigation, because psychological ideas cannot be falsified, *psychology is not scientific* as the law defines science. This is why psychologists describe but don't explain, and why they don't shape and test general, falsifiable, unifying scientific theories – they can't.

2.3 The Role of Theory in Science

As explained above, crafting and testing theories is central to science. This is true for a number of reasons – theories serve as validation or refutation of observations, they expand the scope of ideas, they suggest new practical applications, and they unify seemingly unrelated fields in the pursuit of knowledge. Let me give an example from physics. Newton's theory of gravity, when expressed mathematically, looks like this:

$$f = \frac{Gm_1m_2}{r^2} \tag{1}$$

Where:

- f = force, Newtons
- G = universal gravitational constant[21]
- m_1 = first mass, kilograms
- m_2 = second mass, kilograms
- r = distance between masses m_1 and m_2, meters

Equation (1) represents science at its best. It applies to any masses, it can be falsified by empirical observations, and it creates a common ground between apparently unrelated activities like astrophysics and baseball. Its predictions are accurate enough to guide a spacecraft to a particular location on Mars, consistent enough to detect new phenomena like dark matter[22], and reliable enough to tell a civil engineer how to build a bridge.

In a popular folk tale, Isaac Newton saw an apple fall from a tree and began thinking. He eventually created a theory of gravitation, expressed in Equation (1), that unifies falling apples, baseballs, Mars, and every other object affected by gravity. The theory is testable and falsifiable, it's based on empirical observations, and it forges a consensus between different fields about the meaning of gravity.

Particle physics studies nature at the smallest scales, less than the size of an atom, while cosmologists study nature at the largest scales, up to the entire universe. Even though their fields are very different, particle physicists and cosmologists attend each other's conferences and have mutual respect. When particle physicists discovered that neutrinos have mass[23], cosmologists modified their own theories, like those that describe stellar evolution. When cosmologists discovered Dark Matter, particle physicists began a search for candidate particles. Particle physicists and cosmologists have much less in common than do psychiatrists and psychologists, but they're united in a very productive pursuit of knowledge. The reason? *Physical sciences are united by theory.*

Biologists also shape and test theories. One example is the theory of evolution by natural selection. Every specialty of biology is informed by this powerful theory, and if an exception were to be observed and verified, it would transform all related fields. The reason? *Biological sciences are united by theory.*

Is there a basis on which psychology can be compared to the above examples? Well, no, not really, for the reason that psychologists don't craft or test theories. Modern psychology is based on description, not explanation. The absence of a theoretical dimension in psychology explains why it has the past and present it does.

Here's an example showing the consequences arising from psychology's theory vacuum. Listed below are two popular descriptions that can be applied to the same behavior:

- Asperger Syndrome[24] – a disorder characterized by, among other things, repetitive patterns of behavior and interests.
- Grit[25] – a positive personality trait characterized by intense focus, perseverance and drive.

Let's say Bob is a young person who has an intense interest in, and an uncanny adeptness for, memorizing the personal histories and batting records of baseball players. Bob decides to find out what psychologists think of his abilities. Because there's no theoretical unification in psychology and very little depth of understanding, depending on which door Bob walks through, he might be diagnosed with the Asperger Syndrome disorder and be enrolled in therapy, or he might be congratulated for possessing Grit and encouraged to further develop his abilities. *Both diagnoses apply equally well to his behavior.*

How can two opposing outlooks on the same behavior coexist in a scientific field? The behaviors that Asperger Syndrome and Grit describe are too similar for someone not to have noticed the similarity and endeavored to unify the two descriptions into one common theory about behavior. The answer should be obvious – *psychology is not a scientific field.* No one tries to craft and test general theories about specific observations. No one tries to explain what's been described, or forge a consensus between workers about what observations actually mean.

In fairness to psychologists, because their subject is the mind, and because the mind is not a physical organ accessible to unambiguous observation, if someone tried to turn psychology into a science, he might quickly discover that it cannot be done, that the kind of evidence available to psychologists can never be used to build a reliable science of mind. But this doesn't stop psychologists from describing themselves as scientists, based on zero evidence.

2.4 Curing the Common Cold

I regularly talk to people who think the previously described requirements for science are overly strict, that courts of law and scientists have set the bar too high. According to this argument, even if there's no theory under test, even if strict experimental controls aren't practical, even if falsifiability isn't possible, it's still science. Let's examine this idea with an example – let's say I'm an ambitious doctor who thinks he's invented a cure for the common cold. My cure is to shake a dried gourd over the patient until he's all better. My cure might take a week, but it always works. The cure is repeatable – other people have tried it, and it works for them too. It's reliable, repeatable, consistent – doesn't that make it science?

For those who think this example is silly, that no one would seriously call it science, I can only say they haven't read much contemporary psychological literature, where similar experimental protocols and outcomes are routinely described as science.

Others have objected that this example is unfair because there's no control group[26], and psychology studies almost always have a control group. Well, yes, that's true, psychologists know that scientists expect a control group to be present in a human study, so they do what they can to include one, even though it may not be possible to keep the control group members from finding out who they are.

A surprising number of psychology studies rely on something called a "no-treatment control"[27], which means someone who won't be an experimental subject is sent home without treatment. But this contradicts the scientific meaning of control group (the experimental and control groups should be identical in every way except one: the treatment under test, and the subjects must not know to which group they belong). In the "no-treatment control" article cited above, we read this warning: "Although no-treatment controls have an appealing simplicity, they also have a number of potential disadvantages." Well, yes, but more to the point, a "no-treatment control" is *not a control group* as science defines the term, and the resulting study has no scientific value.

2.5 Depression

There's a great deal of money to be made in psychiatry and psychology, both from drugs and therapy (in modern times psychiatrists focus mostly on drug therapies, psychologists on talk therapy). Unfortunately for those diagnosed with depression, psychologists can't explain it, they can only describe it, consequently the available treatments are symptomatic and endless – and therefore very profitable.

For many years a certain kind of drug called a *selective serotonin reuptake inhibitor (SSRI)*[28] has been the treatment of choice for depression, based on a theory that brain serotonin levels might play a part in depression. Pharmaceutical companies make billions of dollars annually in SSRI drug sales, so they're motivated to show them in a positive light, and many published studies support the idea that these drugs have a clinically significant positive effect.

Someone finally noticed that not all drug studies that were funded and performed were being published, and a meta-analysis was performed[29] that evaluated all existing SSRI studies – both published and unpublished. The study concludes, "Meta-analyses of antidepressant medications have reported only modest benefits over placebo treatment, and when unpublished trial data are included, *the benefit falls below accepted criteria for clinical significance.*" In plain language, the study finds that, when all available studies are analyzed, SSRI drugs don't work for any but the most severely depressed.

On reading this study, some readers might think the drug companies might have created a positive impression by preventing the publication of studies that failed to make their drugs look good. Perhaps, but there's a simpler explanation that doesn't involve bad behavior – scientific journals prefer to publish studies that break new ground and/or report dramatic outcomes. An SSRI study with a neutral or ambiguous outcome, or one that found no clinical significance, has less chance to be published in a scientific press that's addicted to phony breakthroughs and drama.

That's step one – SSRIs don't really work for most people. In step two, a study[30] that will need to be replicated to be taken seriously, seems to show there's little or no correlation between brain serotonin levels and depression. If this study is confirmed, if it is successfully replicated, it would explain why SSRIs don't work for the majority of people.

Given the declining evidence for brain serotonin's role in depression, why do some people sometimes report a positive response to SSRIs? The answer is the *Placebo Effect*[31] – a powerful psychological factor that must always be kept in mind in human studies. The Placebo Effect is a powerful factor in human studies, and it explains why rigorous experimental controls are a requirement in any study having pretensions to science.

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I'm happy to be able to close this section with some positive news – SSRIs and talk therapy aren't the only treatments for depression. Alongside psychology, the study of the mind, is neuroscience, the scientific study of the brain and nervous system. Neuroscientists have been experimenting with a technique called Deep-Brain Stimulation (DBS)[32]. I warn my readers that what follows is a preliminary study, a research experiment, not a clinical therapy.

A recent series of DBS experimental procedures[33] have produced rather dramatic results. From the cited article, "As it turned out, 8 of the 12 patients he operated on, including Deanna, felt their depressions lift while suffering minimal side effects — an incredible rate of effectiveness in patients so immovably depressed. Nor did they just vaguely recover. Their scores on the Hamilton depression scale, a standard used to measure the severity of depression, fell from the soul-deadening high 20's to the single digits — essentially normal."

These results are preliminary, there's no control group, it relies on self-reporting, but those who've dealt with depression either as clients or treaters should consider that a neuroscientific approach might produce results that psychology cannot. Again, much more work is needed before this procedure can be offered as a clinical practice.

And from a scientific perspective, all this activity may seem incredibly primitive at some future time when we actually know what causes depression in a biological sense. For that future to come to pass, we'll need much more science than psychology can offer.

2.6 Disease Mongering

Disease mongering[34], an expression that I believe originated with the British, describes psychologists' tendency to invent new pretend diseases that we're all suffering from and for which we need the help of psychologists. The process that led to the new edition of the DSM[35], psychology's "bible", was so obviously an example of disease mongering that its abandonment is now being recommended by a number of influential agencies including the National Institute of Mental Health (NIMH)[36].

About the DSM, and as part of his agency's effort to replace it, NIMH chairman Thomas Insel said:

> "While DSM has been described as a 'Bible' for the field, it is, at best, a dictionary, creating a set of labels and defining each. The strength of each of the editions of DSM has been 'reliability' – each edition has ensured that clinicians use the same terms in the same ways. The weakness is its lack of validity.
>
> "Unlike our definitions of ischemic heart disease, lymphoma, or AIDS, the DSM diagnoses are based on a consensus about clusters of clinical symptoms, not any objective laboratory measure. In the rest of medicine, this would be equivalent to creating diagnostic systems based on the nature of chest pain or the quality of fever. Indeed, symptom-based diagnosis, once common in other areas of medicine, has been largely replaced in the past half century as we have understood that symptoms alone rarely indicate the best choice of treatment. Patients with mental disorders deserve better."[37]

Interestingly, Insel's remarks about the DSM address the same issues this article does – mere descriptions of symptoms isn't science, for that we must endeavor to explain, to theorize about causes, and then test our theories with empirical experiments.

3 Conclusion

3.1 Brain Initiative

As time passes, as we acquire more knowledge, it seems increasingly likely that the route to science cannot be by way of psychology, but via neuroscience, and by addressing biological causes rather than mental symptoms. Unfortunately neuroscience, the likely inheritor of responsibility for brain dysfunctions, isn't ready yet. Among other things, it needs more attention and funding.

When President Obama announced his program to address some of the issues discussed here, he called it the Brain Initiative[38], not the Mind Initiative. The choice of name was no accident – opinion leaders in the mental health field are thinking more in terms of biological causes than mental symptoms, and there are indications that science funding patterns are changing in step.

Indeed, in the final analysis it may turn out that all mental illnesses are either the self-serving fantasies of psychology experts or have biological roots and biological causes, and that therefore a future science may discover that there are *no mental illnesses* as that term is presently understood. All the conditions we now call mental illness may turn out to be either inventions or symptoms of biological ailments, some curable, some not.

3.2 Technical Notes

This is a technical note about how this article was created, it's not about psychology.

For many years I've written technical articles in HTML using my program Arachnophilia[39], then sometimes created a PDF version of the same article for my more technically oriented readers. This process was helped along by the existence of MathJax[40], a browser plugin able to render equations written in TeX notation, so one can enter equations into a Web page's plain-text form and expect them to be rendered properly, just as though HTML was a rich development environment such as exists for more academic work.

But as time passed I became less satisfied with this scheme for a number of reasons. One of the issues was the handling of numbered footnotes, which over the years have become more numerous in my articles and harder to manage by hand. A LaTeX editor like Texmaker[41] makes the article creation process much easier, and most modern browsers provide a built-in PDF reader.

My point is that, with this article and for the first time, an online PDF document renders the content of a LaTeX source, rather than an HTML source. This change makes technical content easier to archive and less subject to changes in browser features over time.

Thanks for reading.

References

[1] Francis Bacon – English philosopher and scientist.
[2] Novum Organum(New Method) (1620) – A philosophical work by Francis Bacon that described and anticipated the modern form of science.
[3] Aristotelianism – a philosophical scheme devised by Aristotle that predated the ideas of modern science.
[4] Aristotle – Greek philosopher of great influence.
[5] Inductive Reasoning – a method of analysis in which (at some risk of oversimplification) general principles are derived from specific observations.
[6] Baconian Method – the name given to Francis Bacon's approach to scientific observation and reasoning.
[7] Null Hypothesis – the default precept of scientific observation, which presumes there is no effect and tests the data's ability to refute the presumption.
[8] Alternative hypothesis – the opposite of null hypothesis in significance testing.
[9] Proof of a Negative (Evidence of Absence) – an evidentiary burden in which the *absence* of something is proven, i.e. an impossible task.
[10] Pseudoscience – faux science, activity that bears a superficial resemblance to science but that fails to meet science's requirements.
[11] Drawing the line between science and pseudo-science – an apt analysis of pseudoscience's philosophical underpinnings.
[12] Psychiatry – a "medical specialty devoted to the study, diagnosis, treatment, and prevention of mental disorders."
[13] American Psychological Association – a professional association of psychologists.
[14] How does the APA define "psychology"? – the APA's definition of psychology.
[15] Psychology (Wikipedia) – the "scientific study of mental functions and behaviors."
[16] Neuroscience (Wikipedia) – "the scientific study of the nervous system."
[17] Demarcation Problem – the problem of separating science from non-science.
[18] McLean v. Arkansas Board of Education (1982) – A landmark ruling that prevents religion from being presented as science in public school classrooms.
[19] Empirical – an essential property of scientific observations.
[20] Falsifiability – an essential property of scientific ideas.
[21] Gravitational constant – used in physics to analyze gravitation.
[22] Dark matter – a poorly understood kind of matter at the frontier of physics.
[23] Neutrino : Mass – an account of the recent discovery that neutrinos have mass.
[24] Asperger Syndrome – a now-abandoned diagnosis characterized by repetitive patterns of behavior and interests.

[25]Grit – a positive personality trait characterized by intense focus, perseverance and drive.
[26]Treatment and control groups – two groups that form the basis for a controlled experiment.
[27]The Selection and Design of Control Conditions for Randomized Controlled Trials of Psychological Interventions – a technical paper that explains the meaning of "no-treatment control".
[28]Selective serotonin reuptake inhibitor – a class of drugs used to treat depression.
[29]Initial Severity and Antidepressant Benefits: A Meta-Analysis of Data Submitted to the Food and Drug Administration – a study that shows no clinically significant SSRI effect for most subjects.
[30]Mice Genetically Depleted of Brain Serotonin Do Not Display a Depression-like Behavioral Phenotype – a study that calls into question the correlation between brain serotonin levels and depression.
[31]Placebo – a treatment with no effect, meant to serve as a control in a controlled study.
[32]Deep Brain Stimulation (DBS) – a method to create behavioral changes by applying electrical fields to brain tissues.
[33]A Depression Switch? – a popular account of some recent work in Deep Brain Stimulation.
[34]Disease mongering – the practice of inventing phony diseases, then offering equally phony cures.
[35]DSM – psychology's "bible", primarily a diagnostic guide.
[36]National Institute of Mental Health – an influential U.S. mental health agency with substantial responsibilities.
[37]Transforming Diagnosis – NIMH chairman Thomas Insel speaks out.
[38]Brain Initiative – a federally funded neuroscience program meant to accelerate brain research.
[39]Arachnophilia – the author's HTML development tool.
[40]MathJax – a browser plugin able to render TeX-syntax equations.
[41]Texmaker – a free, open-source LaTeX editor.