Building Science

On the architecture of modern science

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Introduction

Readers might question this essay's title — can science be compared to a building, to architecture? Isn't science just a disciplined way to observe nature and draw conclusions about it?

Glasgow University Computer Science (Sir Alwyn Williams) building

At the level of laboratory observation, science is relatively simple — at its best, it's a dispassionate way to observe and describe reality, with efforts to minimize observational biases and an awareness that a given observation can have multiple explanations. But a scientific field is constructed from one or more explanations — theories — that have general applicability, and it is in the process by which a scientific theory becomes a scientific field that science becomes architectural.

Falsifiability

There's one non-negotiable requirement attached to each scientific explanation — the explanation must be open to falsification by new evidence. This requirement is central to the definition of science, and serves as a litmus test that distinguishes science from pseudoscience.

The meaning of the falsifiability criterion is often misunderstood. The statement that a scientific idea must be open to falsification simply means that it must be possible to compare the idea to reality, and if the reality-test fails, scientists are expected to abandon the idea. (Pseudoscientists may elect to abandon reality instead.)

This article describes the relationship between scientific ideas and scientific fields, and shows how such fields are defined by a scaffolding of theory that serves to focus work within the field. But just as with individual explanations, scientific fields must also meet the falsifiability criterion. Science history shows many examples where an entire field has been falsified and cast aside.

Status

Because of the central role played by science in modern society, because of its successes, many individuals and organizations want the imprimatur of science without the discipline, the substance. This has created a problem at the crossroad of science and public understanding — many people don't understand that science is more than its name, that certain criteria must be met for the label "science" to be accurately applied.

There are any number of reasons to exploit the label "science" — by an association with science, an individual or organization gains unearned respectability and status, and ideas thought scientific are automatically given more weight. It is for these reasons that science is now very clearly defined, clearly enough to appear in legal rulings that steer public policy.

There was a time when science was a hobby practiced by the idle, curious rich, but those days are long past. Science is now a very serious activity with far-reaching consequences, consequently it's in the public interest to clearly say what is and is not science, both with regard to specific explanations and theories, and with regard to entire fields.

Science Defined

Before describing how scientific fields are constructed from theories, we must first address the definition of science itself. When science was just the pastime of a handful of curious 18th century polymaths, no one particularly cared how science was defined, and indeed the definition was less clear than it is now. But one increasingly sees public debates about whether a particular idea or field is or is not scientific, and the stakes are often high.

Creationism

I think the public debate about Creationism and Intelligent Design is a suitable example of an issue that hinges on whether a particular idea is a scientific one — if the debate goes one way, unscientific ideas will be excluded from science classrooms, if it goes another, religious ideas will be included in public school science curricula. And I have phrased this as a current issue for a reason — Intelligent Design isn't going away. It has lost a couple of rounds in courtrooms and in public opinion, but the match isn't over by any means, and we all need to remain vigilant.


Large Hadron Collider beam tunnel

Here's the essence of the Creationism/Intelligent Design issue: a powerful and vocal religious constituency would like to see Biblical ideas put forth as science in public schools. But in order to do this, to get around a U.S. Constitutional prohibition against granting religion a special place in public affairs, that constituency needs to redefine as science what is in fact a religious belief in the divine origin of complex life.

Intelligent Design was once known as Creationism, but that caused a problem when trying to translate the idea of divine creation into scientific terms, into something acceptable in a science classroom:

- "Creationism" implies a creator.
- Nature reveals no evidence of such a creator.
- Therefore the creator under discussion must exist in a supernatural plane.
- Science is empirical, meaning its conclusions must be drawn from observations of nature.
- Therefore there is no place in science for supernatural explanations.
- Therefore Creationism is by definition unscientific.
- Therefore to teach Creationism in public schools would be to put forth a religious idea, not a scientific one.
- Such religious teaching would violate the Establishment Clause of the U.S. Constitution, and therefore cannot be permitted.

Legal Definition

Because of the seriousness of education, and because of the Constitutional issue, Creationism was quickly tested in courts of law. One of the legal rulings included a concise definition of science — in McLean v. Arkansas Board of Education (1982) (hereafter McLean), Judge William Overton heard testimony from expert witnesses, then ruled against Creationism by spelling out what science is, and is not. Overton ruled that the essential characteristics of science are:

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 ;
4. Its conclusions are tentative, i.e. are not necessarily the final word; and
5. It is falsifiable .

The 1982 McLean ruling, and many more recent rulings on similar issues, have prevented Creationism and its offspring Intelligent Design from entering public school classrooms (so far), and as a side effect, these rulings serve to concisely define science as well as create a legal precedent for disputes that bear on science.

- According to McLean points 1 and 2 above, science is "guided by natural law" and "explanatory by reference to natural law", meaning it's empirical — its principles derive from observations of reality. I caution my readers not to take the word "law" in "natural law" too literally — in a scientific context, "law" means *established principle, not ordinance*. I say this because all scientific ideas are potentially falsifiable and are therefore perpetually open to question, but this conflicts with the legal meaning of "law", something one must obey without question.

  In popular science writing one regularly hears the expression "scientific law" , when "scientific principle" would be more accurate (but perhaps less dramatic). To avoid public confusion I would prefer it if science journalists avoided the expression "scientific law" entirely, but there's little chance of that.

- According to McLean point 3, scientific theories must be "testable against the empirical world". This point requires that legitimate scientific theories must be based on practical, falsifiable experiments and observations of nature rather than philosophical reflection.

- According to McLean point 4, science's conclusions are "tentative, i.e. are not necessarily the final word." This addresses the falsifiability issue by declaring all scientific issues open to revision in perpetuity. This point also means scientific theories cannot become final truths about nature, and contrary to a persistent public myth, *science is not a search for truth*.

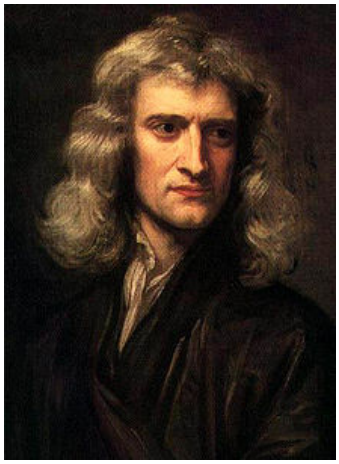
  It is a central tenet of scientific philosophy that human knowledge is imperfect and perpetually open to improvement and revision. On that basis we can say that if an idea were to be declared true, it would move beyond potential falsifiability, and on that basis it would leave the domain of science. This is the reason science cannot accurately be described as a search for truth.

  We can summarize the above point by saying that science cannot ever prove an idea true, only false. This idea was perhaps best expressed by philosopher David Hume , who said, "No amount of observations of white swans can allow the inference that all swans are white, but the observation of a single black swan is sufficient to refute that conclusion."

- According to McLean point 5, scientific findings are potentially falsifiable — refutable using new evidence. Even though this point appears at the end of the list, it's by far the most important to an understanding of science. Without the falsifiability criterion, ideas that are beyond practical test or refutation could become part of science.

Scientific Theories

Modern definitions of science give falsifiability its proper place but don't specify what might be falsified. If I say, "the night sky is full of little points of light", my observation, my *description*, can't be meaningfully falsified (all observers of the night sky will report the same thing). But if I say "those points of light are actually distant thermonuclear furnaces like our own sun", my *explanation* — my theory — can be tested and potentially falsified.


Isaac Newton

The distinction between description and explanation is critical to a definition of science — it's the distinction between a specific observation of nature (a *description*) and the shaping of a general, testable scientific theory (an *explanation*) based on that observation.

Description vs. Explanation

To clarify the difference between description and explanation, we might recall a classic tale in which Isaac Newton observed an apple falling from a tree. The observed event, the *description* — "an apple fell from a tree" — is not yet science. But Newton drew a parallel between the apple's motion and that of the moon, indeed all objects influenced by gravity, and wrote a general *explanation* of gravity that could track the motion of both the apple and the moon, but more important, it was able to predict gravitational motions not yet observed. And possibly most important of all, Newton's theory was testable and falsifiable.

In its article Science, Evolution, and Creationism , the U.S. National Academy of Sciences defines "scientific theory" this way :

> The formal scientific definition of theory is quite different from the everyday meaning of the word. It refers to a comprehensive explanation of some aspect of nature that is supported by a vast body of evidence ... One of the most useful properties of scientific theories is that they can be used to make predictions about natural events or phenomena that have not yet been observed.

It's not possible to overemphasize the scientific importance of theories. Theories are usually inductive generalizations about reality, general statements predicated on specific observations, statements that can be tested and that may lead to predictions about unobserved events.

Miracle Cure

This leads to an important question — if one makes observations (if one *describes*), but never tries to generalize the observations by shaping theories (by *explaining*), is that science? No, not really — description without explanation can too easily lead us astray:

- Let's say I'm a doctor searching for a cure to the common cold, and let's also say I have an idea for a novel treatment.
- My treatment is to shake a dried gourd over the cold sufferer until he is cured.
- I think I understand science, so I've tested my idea in a lengthy clinical trial with many patients, and it always works — my patients always get better.
- As far as I'm concerned, my treatment is a breakthrough — it is 100% effective. I have never seen a patient who didn't eventually get better when I shook my gourd over them.

Why is the above not science? It's not science because it only *describes* — "I shake the gourd and the patient eventually improves" — it doesn't make an effort to *explain* the result or consider other explanations for that outcome. Remember that

descriptions are specific, but explanations are usually statements of general principles, principles that can be more easily examined for logical flaws.

Witch Doctor

The process of shaping scientific theories includes a number of important corollaries:

- All possible explanations should be considered — intellectual honesty requires that we avoid focusing attention on just one or overlooking plausible alternatives.
- When comparing alternatives, the simplest explanation is to be preferred (the Law of Parsimony).
- We must guard against giving undue weight to explanations we prefer for emotional reasons.
- A conscientious scientist considers all the ways by which his explanation might be mistaken — that the observation arises from chance, that there is an overlooked cause, or that the method of observation is flawed.

Theory creation has another important property — successful theories, those that survive careful thought and repeated tests, may become the foundation for new fields of science.

Scientific Fields

At this point it should be apparent that, with respect to specific theories and observations, it's difficult to decide what is and is not science. But this isn't true about scientific fields — the demarcation problem is easier to solve for scientific fields.

Astrology?

Here's an example — it's generally agreed that astrology is not scientific. The reason? Astrology makes claims (has theories) that don't survive reality-testing. So, even though astrology has falsifiable theories, and even though the field may include scientists studying some aspect of astrology, astrology isn't scientific.

How is that possible? How is it that a field based on falsifiable theories, that (for the sake of argument) has fully qualified scientists working in the field, might not be considered scientific? The answer will require some telling:

- Let's say I'm an astrologer and I want to redefine astrology as a science.
- I know that real sciences have scientists performing and publishing scientific studies, so I decide to create a scientific study within astrology that everyone will agree is an example of solid science.
- I hire a real scientist to consult a large population database that includes birthdates, process it, and produce a scientifically valid statistical result that breaks the population down by astrological sign.
- The result comes from a fully qualified scientist, it is legitimate science, it's about astrology, and it's useful to astrologers, who now can order supplies more intelligently.

The Role of Theory

To summarize, I have a scientific result, created by a scientist, that passes muster as science and that is useful to working astrologers. Have I made astrology into a science? Well, no, I haven't. I haven't because my study doesn't either address or test the theories that define astrology — for example, the idea that the position of the stars and planets on a given day, and at the time of our birth, influences our lives.

I have just stated a criterion for acceptance or rejection of a scientific field — a criterion that, when stated, seem perfectly obvious, but one that is tacit, not clearly stated in the philosophy of science. Here's a more complete statement of this idea — for a field to be accepted as scientific:

- The field must be defined by theories that are themselves scientific as explained above, that is, testable, empirical, and falsifiable.
- The field's theories must resist falsification.
- Work within the field must address the field's defining theories.

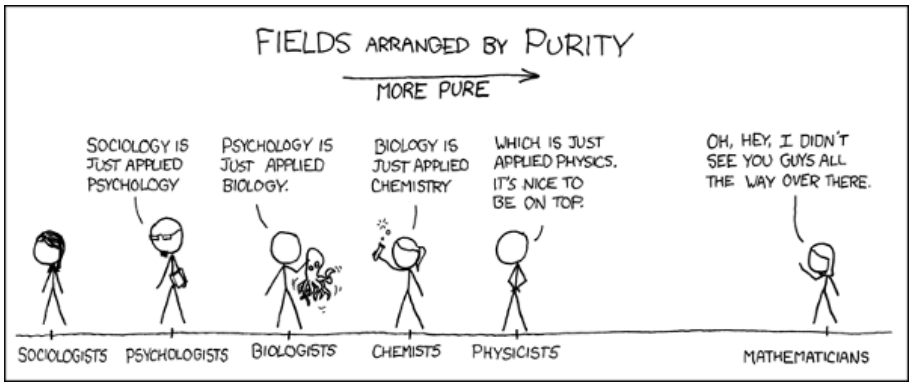
I emphasize that these requirements don't break any new ground — they're common knowledge among working scientists. In the history of science, any number of fields have been accepted or rejected based on the above criteria, but without necessarily listing the requirements as is done here. To show how these criteria work in practice, here are some examples of fields that are, or are not, scientific:

- **Creationism/Intelligent Design**: *not scientific*. It's not scientific because, even though Creationist organizations have scientists writing and publishing scientific papers, the field's defining theories require acceptance of supernatural agencies, agencies not open to empirical observation or falsification.

- **Astrology**: *not scientific*. It's not scientific because, regardless of how many scientists might be associated with it, its theories don't survive objective tests — the field has been falsified.

- **Sociology**: *not scientific*. Although this field has the potential to become a science in the future, it lacks a central theory to define it and provide a context for work in the field. This is an example of a field where, even though sociologists create and publish legitimate science, this can't make the field itself scientific for lack of a coherent, tested, scientific theory that defines the field. Also, sociological work is often incredibly sloppy. A classic case is Margaret Mead's very influential book Coming of Age in Samoa . Mead's field work was eventually shown to consist of interviews in which her subjects just made stuff up, but because there were no meaningful controls, these fairy tales ended up masquerading as science.

- **Psychology**: *not scientific*. This field isn't scientific for the same reason that sociology isn't scientific. Even though there are any number of psychologists creating legitimate science within the field, their work doesn't address a nonexistent central theory that would give the field scientific legitimacy and unify research efforts. This is an example where, for lack of a unifying corpus of tested theory, no amount of legitimate science can make the field itself a science. And worse, over time the absence of a central theory has Balkanized the field — there are as many independent psychological fiefdoms as there are laboratories, many of whom doubt the scientific legitimacy of the others. These issues are discussed at length below.



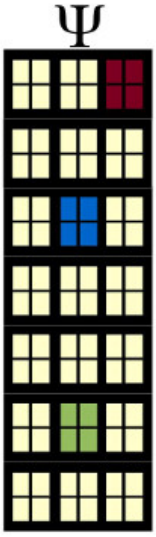
"Purity" , Copyright © 2007, Randall Munroe

- **Biology**: *scientific*. Even though typical biological studies seem far removed from the purity of physics (discussed next), the field has a strong, well-tested body of defining theory, to which all ideas are compared — a given idea can be shown to agree or disagree with the theories of evolution, natural selection and cell biology, theories that identify biology as a science.

- **Physics**: *scientific*. Physics is the model scientific field. It possesses a well-tested corpus of defining theory, much disciplined work, aggressive abandonment of theories that don't survive reality-testing, a high degree of intellectual honesty and candor, and in most cases a degree of objectivity toward competing ideas not seen in other fields. The scientific reputation of physics is such that other fields are said to experience physics envy .

- **Mathematics**: *open question*. I include mathematics to address one of the more interesting open questions in the philosophy of science. Mathematics is defined by clearly stated conjectures, theorems and axioms, and possesses a property one might describe as "purity" compared to fields that must derive their content from imperfect observations of nature. That argues *for* mathematics as a science. But mathematics isn't empirical — its theorems arise in a realm of pure thought. That argues *against* mathematics as a science. So if science must be empirical, then mathematics, as important as it is for all other sciences, is itself not science as strictly defined.

Science and Pseudoscience



In this section I will compare methods and results from scientific fields — like physics and biology — with those from a field that's scientific in name only. Those who have read my prior articles will be able to guess which pseudoscientific field I'll choose to make my points.

To me, psychology is the ideal pseudoscientific model. On one hand, it's extremely popular with the public, who want to believe it's a science and can produce reliable results, as a result of which there's plenty of funding for psychological studies, and plenty of patients in clinics who believe they're getting meaningful treatments. On the other hand, psychology's subject is the mind, which, by inconveniently not existing, can't present an empirical target for research.

Why Psychology?

Some of my readers have asked why I choose psychology over, say, sociology, for critical comparisons — after all, both psychology and sociology have serious credibility problems. My answer is that, unlike sociology, psychology has clinics and patients. Psychologists try to pose as mental doctors, faux medical specialists, but without medicine's scientific foundation. This is a very serious problem and public policy issue.

Faulty Circuits

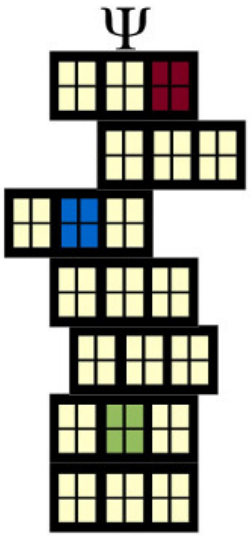
Other readers have wondered whether I seriously expect to change psychology's standing with the public, force a reëvaluation of its scientific effectiveness compared to, say, neuroscience. In answer I say that train has already left the station — psychology has been tested and found wanting, and is being replaced by more effective methods. But I'll let Thomas Insel , the present director of the National Institute of Mental Health , say it for me. In his 2010 Scientific American article Faulty Circuits , Insel says:

> In most areas of medicine, doctors have historically tried to glean something about the underlying cause of a patient's illness before figuring out a treatment that addresses the source of the problem. When it

> came to mental or behavioral disorders in the past, however, no physical cause was detectable so the problem was long assumed by doctors to be solely "mental," and psychological therapies followed suit.
>
> Today scientific approaches based on modern biology, neuroscience and genomics are replacing nearly a century of purely psychological theories, yielding new approaches to the treatment of mental illnesses.

But the above process will require more than a wave of the hand, and psychologists aren't going quietly. They correctly point out that the public adores them — people who, without psychology's unearned standing, would be set adrift in a sea of doubt. That's true and deplorable, but the fact that it's based on carefully crafted illusions doesn't reduce the severity of the problem.

Fragmentation



My voluminous correspondence with psychologists, which extends over a decade, includes every imaginable argument and objection. One common objection is that I speak of psychology as though it's one field, like physics or biology. Don't I realize that clinical psychology and psychiatry, although apparently fields within human psychology, are in fact separate fields with different foundations? In answer I point out (so far with no effect) that this fragmentation reflects poorly on psychology as a scientific field. By comparison, physics can and should be spoken of as a single field, because all activities within theoretical and applied physics are united by a single theoretical foundation — the Standard Model . The Standard Model provides one context for all work in physics, as well as for applied physics activities like civil and electrical engineering and aeronautics.

Unification

Because of the unified and interdependent nature of modern physical theory, progress in cosmology (the study of events at the largest scale) depends on discoveries in particle physics (the study of events on the smallest scale) — for example, resolution of the cosmological Dark Matter issue will require particle physicists to locate and characterize the particles that make up Dark Matter. In the same way, particle physics discoveries influence cosmology — for example, it's been discovered that neutrinos have mass, a finding that requires us to rewrite theories of stellar evolution.

Conservation of Energy

Here's an example to show the interdependence of physical theories — what do rubbing one's hands together on a cold morning, and a planet in an elliptical orbit, have in common? The answer is that these apparently unrelated events are united by the principle of conservation of energy :

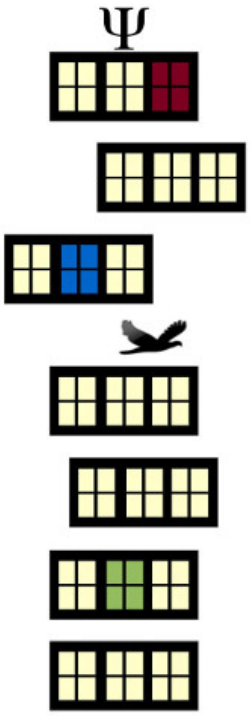
- By rubbing our hands together, we convert some energy derived from food into mechanical motion, then friction, then heat, finally the heat causes air molecules to move more energetically. At each step in the process, we can observe and confirm that no energy is gained or lost.
- A planet in an elliptical (oval-shaped) orbit conserves energy in an interesting way. As a planet approaches its parent body, it loses gravitational potential energy. If there were no correcting factors, this lost energy would violate the principle of energy conservation, but as the planet approaches the parent body its orbital velocity increases. That velocity increase represents increased kinetic energy. So, at each location in the planet's orbit, the sum of potential and kinetic energy is a constant — which means energy is conserved. Here are the equations:
  - (1) Gravitational potential energy : $e_p = \frac{-Gm_1 m_2}{r}$
  - (2) Kinetic energy : $e_k = \frac{1}{2} mv^2$
  - (3) Constant total energy: $e_t = \frac{-Gm_1 m_2}{r} + \frac{1}{2} mv^2$
  - For a more comprehensive look at this system, read my article Conservation of Energy.

My reason for listing the equations in the orbital example is to demonstrate that physics makes perfectly reliable, quantifiable predictions based on relatively simple theories, and to show that different physical theories are (and must be) consistent with each other. If one observes the motions of planets or satellites in elliptical orbits, one sees changes in orbital velocity that exactly meet the requirement that equation (3) above show a constant amount of energy — no energy gained or lost — confirming the principle of energy conservation. The first example, in which we rub our hands together to warm up, can also be quantified with equations and field measurements, but the mathematics is a bit more complex . Both examples show how theory unifies physics and, by predicting the outcome of physical measurements, establishes it as an empirical science.

Biology

The same principle applies to biology — all theoretical and applied fields of biology are united by a handful of well-tested theories, primarily evolution, natural selection and cell biology. Because of this

theoretical unification and unlike psychology, specific fields within biology don't presume to describe other fields as unscientific or questionable. And the reason should be obvious — evolutionary theory , a very important and well-established scientific theory, relies on natural selection as its mechanism, and natural selection in turn relies on cell biology and genetics as its mechanism. These scientific theories are interdependent — they both unite biology and define it as science.



Psychology

In psychology by contrast, for lack of a theoretical foundation, psychiatry and clinical psychology regularly describe each other as unscientific frauds, maintain separate publications and conferences, and don't bother to read the literature of the other field. But the Balkanization of psychology is deeper and more profound than the schism between psychiatry and clinical psychology — even within the same subfield, different groups publish "scientific findings" that flatly contradict each other without anyone noticing or caring. Here's an example:

- Grit : This psychological theory identifies the ability to focus one's attention on a few activities, or just one, as a way to achieve remarkable results: "Grit in psychology is a positive, non-cognitive trait, based on an individual's passion for a particular long-term goal or endstate coupled with a powerful motivation to achieve their respective objective."

  According to the grit theory, people achieve extraordinary things by focusing their attention on specific objectives, sometimes to the exclusion of all other activities. Imagine a pianist or violinist practicing alone for years, in order to qualify for a seat in a symphony orchestra or a Carnegie Hall performance. Imagine Isaac Newton struggling in isolation to craft the first coherent theory of gravity. Imagine Albert Einstein working for years, alone, on his General Relativity theory, now described by some as the crowning intellectual achievement of 20th century physics.

- Asperger Syndrome : This psychological theory identifies the ability to focus one's attention on a few activities, or just one, as a symptom of mental illness: "Asperger syndrome (AS), also known as Asperger's syndrome or Asperger disorder, is an autism spectrum disorder (ASD) that is characterized by significant difficulties in social interaction, alongside restricted and repetitive patterns of behavior and interests."

  So it seems that Asperger Syndrome "sufferers" are stigmatized for focusing their attention on few activities, for engaging in repetitive behaviors and interests that set them apart from average people, and for occasionally becoming rich and famous. Because the roster of past and present Asperger Syndrome sufferers now includes Isaac Newton, Albert Einstein and Bill Gates, I humbly suggest that wealth and fame be included among the Asperger Syndrome diagnostic indicators.

What's remarkable about the Grit / Asperger's schism is that, like the psychiatry / clinical psychology schism but more extreme, the two theories don't even acknowledge the existence of the other — in the "Grit" technical literature , Asperger Syndrome isn't mentioned, and in the Asperger Syndrome technical literature , "Grit" isn't mentioned, even though *they describe the same behavior*.

How can this happen? How can two groups of "scientists", ostensibly in the same field, arrive at diametrically opposite conclusions about the same behavior? And more important, how can these "scientists" presume to label people as mentally ill, based on behaviors that are equally likely to be celebrated, depending on the outcome?

Central Theory

The answer is that, unlike scientific fields, psychology has no central theory to unite and define it. The Asperger / Grit example given above, the older psychiatry / clinical psychology example, and many other examples of mutually exclusive ideas, show that the absence of a central theory *prevents meaningful, coherent scientific work*. This is why, in spite of much individual scientific work within the field, psychology isn't a science.

Cargo Cult Science

Nobel Prizewinner Richard Feynman was a longstanding critic of the field of psychology, at a time when psychology seemed more like a science than it does now (before neuroscience presented more effective methods). In his now-famous 1974 CalTech commencement address "Cargo Cult Science" , Feynman says:

> I think the educational and psychological studies I mentioned are examples of what I would like to call cargo cult science. In the South Seas there is a cargo cult of people. During the war they saw airplanes land with lots of good materials, and they want the same thing to happen now. So they've arranged to imitate things like runways, to put fires along the sides of the runways, to make a wooden hut for a man to sit in, with two wooden pieces on his head like headphones and bars of bamboo sticking out like antennas — he's the controller — and they wait for the airplanes to land. They're doing everything right. The form is perfect. It looks exactly the way it looked before. But it doesn't work. No airplanes land. So I call these things cargo cult science, because they follow all the apparent precepts and forms of scientific investigation, but they're missing something essential, because the planes don't land.

Stapel Affair

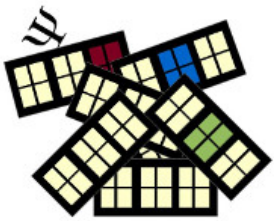
That was 1974, decades have passed, but psychology's airplanes still aren't landing. In a recent psychology scandal and investigation, a very influential professor named Diederik Stapel was discovered to be engaged in widespread fraud. About the investigation, Stapel said , "I have failed as a scientist and researcher ... I feel ashamed for it and have great regret." But the resulting investigation quickly moved beyond Stapel to examine psychology itself. In a summary of the investigation's final report , Science Insider says, "three investigative panels today collectively find fault with the field itself. They paint an image of a 'sloppy' research culture in which some scientists don't understand the essentials of statistics, journal-selected article reviewers encourage researchers to leave unwelcome data out of their papers, and even the most prestigious journals print results that are obviously too good to be true."

Astute readers, in particular those in the field of psychology, will notice that the Stapel scandal isn't about psychology per se, but social psychology. But the most astute among those astute readers will realize that, if psychology were a science, there would be no meaningful distinction between "psychology" and "social psychology" with respect to scientific discipline, any more than there is a meaningful distinction between cosmology and particle physics, all appearances to the contrary.

DSM-V

As this is being written, the latest edition of the DSM — DSM-V — is about to be published. The editorial process for DSM-V differed in important ways from that of prior versions. The most important change, because of the increasing amount of controversy surrounding the DSM, was that the editorial process was carried out primarily in secret. All decisions about diagnoses are made by way of secret votes.

The new DSM continues a longstanding trend of identifying behaviors once thought normal, as diagnostic indicators of mental illness. Proposed for inclusion in the new text are:



- Recategorization of bereavement as depression — meaning what was once a normal period of bereavement at loss of a loved one is now clinical depression, which makes it possible to offer treatment and drugs to anyone sufficiently saddened by loss of a loved one.
- Childhood tantrums — once an expected stage of growing up, tantrums are now a mental illness.
- Internet Addiction (Internet Use Disorder) — many saw this coming, especially those who spend lots of time online.
- Apathy — meaning if the client doesn't care, then the therapist does.
- Hoarding — but not hoarding money, since to get the diagnosis, you have to submit to expensive therapy.
- Binge eating — like skipping breakfast and making up for it at lunch?
- Passive-aggressive disorder — I wish I were making this up. Next to rationalization, passive-aggressive behavior was one of the few remaining psychological luxuries left that didn't merit a diagnosis. Not any more, it seems.
- Sluggish Cognitive Tempo — no, boys and girls, I'm not making this up. It's defined as "a cluster of symptoms ... characterized by the individual being daydreamy, mentally foggy, easily confused, and staring frequently." I spent the first 15 years of my life in this state, brought on by enforced attendance in public schools. And now it's a mental illness?
- Dermatillomania (Skin Picking Disorder) — I can't believe this got included. Do these people realize there is survival value in picking at small wounds?
- Relational Disorder — after reading the details , I see that this catchall diagnosis can be applied to any relationship that one of the participants doesn't like.
- Olfactory Reference Syndrome — a preoccupation with the idea that the sufferer has body odor. No, I'm not kidding — that's now a mental illness.

Allen Frances

About the above list, I confess that I stopped long before exhausting the roster of proposed new DSM-V diagnoses — there are too many, and most are too absurd to merit comment. About the DSM-V process, the linked DSM-V article describes the reaction of Allen Frances, who was head of the DSM-IV task force:

> In June 2009 Allen Frances issued strongly worded criticisms of the processes leading to DSM-5 and the risk of "serious, subtle, (…) ubiquitous" and "dangerous" unintended consequences such as new "false 'epidemics'". He writes that "the work on DSM-V has displayed the most unhappy combination of soaring ambition and weak methodology" and is concerned about the task force's "inexplicably closed and secretive process.". His and Spitzer's concerns about the contract that the APA drew up for consultants to sign, agreeing not to discuss drafts of the fifth edition beyond the task force and committees, have also been aired and debated.

Frances' reference to "false epidemics" may refer in part to the much-analyzed phony epidemic of Asperger Syndrome diagnoses now coming to a close.

Process

The process that's leading to the new DSM version (and all past DSM versions) tells us volumes about psychology and its respect for the scientific method:

- When a medical researcher wants to identify a new illness, she acquires images of the responsible pathogen, discovers its vulnerabilities, creates a treatment that's vetted in clinical trials, then publishes her findings. That's how modern medical practice is managed.
- When a psychologist wants to identify a new illness, he gets together with like-minded psychologists, they hold a secret meeting and *they vote*. That's how psychology is managed.

Imagine if science were run like psychology — "Is there life on Mars? Rockets are expensive — let's vote!"

Conclusion

Readers from the field of psychology may object that the above criticisms deal primarily with clinical psychology and psychiatry, and "everyone knows" they aren't really scientific, even though they're recognized fields within psychology (I'm not guessing — I've heard this objection many times). But if that's true, and if the more scientific parts of psychology can't produce scientific evidence and theories to stem the flood of nonsense within the field, what does that tell us about the field as a whole? *It says the field doesn't have any persuasive theories with which to unify itself*.

I have always thought the most reliable test of a field's scientific standing is to locate the worst examples from within the field that weren't examples of outright fraud, examples that didn't cause the originators to be expelled from the field, and make that the standard by which the field's overall scientific standing could be measured. If psychologists think that's too harsh, perhaps they should solve the credibility problem by expelling clinical psychology and psychiatry from the field.

I know that won't happen — clinical psychology and psychiatry are too lucrative and are too much a part of the public's sense of what psychology is, as well as being a large source of income for universities that offer training in those disciplines. Also, if that change were made, it would leave social psychology intact, and that field is as big a disaster as clinical psychology.

So, given those practical constraints, I close this article in the most constructive possible way — by warning lay readers that *psychologists aren't scientists*. If psychologists were scientists, they would move beyond individual studies — they would shape and then test general principles and theories about the human mind, *about psychology itself*, with the intent to place the field on a solid scientific foundation, just as though they were biologists or physicists. And if the theoretical tests failed, psychologists would move on to a more promising field like neuroscience. But I know psychologists won't do either of these things, which explains why psychology remains the last great medieval discipline, reliant as much on magic as reason.

Feedback

- Reader responses to this article.

References

1. Evolution — the scientific theory saying that species evolve over time by means of inherited traits.
2. Natural selection — the scientific theory saying that species with favorable inherited traits are likely to sire more offspring, thus producing an advantage for that genotype.
3. Cell Biology — the science of individual living cells.
4. Genetics — the study of DNA and related mechanisms of inheritance.
5. Creationism — the idea that complex creatures were created directly by God, fully formed, rather than having evolved over time by way of natural selection.
6. Intelligent Design — the idea, derived from Creationism, that complex creatures result from intervention by a "designer" rather than by way of natural selection.
7. Establishment Clause — A clause in the U.S. Constitution that prevents granting religion a special place in public affairs.
8. Empirical — the property of scientific theories that they are based on experimentation rather than philosophical reflection.
9. David Hume — science philosopher responsible for the well-known "black swan" aphorism.
10. Falsifiability — the requirement that scientific theories be in principle falsifiable by new evidence.
11. Scientific Law — not the legal meaning of "law", instead, either a principle or an axiom, modifiable or refutable by new evidence.
12. Scientific Theory — scientific theories define scientific fields.
13. National Academy of Sciences — An influential U.S. scientific society.
14. Science, Evolution, and Creationism (National Academy of Sciences) — the full text.
15. Science, Evolution, and Creationism (National Academy of Sciences) (Excerpt) — an excerpt that concisely defines "scientific theory".
16. Inductive Generalization — the process by which one shapes general scientific theories based on specific observations.
17. Demarcation Problem — the philosophical problem of distinguishing between science and non-science.
18. Law of Parsimony — also known as Occam's razor, the precept that simple explanations are to be preferred over complex ones.
19. Coming of Age in Samoa — A landmark book in sociology that made Margaret Mead world famous, but that was

eventually shown to rely on fantasies concocted by her teenage subjects.

20. Balkanization — a process of fragmentation of a territory into mutually hostile regions.
21. Physics Envy — the envy said to exist toward physics by other, less scientific disciplines.
22. Thomas Insel — director (2013) of the National Institute of Mental Health.
23. National Institute of Mental Health — the primary U.S. agency for mental health issues.
24. Faulty Circuits (Scientific American, April 2010) — NIMH director Thomas Insel describes a transition from psychology to neuroscience as the preferred approach to mental health issues.
25. Standard Model — the theoretical foundation of modern physics.
26. Cosmology — the branch of physics that studies events and processes at the largest scale.
27. Particle Physics — the branch of physics that studies events and processes at the smallest scale.
28. Dark Matter — a relatively recent discovery in physics that posits a new form of matter.
29. Conservation of Energy (Wikipedia) — a physical principle that says energy cannot be created or destroyed, only changed in form.
30. Conservation of Energy (local) — a mathematical analysis of an elliptical orbit
31. Gravitational potential energy — the energy intrinsic to a gravitational field.
32. Kinetic Energy — the energy of motion.
33. Thermodynamics — the branch of physics that analyzes heat and work.
34. Grit — a psychological theory that identifies focus on a few activities, or one activity, as a sign of remarkable personal achievement.
35. Asperger Syndrome (Wikipedia) — a psychological theory that identifies focus on a few activities, or one activity, as as sign of mental illness.
36. Asperger Syndrome (National Library of Medicine) — another source referencing Asperger Syndrome.
37. Grit: Perseverance and Passion for Long-Term Goals (PDF) — a technical article that summarizes the "grit" (perseverance) theory.
38. California Institute of Technology — Richard Feynman's home for many years.
39. Diederik Stapel — a psychology professor found to have committed extensive fraud.
40. Fraud Case Seen as a Red Flag for Psychology Research — the Stapel Affair is seen as reflecting badly on psychology as a science.
41. Flawed science: The fraudulent research practices of social psychologist Diederik Stapel (PDF) — the investigating committee's final report (English translation).
42. Final Report: Stapel Affair Points to Bigger Problems in Social Psychology — a science magazine's concise summary of the Stapel investigation.
43. Diagnostic and Statistical Manual of Mental Disorders — psychology's "Bible" and a very influential diagnostic guide.
44. DSM-V — at the time of writing, the most recent version of the DSM.
45. Relational Disorder — one of the more nebulous DSM-V diagnoses.
46. Olfactory Reference Syndrome — in DSM-V, a diagnosis based on a preoccupation with the idea that the sufferer has body odor.
47. A Warning Sign on the Road to DSM-V: Beware of Its Unintended Consequences — DSM-IV task force chair Allen Frances criticizes the DSM-V editorial process.
48. What's A Mental Disorder? Even Experts Can't Agree — Allen Frances discusses the Asperger's "epidemic".

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