No Theory, No Science

Paul Lutus
http://arachnoid.com

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Abstract

The formal scientific standing of most technical fields isn't controversial – biology is regarded as a science, astrology is regarded as a pseudoscience – and scientific fields are defined by theories that have survived sincere efforts at falsification. But as to psychology, because of the field's ambiguous location on the spectrum of formal disciplines and because of recent controversies surrounding the linked issues of evidence and theory, there appears to be an attempt to, not move psychology toward science, but move science toward psychology. This article addresses these issues and, in an effort to clarify psychology's standing, presents and discusses a clear definition of science.

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1 Definition of Science

We start with a definition of science about which there is reasonable agreement. The question of what is and is not science is formally known as the *demarcation problem*[1], and as time passes and more social issues come to rely on a scientific standing for credibility, the issue has become somewhat contentious.

1.1 Required Properties

A search of online resources produces a brief but practical definition of science. A scientific theory must be:

1. empirical, meaning based on observations of nature[2].
2. tentative, meaning always open to further investigation.
3. falsifiable, meaning capable of being proven false by contradicting observations of nature[3].
4. regarded as without merit until empirical evidence supports it (the *null hypothesis*[4]).

Beyond the above points, an essential but less easily stated property of scientific theories is that they *explain* one or more observations of nature, that is, they provide an intellectual framework for our observations, one able to predict observations not yet made. Here's an example – if I say, "the nighttime sky is filled with tiny points of light," I've offered a *description*. But if I say, "those points of light are actually distant thermonuclear furnaces like our sun," I have offered an *explanation*, a *theory*, one that can be tested and possibly falsified.

Another way to say this is that an observation *quantifies*, but a theory *synthesizes*, joins different observations in a unifying intellectual framework, a framework that may include the notion of first principles[5], which are axiomatic propositions that hold true across many seemingly unrelated observations.

1.2 Sources

The above points were to some extent derived from online resources, academic and legal. Here are some of them.

1.2.1 Encyclopedia Britannica

The online Encyclopedia Britannica entry for the term *falsifiability*[6] says that falsifiability is "... a standard of evaluation of putatively scientific theories, according to which a theory is genuinely scientific only if it is possible in principle to establish that it is false." The article then offers counterexamples: "According to [Karl] Popper[7], some disciplines that have claimed scientific validity — e.g., astrology, metaphysics, Marxism, and psychoanalysis —are not empirical sciences, because their subject matter cannot be falsified in this manner."

1.2.2 Wikipedia

In its science article[8], the online encyclopedia Wikipedia says, "A scientific theory is empirical, and is always open to falsification if new evidence is presented." This description corresponds reasonably well with the science definition set out above.

1.2.3 Legal Rulings

As time passes, more social and legal issues cross paths with science, and legal rulings have become more reliant on scientific evidence, which requires that science have a clear definition. In an influential 1982 ruling[9] whose purpose is to keep religious teachings out of public school science classes, a court defined science this way:

- It is guided by natural law;
- It has to be explanatory by reference to natural law;
- It is testable against the empirical world;
- Its conclusions are tentative, i.e. are not necessarily the final word; and
- It is falsifiable.

In my view the wording of the ruling could have been made less ambiguous. The last point – falsifiability – should have emphasized that this means falsifiable by means of contradicting empirical evidence. But as with the other definitions, this source shows essential agreement with the definition given at the top of this section.

A similar but more important ruling by the U.S. Supreme Court, now known as the *Daubert* standard[20], changed the rules for scientific testimony in 1993. I cover this ruling in greater detail below, but *Daubert* also defines science in a way consistent with the definition given above.

1.2.4 Dictionaries

For the benefit of students reading this article, I will explain why a dictionary is not a suitable resource for discovering the technical meaning of science, or for that matter, any technical term.

Contrary to common belief, a *dictionary is not a list of word meanings.* A dictionary's purpose is not to define words correctly (i.e. *prescribe*) but to report what people think words mean (i.e. *describe*).

Evidence for a dictionary's true purpose can be shown by looking up the word "literally" – a typical dictionary[10] lists two meanings:

- "in a literal sense or manner"
- "in effect, virtually"

This dictionary definition means the word "literally" can be assumed to have its default meaning, and the opposite of that meaning as well. This makes a dictionary the wrong tool for finding a reliable definition of science or any other technical term.

1.3 Skepticism and Authority

Point (4) in the Required Properties list above summarizes an important property of scientific thinking, one that may be described as healthy skepticism toward ideas lacking empirical evidence. Formally described as the *null hypothesis*[4], this precept is a litmus test for disciplined scientific thinking.

It is a corollary of the null hypothesis that evidence has the highest standing, and authority has no standing at all. This precept has deep roots in science, extending back in time at least to the founding days of the Royal Society[11], the oldest scientific society still in existence (dating to A.D. 1660), and whose motto is *nullius in verba*[12] or "take no one's word for it."

Science's skeptical posture toward authority poses a problem for the clinical practice of psychology, which requires a pseudo-medical authority to function, a topic to which we shall return.

1.4 Science and Pseudoscience

When people come to agreement on the meaning of science, the distinction between science and pseudoscience[13] can be concisely expressed:

1.4.1 Posture toward Evidence

- A scientist assumes an idea has no merit until there is empirical evidence to support it[4] and accepts personal responsibility for producing the evidence.
- A pseudoscientist takes the opposite position – he believes an idea is true until it's been proven false, accepts no responsibility for evidence, and requires others to produce the falsifying evidence.

The scientist's choices conform to the Required Properties of science put forth at the top of this section. The pseudoscientist's posture accurately reflects a number of modern practices that masquerade as science, and it often leads to a requirement for *proof of a negative*, which in the general case is a logical error named *argument from ignorance*[14]. An example may serve to reveal the error:

- To the claim "Bigfoot exists," a scientist will assume the claim has no merit until empirical evidence supports it.
- To the same claim, a pseudoscientist will assume the opposite – that the claim is true until Bigfoot can be *proven not to exist*.
- But proving Bigfoot doesn't exist would require a search of the entire universe, an impossible burden of evidence, one aptly described in an analogy called Russell's Teapot[15].

To summarize this point, to a scientist, Bigfoot's existence hinges solely on empirical evidence, while to a pseudoscientist, Bigfoot exists because it hasn't been proven not to exist. And because no one can possibly prove Bigfoot's nonexistence, the pseudoscientist is secure in his belief.

1.4.2 Pseudodiseases

If the pseudoscientist's outlook seems irrational, one that couldn't possibly be taken seriously, consider that psychologists accepted the existence of Asperger Syndrome[16] without any evidence that it was real and distinct from other mental states, until the public cried foul and forced its abandonment[17].

In an earlier episode, psychologists accepted the validity of Recovered Memory Therapy[18] until the legal system, burdened with scores of nonsense sexual and other abuse claims, cried foul and changed the requirements for scientific testimony*.

1.4.3 Scientific Testimony

The practice of Recovered Memory Therapy, and the flood of bogus legal cases based on claims from this therapy, was one of the reasons the U.S. Supreme Court changed the rules for scientific testimony in 1993. In *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[19], the Court produced an influential ruling now known as the *Daubert* standard[20]. At risk of oversimplification, *Daubert* says that scientific expert testimony must derive from scientific methodology, using a list of requirements that closely resembles the definition of science provided above, including the phrase "Empirical testing: whether the theory or technique is falsifiable, refutable, and/or testable."

The Court's ruling in *Daubert* relies on, and quotes from, Karl Popper's[7] book *Conjectures and Refutations: The Growth of Scientific Knowledge*[21]: "the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability." In an online excerpt[22] from *Conjectures*, Popper says about Marxism, psychoanalysis, and individual psychology, that they "had in fact more in common with primitive myths than with science; that they resembled astrology rather than astronomy."

It should be apparent that the *Daubert* legal standard provides a basis for excluding psychological testimony on the ground that psychology fails *Daubert*'s requirements for scientific substance.

1.4.4 Pseudopatients

Because the mind cannot be a source of empirical evidence, psychologists are forced into reliance on the self-reports of their clients. In the now-famous Rosenhan experiment[23], researchers gained admission to a mental hospital by

*But not for this reason alone – the rules for scientific testimony were overdue for an upgrade.

feigning symptoms of mental illness. Of eight pseudopatients including Rosenhan, all were promptly diagnosed with serious mental ailments and admitted to the facility for treatment. Then, on cue, the pseudopatients announced they were feeling much better and asked to be released. But as a condition of their release, all were forced to admit to having been mentally ill, and were required to take antipsychotic medications.

After publication of the results and subsequent controversy, an unplanned second phase of the study began – an offended mental hospital administration challenged Rosenhan to send more pseudopatients to the facility to try to gain admission by faking symptoms. In the following weeks 193 new patients arrived at the hospital, and of that number, 41 were identified as faking their symptoms and refused admission. But in fact, Rosenhan had not sent any more pseudopatients to the mental hospital – the rejected patients sincerely believed they were suffering from a mental illness.

The self-reporting problem reveals the difference between the mind and the brain. Imagine an actor, skilled in the dramatic arts and familiar with the symptoms of, say, Asperger Syndrome[77] or Post-Traumatic Stress Disorder[24] – can such an actor fake the symptoms of a *mind* dysfunction and acquire a phony psychological diagnosis? Well, yes – indeed it's been shown repeatedly, in many experiments like the above, and in police reports[25], that a person sufficiently motivated can play the system and acquire a mental diagnosis for research or personal gain.

Now let's compare the practice of psychology to the practice of medicine. Can the same actor fake the symptoms of a *brain* dysfunction and acquire a phony medical diagnosis? Well, no, he can't, because physicians have objective laboratory criteria to detect brain dysfunctions – empirical evidence that rises above opinion.

Let's summarize. A psychology pseudopatient can gain admission to a *mental* hospital and receive pseudotherapy for a nonexistent *mind* pseudodisease, but a medical patient cannot gain admission to a *medical* hospital and receive therapy for a nonexistent *brain* disease. The reason is that psychological evidence is neither empirical nor objective – it relies on statements made by people who may have any number of reasons for deceiving themselves, or others, or both. What conclusions can we draw from this? One, that *the mind is not the brain* – the mind is an idea, not an organ. And two, that psychologists and psychiatrists accept pseudopatients and dispense pseudodiagnoses because psychology is a pseudoscience[13].

The point of this section is not to say that all mental illnesses are phony – it is to say that we have no objective way to find out. It's also not to claim that psychologists and psychiatrists don't help people. Many of these people are very skilled and helpful, but this results from their individual abilities, not because of psychology's standing as a science.

1.4.5 Psychology Defined

The online encyclopedia Wikipedia[26] has a psychology section that sees frequent edits as social events unfold. At one time psychology was defined as "the study of the mind and behavior," until someone pointed out that this made psychology seem less scientific than neuroscience[27], defined as "the scientific study of the nervous system." So, Wikipedia editing being a relatively open process, someone simply added the word "scientific.": "The *scientific* study of the mind and behavior." Much better.

But eventually someone, possessed of more than average insight, realized the new definition included a contradiction in terms – how can study of the mind be scientific? The mind isn't accessible to empirical study, even for something so trivial as producing an empirically testable, falsifiable claim that the mind exists. How then can study of the mind be described as scientific?

It seems this outlook won over its critics, and the current Wikipedia definition of psychology[28] has been changed to read, "the study of behavior and mind." The definition goes on to say psychology "... is an academic discipline and an applied science ...".

I won't try to imagine the struggle over this definition that must have taken place behind the scenes, because applied science[29] isn't science[8], it is the application of results acquired from a science, by people who don't necessarily understand the science they're applying.

The new definition of psychology as "applied science" represents an incremental step toward the truth, but as Louis Pasteur[30] said, "There are no such things as applied sciences, only applications of science."[31] Pasteur took this position to object to things being defined as science solely on the ground that scientific methods are applied. Were this practice to be accepted, such fields as Astrology would become science on the ground that a person could use scientific methods to create unscientific results.

2 Scientific Theories

2.1 Dictionary Definition

A large chasm separates the public's understand of science, and science itself. The public view of science can be gauged by examining a dictionary's definition of science*. The Merriam-Webster[32] online dictionary defines science this way[33]:

- knowledge about or study of the natural world based on facts learned through experiments and observation
- a particular area of scientific study (such as biology, physics, or chemistry) : a particular branch of science
- a subject that is formally studied in a college, university, etc.

At small risk of oversimplification, this defines science as knowledge, as facts. But science is not a *product*, it is a *process*, a discipline for arriving at testable theories about nature, and the most important part of the process is a sincere effort to prove theories false.

The end product of scientific activity is, not theories that have won a popularity contest, but theories that have survived repeated efforts at falsification and that remain open to similar efforts in the future.

2.2 Mathematical Theories

(Readers not interested in a technical description of science may prefer to skip forward to this section's Summary on page 7.)

The highest quality science resides in theories expressed mathematically, for the reason that mathematics expresses theories, and suggests comparisons with nature, in a clear and unambiguous way. When comparing mathematical and other kinds of theories, the former's clarity of expression means:

1. Mathematical theories are more easily falsified by comparison with nature.
2. Because of point (1) above, mathematical theories are regarded as more reliable.
3. It's much easier to see connections and associations between mathematical theories than for theories lacking this property. Over time this may reveal connections between theories, and sometimes between fields, that either strengthens or falsifies the theories†.

Here's an example of point (3), showing connections between mathematically expressed theories:

2.2.1 Kepler's Laws

In 1609, Johannes Kepler[34] published his laws of planetary motion[35], which say that:

1. The orbit of a planet is an ellipse with the Sun at one of the two foci.
2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time.
3. The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit.

2.2.2 Newton's Theory of Gravity

In 1687, Isaac Newton[36] created a theory of gravitation consistent with Kepler's Laws. At first Newton relied on Kepler's Laws for intuition about what form a gravitational theory might take, then, as his theory developed, he was able to test whether the result agreed both with Kepler's Laws and with what astronomers observed.

2.2.3 Conservation of Energy

In 1676, Gottfried Wilhelm Leibniz[37] created an early expression of the idea of conservation of energy[38], the idea that energy is neither created nor destroyed, only changed in form.

2.2.4 Kinetic Energy

First articulated by Liebniz and Johann Bernoulli[39], kinetic energy[40] is the energy a body possesses resulting from its motion. It is proportional to a body's mass times the square of its velocity.

2.2.5 Gravitational Potential Energy

Gravitational potential energy[41] is energy arising from an object's position in a gravitational field, and includes the idea that ascending within a gravitational field requires an expenditure of energy.

*For reasons given earlier, a dictionary records what people think words mean, not technically accurate definitions.

†Both outcomes are regarded as beneficial to science.

2.2.6 Synthesis

Above we list five apparently independent scientific theories, each expressed mathematically, each empirically falsifiable by comparison with nature. As it turns out, because of the clarity of expression granted by mathematics, the five theories can be tested *and potentially falsified* at once by observing the motion of a body in an elliptical orbit:

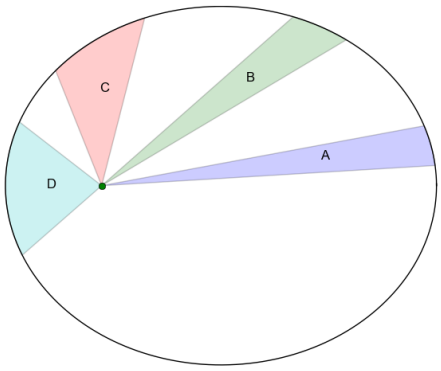

Figure 1: Computer-modeled elliptical orbit

By observing the motion of orbiting bodies, astronomers subject mathematical theories about nature to a rigorous empirical test that could overthrow all of them. In an elliptical orbit (see Figure 1), the principle at work is that, as the orbiting body moves closer to the parent body, it loses gravitational potential energy (decreased distance) but gains kinetic energy (increased velocity). In order for the orbit to confirm Conservation of Energy (2.2.3), the two kinds of energy, potential and kinetic, *must sum to a constant* everywhere in the orbit. As it happens, in computer models of elliptical orbits as well as in observations of nature, the results agree with theory to ten or more decimal places:

- Observed and modeled orbits agree with Kepler's Second (equal-area) law[82] to a high degree of precision (the shaded sections A-D in Figure 1 all have equal areas).
- The motion of bodies in elliptical orbits agree with Newton's Theory of Gravity (2.2.2, also see equation 5.1 in this article's appendices).
- Bodies in elliptical orbits show energies consistent with theories of Kinetic Energy (2.2.4) and Gravitational Potential Energy (2.2.5) at each point in their orbits.
- The total energy of an orbiting body, the combination of kinetic and potential energies, sums to a constant, confirming Conservation of Energy (2.2.3).

See the Energy Conservation appendix on page 12 for a more technical treatment of this subject.

2.3 Summary

The above analysis shows how science is created. As in all worthwhile scientific analyses, it's entirely dependent on observations of nature, it's expressed mathematically, and it's falsifiable. If any part of the analysis fails, the entire analysis fails. If the analysis fails, the theory fails.

To emphasize this point, let me compare science to psychology.

In science:

- The process begins with observations of nature,
- moves to the shaping of theory,
- compares the theory to nature in new contexts to see if it remains valid,
- and may end with the theory's application to practical problems.

At each step in this process, the null hypothesis[4] rules – without supporting empirical evidence, a theory is assumed to have no merit.

In psychology, the order of events is reversed:

- Psychologists begin by applying an idea* to patients in clinical settings,
- then compare the idea to other ideas,

*We can't call them theories, that would be misleading.

- then sample public and legal opinions,
- then abandon the idea*.

At each step in this process, the null hypothesis is *ignored* – ideas are assumed to be valid to the degree that no one has yet proven them false. A historical list of psychological ideas, provided in the Psychological Pseudoscience appendix, shows this process clearly.

The irony of modern psychology is that psychologists insist that their activities pass muster as science, and their clients believe them.

3 Recent Controversies in Psychology

3.1 Replicability

It's been recognized for some time that the rate of successful *replications*[42] (efforts to reproduce a prior result) in psychology is very low, primarily because replications are rarely undertaken. There are many reasons for this – psychology journals favor original work over re-examinations of prior work[43], psychologists expect more professional advancement from original work compared to reviews and reassessments of work performed by others[44], and psychologists have a generally negative view of replication efforts[45].

3.1.1 Failed Replications

About the replication issue, some psychologists move beyond indifference to hostility. In an article entitled "On the evidentiary emptiness of failed replications"[46], Harvard psychology professor Jason P. Mitchell[47] says, "Recent hand-wringing over failed replications in social psychology is largely pointless, because unsuccessful experiments have no meaningful scientific value ... the likeliest explanation for any failed replication will always be that the replicator bungled something along the way." It seems not to have occurred to Professor Mitchell that the original finding might also have resulted from someone bungling something along the way, and the scientific purpose of replication is to evaluate this possibility.

Professor Mitchell goes on to say, "The field of social psychology can be improved, but not by the publication of negative findings ... authors and editors of failed replications are publicly impugning the scientific integrity of their colleagues." But one purpose of science is to transcend feelings on a journey toward facts, and how we feel about the outcome must never be allowed to undermine the process.

It's my hope that the above represents a minority outlook. Among properly trained scientists it's recognized and accepted that successful study replications are essential to the scientific standing of a theory or a field[48]. This is the basis for the replication crisis[49] in psychology.

3.1.2 Reproducibility Project

In response to pressure to address the replication crisis, Brian Nosek and associates in the Reproducibility Project[50] carried out a large-scale study meant to test the replicability of 100 high-profile psychology studies published in three psychology journals.

In August 2015, the project published its conclusions[51]. The study found that, of the 100 studies, only 39% could be replicated, and of the successful replications, the average effect size was half that of the original study.

In some ways the result of the study caused more controversy than the original observation (that psychological studies are rarely subjected to replication efforts), and some researchers have objected to the study's design and conclusions[52], but without going so far as to suggest or perform their own replications.

3.2 Ego Depletion Effect

In a related controversy, a psychological effect called "ego depletion"[53], for some time a mainstay of much psychological research, publication and thinking, appears to have no reliable statistical basis. The authors of a debunking meta-analysis[54] summarize their conclusion by saying, "... we found very strong signals of publication bias[43], along with an indication that the depletion effect is actually no different from zero."

*Yes – over time, all psychological ideas are abandoned (5.1).

3.3 The Role of Theory

It is the thesis of this article that low study replication rates, and widely held beliefs that have no reliable basis, result from a critical structural deficit in modern psychology – an absence of defining, empirical theories. Instead of comparing experimental results to established theories, because there are no such theories available psychologists are reduced to comparing one experimental result to another experimental result, a task not unlike herding cats.

Psychology, in contrast to fields like physics, biology and others, has no empirical, testable, falsifiable theories to define the field, guide research efforts, and incrementally build on prior theoretical falsifications and confirmations. To put this another way, psychology doesn't *explain* the human mind, it *describes* it. It should be apparent that a field only able to describe, that cannot explain (i.e. propose falsifiable theories), doesn't meet science's definition[55].

In recent discussions with psychologists, I've been told that it's not so, that psychology does have theories, for example the Placebo Effect[56] and In-group Bias[57], to name just two. But those ideas originated in fields other than psychology, they're observations, not theories (they have no explanations able to rise above the status of anecdote), and because they don't presume to explain observations, they're unfalsifiable.

The Placebo Effect is a perfect example of something that appears to be a theory but that fails one or more of a theory's requirements. There's universal agreement that the effect is real, but it's equally true that no one knows how or why the effect exists. Until the effect can be explained, and the explanation tested in a way that could lead to a falsification, *and* a testable prediction made about an as-yet unobserved corollary, it's not a scientific theory. Also, the characterization of the effect originated in, and is most reliably confirmed through changes in, biology, not psychology.

3.4 Summary

These findings warrant much greater skepticism toward psychology's claims than exists at present. Based on the outcome of the reproducibility study[51], the ego depletion meta-analysis[54] and related findings, those who read the professional psychological literature are cautioned that, statistically speaking, the probability is *greater than even* that a given article's claims don't correspond to reality, and for the minority of articles having some connection with reality, the significance of the result is much less than claimed.

4 Moving the Goal Posts

4.1 Postmodernism

In my conversations with psychologists I frequently hear that science doesn't have a clear definition, that anything even superficially related to science qualifies as science, and/or that science is like art – it's all in the eyes of the beholder. Not only are these claims not true, but they can lead to real social harm.

Apart from the social and political consequences of a slippery definition of science, to argue that something as basic as science cannot have a clear definition is to embrace *deconstructive postmodernism*[58], essentially the outlook that there are no shared, objective truths, that everything is a matter of opinion. With a little insight one can see the logical error implicit in the postmodernist position: it denies the existence of shared, objective truths, then tries to start a dialogue requiring what's just been denied.

Recent events have undermined the above debate. A number of legal precedents, including the U.S. Supreme Court ruling in *Daubert*[20] discussed above, define science in a way that's compelling on institutions and individuals who must pay attention to issues of law – that is to say, all of us. According to these sources, psychology doesn't meet science's definition.

4.2 Authority in Psychology

For some time I've been hearing from psychologists that authority plays an important part in psychology. This obviously undermines the field's claims to a scientific standing (because science rejects authority[12]), but it also reveals a practical problem for clinicians – without some kind of authority, how can a psychologist meet the expectations of typical modern clients of psychological practice, many of whom simply want to be told what to do?

A medical doctor's diagnoses and proposed treatments have a persuasiveness resulting from the fact that modern medicine is based on science – the doctor can appeal to reason instead of authority. But psychology isn't a medical field and isn't based on scientific results, which means a psychologist can only argue from a position of authority – the old-fashioned, arbitrary kind of authority that lacks a rational basis. But as public understanding of science and evidence-based practice[59] improves, psychology's authority is being gradually undermined.

One solution to this dilemma is for a student to acquire a medical degree and its scientific connections, then acquire a psychology degree and a knowledge base that psychology's clients actually care about. This successful strategy produces an individual called a *psychiatrist*[60], a profession invented to lend scientific substance (medicine) to an unscientific enterprise (psychology). (Another advantage is that psychiatrists can write drug prescriptions, a lucrative practice that often becomes the primary activity.) Second only to the invention of Asperger Syndrome[77], psychology's invention of the psychiatrist has been the most successful strategy yet to acquire unearned public approval.

4.3 Neuroscience

But there's a basis for optimism, for change. The biggest future threat to the imagined authority of psychology is neuroscience[27]. Neuroscience will eventually mature to the point where it can offer real diagnoses – and some treatments – for what psychologists claim to be mental illnesses. During that process, today's "mental illness" category will narrow, and eventually disappear entirely, along with mind studies as a serious pursuit.

Because of the existence and rapid growth of neuroscience, because of an increased respect for the scientific method and evidence-based practice[59], because of a gradual awakening to the fact that "mental" illnesses are either fantasies or physical illnesses with mental symptoms, the end of the historical trend described here will be an *abandonment of mind studies*.

In the closing remarks of a recent "NOVA Science Now" episode entitled "How Does the Brain Work"[61], astrophysicist and science popularizer Neil DeGrasse Tyson compared psychology to alchemy, saying, "Our best hope today lies with the neuroscientists. What are thoughts but electrical impulses among brain cells? What are ideas but novel firings of those cells? What are mental problems if not impulses that have misfired? In the way that chemistry arose from the ashes of alchemy, neuroscience, a field still in its infancy, may one day subsume psychology, laying bare our inner universe, which has remained hidden for so long."

4.4 Gender Shift

In 1970, women acquired 20% of psychology degrees, but in 2005, women acquired 72% of those degrees[62]. During the same period, income from, and employment opportunities in, psychology declined compared to other fields, as a result of which psychology degree holders now have the highest unemployment rate of any degreed profession[63] – in fact, in recent years the unemployment rate among clinical psychologists has been more than twice that of the population as a whole.

I have a prediction about psychology – we're already seeing employment opportunities disappear at an astonishing rate, but this is just the beginning. Today, psychology employment is evaporating. Tomorrow, *psychology will evaporate*[*]. It will be replaced by neuroscience.

But I have a higher purpose than alerting students to the fact that they're entering the wrong field (true, but never mind). When I examine the historical gender-shift statistics quoted above, I despair the flight of women from STEM[†] professions[64], where they belong and where humanity's future lies.

In furtherance of the goal of getting more women out of the dead-end field of psychology and into STEM professions, I offer this advice:

- When you hear people identify psychology as a profession women are designed for, ask yourself whether you're the kind of woman designed to swallow that kind of argument.
- When you hear someone tell you, face to face, that a field of study is too difficult for you, ask yourself if that same advice would be offered to a man in the same circumstances.
- Learning science/technology/engineering/mathematics may be hard, but throwing your life away is harder.
- Someday in the next 50 years, a brave soul is going to step out of a spacecraft onto the surface of Mars and start preparing that planet for human habitation[65]. Would you like to play a large or small part in getting her there, or would you prefer to be an unemployed psychologist?

5 Appendices

5.1 Psychological Pseudoscience

Because psychologists cannot shape and test unifying empirical theories about the mind, this allows them to invent imaginary diseases and offer imaginary cures. Here are a few examples psychologists have dreamt up over the years,

[*]But psychology won't disappear. Instead it will have the status of astrology – a harmless diversion for weak-minded people.
[†]Science, Technology, Engineering, and Mathematics.

based on popular sentiment, prejudice, and social fads.

- **5.1.1 Drapetomania**

  An imaginary mental illness dating to before the U.S. Civil War, Drapetomania[66] presumed to explain why slaves ran away from their masters (apparently a desire for freedom wasn't a suitable explanation). There was no corresponding mental illness to explain why slave owners believed it was moral to own a human being, but the slave owners, not the slaves, paid the psychologists.
  Outcome: abandoned.

- **5.1.2 Prefrontal Lobotomy**

  A procedure developed during the 1930s, then popularized in the U.S. by Walter Freeman[67] and associates, Prefrontal Lobotomy[68] achieved its greatest popularity in the early 1950s, during which time Freeman drove about the U.S. in his "lobotomobile," performing icepick lobotomies at mental hospitals along the way. After a total of 100 of his patients died from the procedure, Freeman, who had no formal surgical training, was banned from performing any further procedures.
  The advantage of the lobotomy was that it rendered mental patients docile and manageable. The drawback was that it often left them without personalities or intelligence. In the U.S. about 40,000 people received the procedure before its terrible effects caused the procedure to be banned. One critic of the procedure remarked, "through lobotomy, an insane person is changed into an idiot."[69]
  Outcome: abandoned.

- **5.1.3 Homosexuality**

  When homophobia reached its peak in the mid-20$^{\text{th}}$ century, psychologists listed homosexuality as a mental illness[70] and offered nonsense "treatments"*. When public attitudes changed, homosexuality suddenly wasn't a mental illness any more and was removed from the diagnostic guide[71]. But because of the undisciplined and unscientific nature of psychology, society now finds it necessary to pass laws forbidding therapists from trying to force changes in people's sexual orientation[72].
  Outcome: abandoned.

- **5.1.4 Refrigerator Mother**

  Invented by a prominent psychiatrist, this widely accepted pseudoscientific diagnosis supposedly explained schizophrenia and autism as resulting from emotionally crippled mothers unable to bond with their children[73]. Relying on the imagined authority of a psychology expert and with no scientific evidence, this outrageous belief held responsible any number of innocent and caring parents for outcomes that actually arose in organic and genetic conditions outside psychology's purview.
  Outcome: abandoned.

- **5.1.5 Recovered Memory Therapy (RMT)**

  This dangerous, nonsense fad took hold in the 1990s. Therapists who practiced RMT[74] talked their clients into imaginary "memories" of (among other things) vile sex crimes. In some cases virgins, brainwashed by their unscrupulous therapists, reported copious details of imaginary rapes[75]. Many lives and families were destroyed before the stupidity of the claims became apparent. Psychology insiders now describe RMT as a "debacle"[76], but in the long term it's had little effect on the relationship between therapists and their naive clients.
  Outcome: abandoned.

- **5.1.6 Asperger Syndrome**

  Also known as "Asperger's", this diagnosis appealed to parents who believed their bright youngsters weren't "normal". Psychologists used the Asperger's[77] diagnostic criteria to misdiagnose bright youngsters as mentally ill, then offered therapies meant to "correct" behaviors that are normal for bright people[78]. After an epidemic of nonsense diagnoses of above-average youngsters, Asperger's lost public credibility and was removed from

*Treatments that drove computer pioneer Alan Turing to suicide.

psychology's diagnostic manual[79]. But, just as with homosexuality, some psychologists still offer "treatments" for this discredited idea.
Outcome: abandoned.

Some notes for the above list:

- It's hardly comprehensive – it only shows a few highlights in the history of modern psychology.
- As with all psychological ideas, each of them has been abandoned.
- On reviewing the list, with a little insight one can see it represents an evolutionary process, of learning by experience, and each new imaginary ailment shows more sophistication in appealing to public taste and prejudice.
- To date, by far the most successful imaginary ailment has been Asperger Syndrome, for these reasons:
  - It exploits a superficial association with an objectively real organic ailment with genetic roots (Autism[80]), that, because of its biological origins, lies outside psychology's purview.
  - Its diagnostic indicators are close enough to the normal behavior of intelligent people that the latter are assured of receiving the diagnosis if they want it (in a practice called "pathologizing normal behavior").
  - In a stroke of public relations genius, psychologists "diagnosed" a number of famous people, living and dead, with Asperger's, including Isaac Newton, Thomas Jefferson, Albert Einstein and Bill Gates. This has had the effect of making a mental illness diagnosis seem appealing, desirable, even a status symbol, for the first time.

Asperger's was as wildly successful as Recovered Memory Therapy was wildly unsuccessful, but Asperger's finally became a victim of its own success. So many people clamored to be allowed into the exclusive Aspie* club that even psychologists realized they had given birth to a monster. So to prevent further damage to psychology, they removed Asperger's from the DSM[81], psychology's "bible", only to discover that, like an undead zombie, Asperger's has taken on a life of its own.

In a perhaps unintended irony, those responsible for removing Asperger's from the diagnostic guide explained their decision by saying, "It's not an evidence-based term[79]," overlooking the fact that none of the DSM diagnoses are evidence-based (all rely on lists of symptoms, none rely on a knowledge of causes, i.e. science).

When reviewing psychology's history and the connection between wealth, power and what society chooses to describe as mental illness, it becomes clear that to predict the outcome of a mental health controversy one need only ask, "Who pays the psychologists?"

5.2 Energy Conservation

The principle of energy conservation[38] states that energy cannot be created or destroyed, only changed in form. As it happens, with respect to an orbiting body four independent physical theories, each expressed mathematically, support a fifth theory (energy conservation), and in principle could falsify it.

The first theory to be tested is known as Kepler's Second Law[82]: "A line joining a planet and the Sun sweeps out equal areas during equal intervals of time."

The second theory is that of gravity, which (at relatively low velocities) has this mathematical expression[83]:

$$f = \frac{Gm_1m_2}{r^2} \tag{5.1}$$

f	Force, Newtons.
G	The universal gravitational constant[84], colloquially known as "Big G".
m_1	Mass of body 1, kilograms.
m_2	Mass of body 2, kilograms.
r	Distance between m_1 and m_2, meters.

When expressed as a time-dependent differential equation[85], the physics behind equation 5.1 causes an orbiting body to describe an elliptical orbit (Figure 1 on page 7), one easily confirmed by empirical observation.

With respect to such an elliptical orbit and barring frictional losses, the principle of energy conservation requires that two kinds of energy, gravitational potential energy (theory three) and kinetic energy (theory four), should sum to a constant.

*Aspie: one who has acquired an Asperger's diagnosis.

The third theory, gravitational potential energy E_p, has this expression:

$$E_p = \frac{-Gm_1m_2}{r} \tag{5.2}$$

With this additional term:

E_p Gravitational potential energy, Joules.

The fourth theory, kinetic energy E_k, has this expression:

$$E_k = \frac{1}{2}mv^2 \tag{5.3}$$

Where:

E_k Kinetic energy, Joules.
m Mass of moving body, kilograms.
v Velocity of moving body, meters per second.

The combined equation for total orbital energy E_t is:

$$E_t = E_k + E_p = \frac{1}{2}mv^2 + \frac{-Gm_1m_2}{r} \tag{5.4}$$

The meaning of equation 5.4 for the present topic is that Kepler's Second Law, gravity, gravitational potential energy (E_p) and kinetic energy (E_k) represent four independent theories with excellent observational evidence, but when they're evaluated together, they confirm a fifth theory, conservation of energy (E_t). The reasoning that leads to this theoretical unification is only possible because the theories are expressed mathematically.

5.2.1 Computer Model

A computer-based orbital model was created to draw Figure 1 on page 7 and to provide the numerical results shown in Table 1. The model's results agree with theory within the accuracy limitations of computer floating-point processing.

Orbital Segment	Kinetic energy (E_k)	Potential energy (E_p)	Total energy (E_t)	Area m^2
A	$2.186\,810\,407 \times 10^8$	$-9.143\,857\,387 \times 10^8$	$-6.957\,046\,980 \times 10^8$	$1.340\,966\,475 \times 10^{21}$
B	$4.778\,249\,536 \times 10^8$	$-1.173\,529\,652 \times 10^9$	$-6.957\,046\,980 \times 10^8$	$1.340\,966\,475 \times 10^{21}$
C	$1.721\,929\,414 \times 10^9$	$-2.417\,634\,112 \times 10^9$	$-6.957\,046\,980 \times 10^8$	$1.340\,966\,475 \times 10^{21}$
D	$2.144\,985\,881 \times 10^9$	$-2.840\,690\,579 \times 10^9$	$-6.957\,046\,980 \times 10^8$	$1.340\,966\,475 \times 10^{21}$

Table 1: Kinetic and Potential Orbital Energies

The fourth column in Table 1, labeled "Area m^2", confirms Kepler's empirical "equal-area" law. The third column, labeled "Total energy (E_t)", is the sum of potential and kinetic energies and confirms the modern energy conservation theory.

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This example demonstrates the power of mathematics to show a relationship between apparently unrelated scientific theories. As explained above, Kepler's Second Law, the theories of gravity, potential energy, kinetic energy, and conservation of energy can all be stated separately, but because of their mathematical expression, as shown in Table 1 the first four theories validate the fifth in a clear and objective way.

This is a model for science. The five theoretical claims are expressed using mathematical equations, easily compared to nature, quantitative, predictive, falsifiable, and mutually supporting. Only perfect theoretical consistency, and perpetual agreement with observation, allows the structure to remain standing. To a scientist, this counts as a strength.

References

[1]Demarcation problem – the problem of distinguishing science from non-science.
[2]Empirical evidence – evidence produced by observations of nature.
[3]Falsifiability – the property of a scientific theory that it may be proven false by contradicting empirical evidence.
[4]Null hypothesis – the default scientific position that there is no relationship between a cause and an effect until evidence supports it.
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[6]Criterion of falsifiability (Britannica) – a definition of falsifiability as it relates to science.
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