

# Psychology and Neuroscience

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## Abstract

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Psychology is in the midst of a crisis with respect to its scientific standing. This article compares present-day psychology with astrology and alchemy, earlier unscientific fields that were replaced by scientific ones (astronomy and chemistry). In each of these fields the absence of reality-testing, of falsifiability, determined the outcome. This article examines the parallels between psychology and these earlier fields – fields that could not survive the transition to scientific discipline and standards.

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## 1 Introduction

*“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.*"<sup>1</sup> – Astrophysicist and science popularizer Neil DeGrasse Tyson<sup>2</sup>

## 1.1 Historical Parallels

The history of science records examples of unscientific pursuits that were replaced by fields able to accept the discipline and standards science requires. This is how astrology was replaced by astronomy and alchemy by chemistry. These replacements have a common property – they follow recognition and acceptance of the central role played by reality-testing, the idea that a theory might be either supported or falsified by comparison with nature, and the idea that the only valid scientific theories are those that survive sincere and meaningful efforts at falsification.

Psychology is in the midst of such a change. The reason psychology has survived so long in its present unscientific form is because the human brain is tremendously complex, which has compelled psychologists to focus their attention on the mind<sup>3</sup> instead. The problem with this focus is that the mind\* is an effect, not a cause, as a result of which it cannot lead to meaningful, empirical, falsifiable theories about causes. To date the brain's complexity has prevented the kind of reality-testing and falsifiability that defines scientific fields.

## 1.2 Role of Reality-Testing

Advances in neuroscience<sup>4</sup> will eventually make it possible to reality-test theories about the brain and about human behavior. This will give us the ability to shape empirically testable, falsifiable theories about *causes* of human behavior and dysfunctions, and thereby put brain studies on a reliable scientific foundation. But these developments won't turn present-day psychology into a science, they will cause its abandonment.

In each historical case in which a scientific field replaced a pseudoscientific<sup>5</sup> one, the abandonment of the earlier field was forced by the fact that reality-testing either completely falsified its conceptual paradigms or showed a random, therefore meaningless, correlation between the field's concepts and reality. In this article we will examine the chasm between concepts and reality in each of these fields, to show how the need to abandon the field became apparent to even its most dedicated followers.

People didn't turn astrology into a science by adoption of scientific standards, instead we replaced astrology with astronomy. We replaced alchemy with chemistry. In the same way we will replace psychology with neuroscience.

## 1.3 Science

### 1.3.1 Definition

The central goal of science is to understand the natural world. To meet this goal, science crafts explanations – “theories” – that are compared to nature, and if the comparison fails, the theory must be discarded. This requirement to compare theories to nature is called *falsifiability*<sup>6</sup>, and falsifiability is the cornerstone on which science is built.

The falsifiability criterion forges an essential link between scientific fields, scientific theories, and nature:

- A field of study that has no empirically testable, falsifiable theories is unscientific.
- A theory that cannot be compared to nature is unscientific.
- A theory that fails comparison with nature must be revised or abandoned.

### 1.3.2 Britannica: Falsifiability

The online Encyclopedia Britannica entry for the term falsifiability<sup>7</sup> 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 entry then offers counterexamples: “According to [Karl] Popper<sup>[8]</sup>, 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.”

### 1.3.3 Explanation versus Description

A scientific theory that makes general statements based on specific observations, that predicts phenomena not yet observed, is said to *explain* some aspect of reality. Another class of theory, one that merely *describes* reality without offering an explanation, isn't scientific on the ground that one cannot falsify general principles that haven't been articulated or predictions that haven't been made. One can only contradict the original observation, but

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\*The mind is an abstraction representing the effects of the brain.

contradictions aren't falsifications because a contradiction can itself be contradicted in turn, *ad infinitum*, with no chance for resolution or contribution to the corpus of human knowledge. Here's an example:

- If I say, "The night sky is filled with tiny points of light," I've offered a *description*. Another observer might contradict my description, for example by emerging from his cave on an overcast night and not seeing points of light, but as explained above, the contradicting observation can itself be contradicted on the next clear night, without any chance for resolution. So, apart from being shallow, inconclusive and trivial, this process is not science.
- If I say, "Those points of light are distant thermonuclear furnaces like our sun," I've offered an *explanation*, one that makes predictions about phenomena not yet observed and that's falsifiable by empirical test. On the basis of this explanation we might build a small-scale star (a fusion reactor) to see if our experiment shows any similarity to the spectra and behavior of stars. This deep explanation represents a theoretical claim that's linked to other areas of human knowledge, predicts phenomena not yet observed and is conclusively falsifiable by comparison with reality (our fusion reactor might fail to imitate the stars). It's science.

## 1.4 Legal Precedents

### 1.4.1 Daubert Standard

Because of science's important role in modern society, and because of the many science pretenders at large, it has come to pass that, in the interest of justice, the legal system has defined science as it relates to expert testimony. As one such example, in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*<sup>9</sup>, the U.S. Supreme Court produced an influential ruling now known as the *Daubert* standard<sup>10</sup>. 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."

### 1.4.2 McLean v. Arkansas Board of Education

An earlier legal ruling<sup>11</sup>, whose purpose is to keep religion out of public school science classrooms, 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<sup>6</sup>.

Apart from improving society's understanding of what constitutes science and distinguishing religion from science, this ruling's existence reveals how a scientific standing confers validation to ideas. This makes that standing a prized possession, to the degree that the legal system must sometimes step in and draw a line in the sand.

## 1.5 Royal Society

Science's focus on empirical evidence means there's no role for authority in science, contrary to appearances, and this has been true across the history of science. The Royal Society<sup>12</sup>, the oldest scientific institution in the world (founded in 1660 CE), chose as their motto *Nullius in Verba* or "Take nobody's word for it"<sup>13</sup>. The society explains their motto this way:

It is an expression of the determination of Fellows to withstand the domination of authority and to verify all statements by an appeal to facts determined by experiment.<sup>14</sup>

This addresses one of the more pervasive public misunderstandings of science – that it relies on authority and expertise. This is quite false – as shown in the above quotation, science explicitly rejects authority.

About this issue Richard P. Feynman<sup>15</sup> said, "Science is the organized skepticism in the reliability of expert opinion."

Science's attitude toward authority and expertise can be summarized by saying that the greatest amount of scientific *eminence* is trumped by the smallest amount of scientific *evidence*.

## 1.6 Skepticism

An important corollary to science's focus on empirical evidence is an attitude of skepticism toward untested claims. This skeptical outlook is formally recognized in the *null hypothesis*<sup>16</sup>, the idea that there's no relationship between a cause and an effect until empirical evidence supports it. The null hypothesis is a cornerstone of scientific experimental design – properly designed studies presume there's no relationship between two phenomena under study, and require that evidence contradict this default assumption.

### 1.6.1 Science and Pseudoscience

An example may show the importance of the null hypothesis and of skepticism:

- To the claim “Bigfoot exists,” a scientist, guided by the null hypothesis<sup>16</sup>, assumes the claim has no merit until empirical evidence supports it.
- To the same claim, a pseudoscientist<sup>5</sup> assumes the opposite – that the claim is true until Bigfoot can be *proven not to exist*.
- But proving Bigfoot's nonexistence would require a search of the entire universe, an impossible burden of evidence and a requirement for *proof of a negative*, which in the general case is a logical error named *argument from ignorance*<sup>17</sup>.

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.

## 1.7 Role of Theory

To summarize the above sections, scientific fields are defined by theories – theories that:

- Explain some aspect of nature, of reality.
- Are based on empirical observations.
- Survive sincere efforts at falsification.

The most reliable and robust theories express their principles in mathematical equations.

Properties of a scientific theory include an intellectual framework that makes general statements derived from specific observations, as well as the ability to predict empirical phenomena not yet observed – for example, Charles Darwin's<sup>18</sup> theory of natural selection anticipated much of modern biology with a handful of empirically testable principles. Most important of all, a scientific theory must be open to unambiguous falsification by way of empirical tests, or in other words, by a meaningful comparison with reality.

## 1.8 Dried Gourd Science

Readers unfamiliar with science may question whether the above requirements are too strict – aren't we defining science too rigidly? Might we sometimes throw away useful observations and theories by applying overly strict rules? To answer, let me offer my cure for the common cold.

In my cure I shake dried gourds over the cold sufferer until his symptoms abate. The cure might take three days, maybe a week, but it always works. It's 100% effective, it's repeatable with different subjects and different gourds, it can be replicated in different laboratories, it's empirical, it might have been falsified but wasn't, so where's my Nobel Prize?

Here's another question – what's wrong with this cure? Here's a short list:

- The cure's description lacks essential elements: skepticism and critical thinking. A skeptical thinker might wonder whether the treatment has anything to do with the outcome, and how we might find out.
- It's only a description, not an explanation (a theory). Science requires theories, generalizations that explain observations and predict phenomena not yet observed.
- Because I don't try to explain my miracle cure (i.e. by crafting a theory), I'm relying on a shallow observation of its apparent effectiveness without wondering whether I'm overlooking other possible reasons for the experiment's outcome.
- The *null hypothesis*<sup>16</sup>, an essential element in modern scientific discipline, is missing from this experiment. If it were present, I would be obliged to make the default assumption that there's no connection between the treatment and the outcome until persuasive evidence suggests otherwise.

About the class of pseudoscience described here, Richard P. Feynman<sup>15</sup> said, “The first principle is that you must not fool yourself – and you are the easiest person to fool.”<sup>19</sup>

This pseudoscience example is meant to show how an absence of theory, skepticism and critical thinking can lead to perfect nonsense masquerading as science.

## 1.9 Summary

Based on these points it's possible to broadly say what science is and is not. If a field produces *explanations*, if it shapes theories that connect seemingly unrelated observations, makes unambiguous theoretical claims preferably in the form of mathematical equations, accurately predicts phenomena not yet observed, and can be falsified by empirical observation, it's science. If a field only offers *descriptions*, descriptions that can be trivially and inconclusively contradicted by other descriptions, without ever rising to the level of theory shaping and empirical tests, it's not science.

### 1.9.1 Isaac Newton



Figure 1: Isaac Newton in thought

For a picture of science, imagine Isaac Newton<sup>20</sup>, who observed a falling apple, then looked at the moon and saw a connection between the motions of the apple and the moon, then wrote a mathematical equation<sup>21</sup> that explained the falling apple, the orbit of the moon, and the motion of every other massive object in the universe. That's science.

(For more on this topic, see the [Newtonian Gravitation](#) appendix on page 17.)

## 2 Astrology

Astrology<sup>22</sup>, a pseudoscience that claims to link human and earthly affairs with the positions and movement of stars and planets, has a history extending to ancient times. Before reliable astronomical observations, before modern mathematical and statistical methods, astrology may have seemed a reasonable theory about the universe.

### 2.1 Early Beliefs

At a time when stars and planets were believed to be attached to revolving quintessential<sup>23</sup> spheres<sup>24</sup>, and when celestial structures and motions were thought to represent purity and perfection in contrast to the corrupt and imperfect earth, it may have seemed reasonable to assert that the positions of stars and planets could directly influence earthly events.

### 2.2 Skepticism and Belief

Modern educated people may wonder how it was possible to believe that the positions of distant stars and planets could influence earthly events, but astrology was very influential until the recent past. Consider that Galileo Galilei<sup>25</sup> cast a few horoscopes before abandoning astrology and moving on to more productive activities, like inventing experimental science. More recently, astrology exerted some influence within the (U.S.) Reagan presidential administration by way of first lady Nancy Reagan's belief in astrology<sup>26</sup>.

## 2.3 Falsification

Among its many other effects, the scientific revolution<sup>27</sup> spelled the end of astrology:

- Using statistics and a skeptical but impartial outlook, it's easy to show that astrological predictions fail to accurately predict anything<sup>28</sup>, fail to rise above a chance correlation with events. Indeed, falsification of astrology's predictive ability is a common undergraduate activity in scientific and statistical college courses\*.
- Beyond statistical falsifications and using present-day physical theories, it's easy to show that the positions and motions of the stars and planets *could not possibly* affect earthly events in the way astrologers claim<sup>29</sup>, apart from the systematic errors astrologers commonly make with respect to the true positions of stars and planets.

## 2.4 Astronomy

Modern astronomy can be said to have begun when Galileo (the former astrologer) built a simple telescope<sup>30</sup> and pointed it at the stars. Over time, improvements in observational astronomy led to theoretical astronomy, and the interplay between observation and theory led to science.

## 2.5 Cosmology

Cosmology<sup>31</sup>, the study of the entire universe, arose from astronomy, the study of planets, stars and (in modern times) galaxies. In some ways astronomy can be thought of as an observational/experimental branch of cosmology, but these fields have a common theoretical foundation in physics.

The relationship between cosmology, astronomy and physics shows an important property of science: scientific theories must not only agree with nature, they must also agree with each other. If two scientific theories contradict each other, this means one or both of them are wrong. The result might be abandonment of one or both of the theories, and/or the creation of a more comprehensive theory that explains what the earlier theories failed to explain, a theory that itself survives efforts at falsification. For example, Einstein's Relativity theories<sup>32</sup> explained the failure of a pivotal physics experiment<sup>33</sup>, as well as replacing the theory<sup>34</sup> that led to the experiment.

These developments caused the demotion of astrology to the status of a simple and baseless belief, for the reason that astrology's ideas don't represent a simplified version of modern theories, they instead represent beliefs having nothing to do with reality. As a result nothing could be salvaged from astrology – it was abandoned in place, like a melted-down nuclear reactor with a flawed design, to be picked over by ignorant followers oblivious to the risks posed by proximity.

## 2.6 Present-Day Astrology

This is not to suggest that astrology is no longer practiced. On the contrary, it's a thriving enterprise with many thousands of practitioners and millions of followers. It's an example of the kind of problem posed by pseudoscience in modern times – astrology's followers either don't know or don't care that astrology has been proven to be bunk.

# 3 Alchemy

Alchemy<sup>35</sup> was a field predating chemistry that had similar aims but no reliable theories for guidance. In Europe it evolved into a search for the Philosopher's stone<sup>36</sup>, thought to be able to turn base metals into gold, confer immortality, and a number of other remarkable properties – all of which seemed designed to win support from wealthy patrons.

## 3.1 Prohibitions

In its time alchemy came to be taken seriously enough that some governments forbade it on the ground that turning base metals into gold would debase the existing currency system. These rulings were helped along by the fact that some “alchemists” were actually counterfeiters.

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\*Statistical disproofs of astrology are a perfect undergraduate exercise because to get reliable results one must avoid emotional attachment to any particular outcome.



### 3.2 Practical Applications

In Renaissance Europe, alchemy began to morph into a more practical form, one in which alchemists created chemicals, medical remedies and metallic alloys – these practitioners were more chemists and metallurgists than alchemists, had those terms been known. By the early modern period, because of an absence of clear theory and knowledge, alchemy became a mixture of sincere practitioners of what we would now call chemistry and metallurgy, and the kind of old-time alchemy indistinguishable from fraud.

### 3.3 Transition to Chemistry

The first steps toward a more scientific form of alchemy, and ultimately chemistry, were taken by Robert Boyle<sup>37</sup> in the 17<sup>th</sup> century. Boyle adopted methods that a modern scientist would recognize as essential to serious research – he recorded everything about his experiments and more importantly he assumed nothing *a priori* – he required that direct evidence guide his conclusions, not conjecture.

Further work by Lavoisier<sup>38</sup>, Dalton<sup>39</sup> and others in the 18<sup>th</sup> and 19<sup>th</sup> centuries led to modern scientific chemistry and a distinction being drawn between chemistry and alchemy, such that alchemists eventually came to be regarded as frauds.

In the transition from alchemy to chemistry and unlike astrology which was abandoned entirely, certain aspects of alchemy proved useful in chemistry. In the course of the transformation, alchemy’s theories were abandoned but some of its practical skills and methods were retained and applied to new purposes.

As with astrology, critics of alchemy were able to use reliable scientific theories to explain *why* alchemy could not accomplish its aims. In this way modern scientific standards, primarily reality-testing and falsifiability, caused alchemy’s ideas to be falsified and abandoned, replaced by modern chemistry.

### 3.4 Revival as Spiritualism

In a 19<sup>th</sup> century revival of old-style alchemy, advocates described it as an alternative to chemistry and science, using an appeal that may sound familiar to modern readers – it was portrayed as a spiritual alternative to materialistic chemistry.

## 4 Psychology



Figure 2: Psychology’s Dilemma

Over time psychologists have changed how they define themselves and the degree to which they regard psychology<sup>40</sup> as a science. Like medicine and unlike physics, psychology is applied in clinics – practitioners include psychiatrists<sup>41</sup>



and clinical psychologists<sup>42</sup>. This means there are serious public-safety issues with respect to how psychology defines itself and what theories define psychology.

## 4.1 Scientific Status

For reasons of public relations and a desire to acquire the status of science, many psychologists spend much time and energy insisting that their field is a science. In modern times most worthwhile pursuits are either themselves sciences or apply reliable scientific results, as with engineering. This requirement for scientific legitimacy is more compelling for fields that presume to open clinics and treat the public's ills. We should therefore ask ourselves: in exactly what sense is psychology a science?

## 4.2 The Mind as a Thing

A psychologist might argue that systematic study of the mind makes psychology a science, but that's only true if the mind is a corporeal thing, a cause, not an idea or an effect of something else. If the mind is a physical thing, a cause, it's part of nature and therefore mind studies count as reality-testing, falsifications are possible and psychology is a science. But the mind is not a cause, it's an effect, a consequence of brain activity, and the relationship between brain and mind is not established to any degree of certainty. By contrast, the brain really is a thing, a part of nature, but expecting to understand the brain by studying the mind is like expecting to understand a computer by studying its display, without ever having direct access to or knowledge of the computer's brain, its central processing unit.

Until we have a deep understanding of the brain, we can't shape falsifiable, general theories about it, and mind studies cannot provide a reliable understanding of the brain. In short, no theory, no falsifiability, no science<sup>43</sup>.

## 4.3 Public Relations

Some psychologists with more than average scholarly ability have responded to this problem by describing the mind as though it's a cause, a source, rather than what it is – a fickle and unreliable representation of a corporeal domain to which we have no access. An example of this tendency is a book titled “How the Mind Works”<sup>44</sup> by psychologist Steven Pinker<sup>45</sup>. The book's many problems begin with its title – for the mind to be said to “work,” it would have to be a cause, a *primum mobile*, a corporeal entity. But the mind is not a cause, it's an effect, a consequence of brain activity.

In any case, Pinker's book doesn't describe how the *mind* works, it presents a hypothesis about how the *brain* works, but without any scientific theory or evidence. In contrast to a psychologist, a neuroscientist<sup>4</sup> wouldn't be likely to write such a book from a scientific perspective, because at this point we don't know enough about the brain to do more than wave our hands in the air, something scientists try to avoid.

## 4.4 Falsifiability and Theory

For reasons given above, psychology's focus on the mind prevents it from shaping empirically testable theories\*. What about the issue of falsifiability<sup>6</sup>, apart from theory? If a psychologist conducts a study of the mind and draws a conclusion, then another psychologist conducts a study that contradicts the original finding, doesn't that count as a falsification? No, because a scientific falsification must be conclusive, it can't be a simple contradiction, a difference in outcome without any understanding of the theoretical roots of the phenomena under study. An example may help clarify this:

## 4.5 Michelson-Morley Experiment

1. Before the Michelson-Morley experiment<sup>33</sup> (hereafter MME), light was thought to propagate through space by way of an aether<sup>34</sup>, a carrier medium for light.
2. In spite of great care and attention to detail, the MME found no evidence for an aether. The MME's negative outcome seemed to contradict the idea of an aether – the aether might not exist at all, or it wasn't detectable, or some experimental complication prevented detection.
3. After the MME physicists, aware of the importance of aether theory, tried to think of a new experiment that might “save the aether” and fix what appeared to be a serious flaw in our understanding of reality.
4. Instead Einstein's Theory of Special Relativity<sup>46</sup> explained the failure of the MME by providing a testable, falsifiable physical theory to replace the aether idea.

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\*For more on this topic, read the [Mind versus Brain](#) appendix on page 17.

Item (1) above posits a mechanism for the propagation of light, one accepted for many years without experimental validation. Item (2) *contradicts* item (1), suggesting but not proving that aether has no role in light propagation. Item (3), had it been successful in finding an experimental result able to contradict the earlier result, would not have counted as a theoretical falsification because there was no theory under test, only the observation of an unexplained aether. But item (4), by producing a testable, falsifiable theory about (among other things) light propagation by a mechanism other than aether, *falsifies* the role of aether in light propagation\*.

In the same way, when a repeat of a psychological experiment (technically a replication<sup>47</sup>) contradicts a prior experiment, that isn't a falsification – there's no testable theoretical basis for conclusively invalidating the original result, and a third psychological experiment might contradict the second, *ad infinitum*. In the general case, if a psychological experiment asserts that X is true, and a failed replication says that X isn't true after all, but neither experiment relies on theory to *explain* why X is true or false, it's not science. Neither the original experiment nor its contradiction approach closer to science than simple observation, description and contradiction. Without a defining theoretical framework, without an *explanation*, contradictions cannot become falsifications.

## 4.6 Replication Crisis

Although regarded as very important to science, study replications are of limited value in a field without theories, they're rare in psychology, and successful replications even more rare. In 2012, Nobel Prizewinner Daniel Kahneman<sup>48</sup> wrote a widely circulated letter<sup>49</sup> in which he characterized the absence of serious replication efforts as a “train wreck looming”<sup>50</sup> in psychology. Kahnemann summarized his remarks by saying, “For all these reasons, right or wrong, your field is now the poster child for doubts about the integrity of psychological research. I believe that you should collectively do something about this mess.”

## 4.7 Resistance to Replication Efforts

Standing in the way of replication efforts is what can only be described as open hostility to the idea of replication among some psychologists, accompanied by confusion about the important scientific role played by replication. In a paper titled “On the evidentiary emptiness of failed replications”<sup>51</sup>, Harvard University psychology professor Jason Mitchell<sup>52</sup> doubts the scientific value of replications, saying “Recent hand-wringing over failed replications in social psychology is largely pointless, because unsuccessful experiments have no meaningful scientific value.” But if conducted competently, a failed replication is not an “unsuccessful experiment,” it's a valid scientific result. Were this not the case, what is probably the most important “unsuccessful experiment” of all time, the Michelson-Morley experiment<sup>33</sup> described above would not have produced a revolution in physics and led to Einstein's Relativity theories. Put simply, when conducted with appropriate discipline, a negative result has the same scientific value as a positive one.

Professor Mitchell's article includes these remarks: “... authors and editors of failed replications are publicly impugning the scientific integrity of their colleagues.” and “The field of social psychology can be improved, but not by the publication of negative findings.” This suggests that emotion and personal issues can be put forth as legitimate arguments against carrying out a scientific study, but that's not how science works.

In his article Mitchell also says, “Because experiments can be undermined by a vast number of practical mistakes, the likeliest explanation for any failed replication will always be that the replicator bungled something along the way.” But that claim must apply with equal force to the original study – maybe that study's outcome only proved that someone “bungled something along the way.”

I would like to report that Mitchell's views aren't typical among psychologists, but in my extensive correspondence with psychologists over the past decade, I must sadly report that such views are relatively common. Meanwhile, in science, replications are both essential to the process and welcomed by scientists, for the reason that the only legitimate goal of science are reliable theories that resist sincere efforts at falsification – how scientists feel about the process cannot play a part. Again, from a scientific standpoint a failed replication has exactly the same value as a successful one – if it's accurate, it tells us something about nature we didn't know.

When I read articles like Mitchell's and as I review my correspondence with psychologists over the years, I'm forced to the conclusion that psychologists learn that the scientific method exists, but don't learn why.

## 4.8 Reproducibility Project

In an effort to address the replicability crisis, a group of psychologists led by Brian Nosek<sup>53</sup>, head of the Center for Open Science<sup>54</sup>, began a project to test the replicability of 98 high-profile psychological studies. The study's

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\*Relativity theory doesn't disprove the existence of an aether, it only makes it irrelevant to light propagation.

findings<sup>55</sup> can be fairly said to have made the problem more apparent to all. Of the 98 replications\* only 39% produced results that supported the findings in the original studies, and among the positive results, the average statistical effect size was half that of the original studies.

In spite of the study's dismal outcome, a number of factors should have increased its success rate – the Reproducibility Project chose studies published in reputable journals with high standards, the tested studies' original authors worked closely with the project, and the project chose studies that used relatively simple experimental methods, all factors likely to increase the probability of a successful replication. In the Nature article referenced above<sup>55</sup>, Stanford University epidemiologist John Ioannidis suggests that a more balanced sampling of psychological studies might produce a failure rate as high as 80%.

## 4.9 Psychology's Critics

Among the psychologists who have analyzed their own field, the views expressed in this article are by no means out of the ordinary. Starting with Sigmund Freud and extending to the present, many critics have made these points in different ways. Here's a representative sample:

### 4.9.1 Sigmund Freud

In his 1895 unpublished work *“Entwurf einer Psychologie”* (draft of a psychology), later translated to English as “Project for a Scientific Psychology”, Sigmund Freud<sup>56</sup> reluctantly came to the conclusion that the chasm separating the mind from physical reality could not be bridged, and therefore that psychology could not become scientific. About this effort Freud later said, “Why I cannot fit it together [the organic and the psychological] I have not even begun to fathom.”<sup>57</sup>

Aware of the negative implications of this work for his field and his personal standing, Freud directed that the book not be published during his lifetime, so its release was delayed until 1950.

### 4.9.2 Karl Popper

Originally trained as a psychologist and earning a Ph.D., philosopher of science Karl Popper<sup>8</sup> eventually came to the conclusion that psychology cannot be science for lack of a grounding in empirical evidence and falsifiability. About this change in outlook Popper said, “I began to feel more and more dissatisfied with these three theories – the Marxist theory of history, psychoanalysis, and individual psychology; and I began to feel dubious about their claims to scientific status.”<sup>58</sup> Popper went on to identify the defect these fields have in common – their theories can't be falsified.

### 4.9.3 Sigmund Koch

A notable psychology critic and philosopher of science, psychologist Sigmund Koch<sup>59</sup> was selected to edit a major work titled “Psychology: A Study of a Science” (Koch, 1959-63)<sup>60</sup>, which became a six-volume series. About this work, Koch came to these conclusions:

The hope of a psychological science became indistinguishable from the fact of psychological science. The entire subsequent history of psychology can be seen as a ritualistic endeavor to emulate the forms of science in order to sustain the delusion that it already is a science.

The truth is that psychological statements which describe human behavior or which report results from tested research can be scientific. However, when there is a move from describing human behavior to explaining it there is also a move from science to opinion<sup>59</sup>.

### 4.9.4 Richard P. Feynman

Well-known for his irreverence and wit, Nobel Prizewinner Richard P. Feynman<sup>15</sup> often criticized psychology for its scientific pretensions. In a now-famous address entitled “Cargo Cult Science”, Feynman said:

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 make things like runways, to put fires along the sides of the runways, to make a wooden hut

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\*Actually a total of 100 replications including two not conducted under the auspices of the Center for Open Science.

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.<sup>61</sup>

#### 4.9.5 Ronald F. Levant

While president of the American Psychological Association<sup>62</sup>, Ronald F. Levant<sup>63</sup> began an initiative to move clinical psychology toward an evidence-based practice model and away from its reliance on anecdote and narrative. It seems psychologists weren’t ready for this change – about their response, Levant said:

Some APA members have asked me why I have chosen to sponsor an APA Presidential Initiative on Evidence-Based Practice (EBP) in Psychology, expressing fears that the results might be used against psychologists by managed-care companies and malpractice lawyers.

To respond, I would start by drawing attention to the larger societal context in which we live. The EBP movement in U.S. society is truly a juggernaut, racing to achieve accountability in medicine, psychology, education, public policy and even architecture. The zeitgeist is to require professionals to base their practice to whatever extent possible on evidence. Thus, psychology needs to define EBP in psychology or it will be defined for us. We cannot afford to sit on the sidelines.<sup>64</sup>

Levant’s critics were right – modern psychological practice is entirely unscientific and an initiative such as he proposed would only have focused public attention on that fact, with significant legal exposure and little compensating advantage. So Levant’s initiative failed.

#### 4.9.6 Thomas R. Insel

While director of the National Institute of Mental Health (NIMH)<sup>65</sup> (2002-2015), Thomas Insel advocated for a shift toward science-based mental health treatments. About the version of the Diagnostic and Statistical Manual of Mental Disorders (DSM)<sup>72</sup> that had just been released (version 5), Insel said:

The goal of this new manual, as with all previous editions, is to provide a common language for describing psychopathology. While DSM has been described as a “Bible” for the field, it is, at best, a dictionary, creating a set of labels and defining each. The strength of each of the editions of DSM has been “reliability” – each edition has ensured that clinicians use the same terms in the same ways. The weakness is its lack of validity.

Unlike our definitions of ischemic heart disease, lymphoma, or AIDS, the DSM diagnoses are based on a consensus about clusters of clinical symptoms, not any objective laboratory measure. In the rest of medicine, this would be equivalent to creating diagnostic systems based on the nature of chest pain or the quality of fever. Indeed, symptom-based diagnosis, once common in other areas of medicine, has been largely replaced in the past half century as we have understood that symptoms alone rarely indicate the best choice of treatment. Patients with mental disorders deserve better.<sup>66</sup>

Over time, as serious problems with the new DSM version became more apparent, the NIMH ruled that its categories would no longer be accepted as the basis for scientific research proposals,<sup>67</sup> for the reason that the DSM has no scientific content.

Insel’s predecessor at the NIMH (Steven E. Hyman<sup>68</sup>) and his successor (Joshua A. Gordon<sup>69</sup>) both also advocate for a transition to science in psychology.

### 4.10 Pseudoscience in Psychology

By listing examples of past and present psychological pseudoscience, this section shows why things must change, and sets the stage for the neuroscience revolution described below.

Because psychology has no defining scientific theories to anchor it in reality, over time the field has drifted aimlessly from one fad to another, often in response to changing public tastes and prejudices or to the personal goals of psychologists. The social harm caused by this fad-chasing behavior is amplified by the fact that much of the public, and even some psychologists (who should know better) believe psychology’s conclusions are backed by scientific authority. The facts that (a) science rejects authority<sup>13</sup>, and (b) psychology is not a science as science is defined<sup>1.3.1</sup>, seem not to have prevented the farces and tragedies described in this section.

#### 4.10.1 Drapetomania

Before the U.S. Civil War psychologists invented Drapetomania<sup>70</sup>, a mental illness diagnosis that presumed to explain why slaves ran away from their masters. Drapetomania was used to justify the racist policies of the era and force free men and women back into the hands of their “owners.” 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. Unlike the other examples in this list, psychologists now accept that Drapetomania was pure pseudoscience.

Outcome: abandoned.

#### 4.10.2 Lobotomy

In the 1930s psychologists invented a simple procedure that greatly improved the behavior of mental patients. Before the procedure, patients might rant and yell for hours, making life miserable for everyone. After the procedure, patients became much more docile and manageable. The procedure involved inserting an icepick into the patient’s prefrontal cortex and moving it around, slicing through brain tissues. This produced a dramatic improvement in behavior, but as a side effect the patient lost any resemblance to a human being. Called “Lobotomy”<sup>71</sup>, the procedure reached its peak popularity in the 1950s, was eventually applied to 40,000 people, but has since been abandoned. The Wikipedia Lobotomy article<sup>71</sup> includes this quote: “The purpose of the operation was to reduce the symptoms of mental disorder, and it was recognized that this was accomplished at the expense of a person’s personality and intellect.”

Outcome: abandoned.

#### 4.10.3 Homosexuality

In the mid-20th century homosexuality was formally identified as a mental illness and various treatments were devised including chemical castration. Since then two things have changed: the public has begun to accept homosexuality, and even psychologists realized their “treatments” weren’t working. Eventually homosexuality was removed from the DSM<sup>72</sup>, psychology’s standard diagnostic manual, but this hasn’t prevented some psychologists from offering ineffective and harmful Conversion Therapy<sup>73</sup> treatments. Because of its potential for harm this therapy has been declared illegal in many regions<sup>74</sup>.

Outcome: abandoned.

#### 4.10.4 Refrigerator Mother

Over the decades some organic ailments have been misidentified as mental illnesses amenable to psychological treatments, among which were the various forms of autism. At the height of psychology’s popularity, autism was widely blamed on “refrigerator mothers”<sup>75</sup>, emotional cripples unable to bond with their children. Fortunately for many innocent and caring parents this fad didn’t last and autism was eventually identified as an organic, not mental, ailment.

Outcome: abandoned.

#### 4.10.5 Recovered Memory Therapy

In the 1990s a fad psychological treatment called Recovered Memory Therapy<sup>76</sup> (hereafter RMT) became popular. In this therapy, psychology clients “remembered” being victims of horrible crimes that were supposedly suppressed from the conscious mind. Recovered memory therapy seemed to bring hidden traumatic memories into conscious recall, but the role of fantasy and invention – in both therapist and client – seems not to have been adequately guarded against. The result was that many people were accused of imaginary crimes.

The apparent goal of RMT was to confer victim status to people who, for one reason or another, couldn’t function in modern times – people who demanded sympathy and money for imagined wrongs. But to work as intended, RMT relied on a pseudoscientific standard of evidence – claims were assumed true until proven false. Unfortunately for the phony victims, this collided with today’s scientific and legal standard in which claims are assumed false until proven true (innocent until proven guilty).

The legal system required some time to awaken, but before too many lives were destroyed, it caught on. About the time virgins began reporting imaginary rapes<sup>77</sup>, the courts realized they were being played,

the wrongly accused were released, the phony victims got no more attention and the therapy lost its popularity.

Outcome: abandoned.

#### 4.10.6 Asperger Syndrome

Even though it's been abandoned, Asperger Syndrome<sup>78</sup>, also known as "Asperger's", is regarded by many as the perfect mental illness diagnosis. With a minimum of acting ability nearly anyone could get the diagnosis, it produced sympathy, special education funds and attention, and a number of important historical figures (Isaac Newton, Thomas Jefferson, Albert Einstein and Bill Gates among others) were assigned the diagnosis. These factors made Asperger's the first genuinely attractive mental illness, it resulted in an epidemic of phony diagnoses and nearly bankrupted some school districts who were obliged to provide special education funds for the victims of this cruel ailment.

Asperger's was popular with overcontrolling parents, who would assign it to their above-average children in order to shame them into acting more "normal." But it was also popular with youngsters – after all, wouldn't you like to have the same mental illness as Albert Einstein or Bill Gates?

In response to public outrage, and to limit further damage to psychology, Asperger's was removed from the standard diagnostic manual (the DSM<sup>72</sup>), but because psychologists aren't obliged to honor the DSM's contents, Asperger therapy, like Conversion Therapy<sup>74</sup> and others, might reappear as public tastes change.

Outcome: abandoned.

#### 4.10.7 Not Otherwise Specified

Until recently the DSM<sup>72</sup> contained a catch-all "diagnosis" of Not Otherwise Specified (NOS)<sup>79</sup>. Psychologists applied it to people who couldn't be easily assigned another diagnosis. Its apparent purpose was to avoid ever having to tell someone, "There's nothing wrong with you – go home and enjoy your life."

Imagine an actual medical doctor telling his patient, "You have a bad case of Not Otherwise Specified. Take two aspirin and call me in the morning."

In the most recent DSM (version 5) (2013)<sup>80</sup>, examples of "Not Otherwise Specified" have been either dropped or renamed "Not Elsewhere Classified (NEC)."

Outcome: abandoned/renamed.

#### 4.10.8 Cognitive-Behavioral Therapy

Cognitive-Behavioral Therapy<sup>81</sup> (hereafter CBT) is a widely practiced therapeutic method in psychiatry and clinical psychology. In spite of its questionable evidentiary basis it's been a mainstay of psychological practice for many decades. Many therapists are confident that CBT is effective and distinct from other therapies, in spite of the many studies that contradict this belief. In a recent meta-analysis<sup>82</sup>, CBT and other therapeutic methods were carefully compared but no statistically significant difference was detected between them. In another study<sup>83</sup> CBT was broken down into its component parts to see which were most effective. This study showed a similar result – the separately applied components produced nearly identical clinical responses, and more important, the responses appeared before any of the tested components should have been able to distinguish themselves.

Faced with these outcomes, a skeptical scientist would suggest that these therapies represent examples of the Placebo Effect<sup>84</sup>, where any plausible faux therapy might produce the same result, but psychologists seem unwilling to consider this possibility.

Outcome: still widely practiced.

These are only a few highlights in psychology's history, examples that show a pattern of opportunism, lack of discipline and disregard for the null hypothesis<sup>16</sup> that a more thorough reading of psychology's history only confirms.

### 4.11 Analysis

When psychology has been set aside in favor of neuroscience, when it's become a historical footnote with no living proponents (true now for alchemy), historians will write a more complete and detailed history than appears here.



Those historians will have the advantage of seeing present-day psychology through the lens of neuroscience’s future achievements – they will know which “mental illnesses” turned out to be physical illnesses with mental symptoms, which were pure invention, and they will know there are *no true mental illnesses* as that term should be defined:

#### 4.11.1 Mental Illness Defined

A true mental illness would be one that exists only in the mind, not the brain or the body, and can be unambiguously and objectively diagnosed, treated and cured by mental health practitioners in such a way that (as with cancer and heart disease) all competent practitioners concur with the original diagnosis, the selected treatment, and the outcome.

Writers in that future time will have an advantage we do not – the existence of reliable science based on theory and observation, of topics presently studied by psychologists. Why is that important? Well, when a psychologist says there’s an ailment called Asperger Syndrome, evidence-based critics can’t say there’s no such ailment. Because there’s no theoretical support or reliable evidence, the psychologist can’t claim the ailment is real (although many do), but for the same reason critics can’t say Asperger’s is not real. This is the burden faced by people who struggle against pseudoscience – in some cases, the pseudoscience is so far divorced from reality that there’s no science to counter the nonsense. This is certainly true for psychology – apart from not being a science itself, the field is disconnected from legitimate scientific fields that might either lend weight to its conclusions or support evidence-based criticism.

#### 4.11.2 Evolution of Diagnoses

Having said that, on surveying the fads that punctuate the history of psychology, it becomes apparent that they represent a learning process. Identifying homosexuality as a mental illness was a low point even for psychology, and it was quickly undermined both by biological studies and changing public attitudes. The “Refrigerator Mother” idea, apart from having no supporting evidence, victimized a large fraction of the population with no apparent purpose. Recovered Memory Therapy was far worse, in both its scale and effects – using narratives that in some cases were completely absurd (virgins accusing family members of rape), it victimized both the accusers and the accused.

But psychologists learn from their mistakes, and Asperger Syndrome proves it – it was a remarkable pseudoscientific achievement. There was never such an appealing diagnosis, and there may never be again:

#### 4.11.3 Asperger Syndrome Diagnosis Benefits

- Because an Asperger Syndrome diagnosis relies on self-reporting\*, any bright person who wanted the diagnosis could acquire it by either having a personality that naturally exhibits the symptoms associated with Asperger’s<sup>85</sup>, or by being coached in certain behaviors popularly associated with the condition.
- If they chose, those receiving the diagnosis could abandon any responsibility for personal advancement in school or work – after all, they’re officially mentally ill, therefore they’re victims of fickle nature and they deserve our sympathy and support.
- Those receiving the diagnosis joined the company of many famous and admirable people, living and dead, whom opportunistic psychologists also “diagnosed” with Asperger’s<sup>†</sup> – a list including Isaac Newton, Thomas Jefferson, Albert Einstein and Bill Gates<sup>87</sup>. This roster of spectacularly successful Aspies<sup>‡</sup> gives mental illness a whole new meaning.
- Those receiving the diagnosis became eligible for thousands of dollars in special education funds, which school districts were compelled to provide regardless of specific case-by-case circumstances<sup>88</sup>.
- Because Asperger’s was included in the Autism spectrum, the family of one receiving the diagnosis became eligible for Social Security disability payments that continued until the “victim” became an adult – after which (s)he became eligible for similar disability payments intended for adults<sup>89</sup>.

When analyzing a controversial social issue, one normally presents a two-column list showing both advantages and drawbacks, but with respect to Asperger Syndrome, there are only advantages – unless you’re a taxpayer, or you have a measure of personal integrity, or you want your children to succeed at an activity apart from playing the system, or you possess self-respect and want your children to acquire that trait, or you are a scientist and expect society to be guided by reason and evidence.

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\*See appendix [Mind versus Brain](#) on page 17 for more about self-reporting.

<sup>†</sup>Psychologists compiled this list in spite of the so-called “Goldwater rule” (section 7.3 of the APA code of ethics<sup>86</sup>), which declares it unethical to diagnose people not personally interviewed.

<sup>‡</sup>“Aspie” is a popular slang expression referring to one having the Asperger Syndrome diagnosis.

#### 4.11.4 Abandonment of Asperger Syndrome

As psychological diagnoses go, Asperger Syndrome was spectacularly successful, but it became a victim of its own success – too many people acquired the diagnosis, the burden on taxpayers became too great, and the diagnosis deprived too many children of a sense of personal responsibility and purpose. Eventually public outrage over these outcomes caused the diagnosis to be discredited and removed from DSM-5<sup>90</sup> (psychology’s “bible”).

This doesn’t mean Asperger Syndrome has been declared false. That’s not how psychology works – because of an absence of science and reliable evidence, old diagnoses tend to be abandoned in place, not refuted. A prominent psychologist and professor, one of those who voted Asperger Syndrome out of the DSM<sup>91</sup>, acknowledged this in an interview<sup>92</sup>, saying about Asperger’s, “We don’t want to say that no one can ever use this word ... It’s not an evidence-based term. It may be something people would like to use to describe how they see themselves fitting into the spectrum.”

On that basis, and acknowledging the interviewee’s professional status\*, we can infer that Asperger Syndrome’s status as a mental illness isn’t based on evidence or science, it’s caused a lot of public controversy, professionals now discourage the diagnosis, but if people would like to say they have it, let them. Professor Lord might as well have added, “And why not? It’s all make-believe anyway.”

For contrast, imagine a medical doctor saying, “You don’t have cancer, but if you would like to say you have it, no problem.” Reality doesn’t work that way<sup>94</sup>, but psychology does.

#### 4.12 Summary

To close this section, we can compare psychology to science by saying that, if the null hypothesis<sup>16</sup> were to be enforced in psychology, if empirical evidence and falsifiable<sup>6</sup> theories were required, the field would collapse.

## 5 Neuroscience

The key difference between neuroscience<sup>4</sup> and psychology is that neuroscience shapes theories based on empirical evidence. The key obstacle to neuroscience is the complexity of the human brain – we’ve only begun to unravel its workings.

Psychologists and neuroscientists generally agree with the idea that human consciousness and behaviors originate in the brain. One important difference between psychology and neuroscience is that neuroscientific theories don’t include the concept of a mind. To a neuroscientist, a human being is a brain that produces behavior, and when we understand the brain, we will understand behavior.

### 5.1 Changes in Psychology

Because of the increasing influence of neuroscience, many psychologists have shifted their focus to the brain instead of the mind, while continuing to practice old-style psychology. This is not unlike a religious person who accepts the idea that natural selection makes antibiotics less effective over time, but who rejects the theory of evolution.

Another effect of the ascendancy of neuroscience and its scientific standing is that psychologists have begun retitling themselves in an effort to distance themselves from psychology’s dismal reputation. In this practice, what was a psychologist might become a “cognitive neuroscientist,”<sup>95</sup> with no retraining or change in behavior.

A long-term goal of neuroscience is to locate biological causes of dysfunctions, with the intent to reduce diagnosis to a routine, objective medical procedure and eliminate self-reporting<sup>96</sup> as a factor in diagnosis. When that threshold has been crossed – when a few dysfunctions have been successfully diagnosed using objective biological tests – that will mark the beginning of the end of psychology, and the start of brain medicine.

### 5.2 Computer Models in Neuroscience

A well-funded and ambitious research program has recently created a computer simulation of the neocortical column<sup>97</sup>. By its success and scale, this project has provided a reasonable time estimate for further advances. From the referenced article: “By demonstrating that their simulation is realistic, the researchers say, these results suggest that an entire mammal brain could be completely modeled within three years, and a human brain within the next decade.”

This class of research has a number of advantages over psychological studies:

- It’s a study of the brain, not the mind, so it’s empirically based and can lead to science.

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\*Catherine Lord<sup>93</sup>, Professor of Psychology in Psychiatry and founding Director of the Center for Autism and the Developing Brain.

- Because it relies on a computer model to imitate the human brain *in silico*, ethical questions are finessed.
- If future simulations are accurate and complete, they can be used to model abnormal as well as normal functioning, which may lead to the ability to identify the root causes of dysfunctions for the first time.

The referenced project is one of several similar projects, including the U.S. “Brain Initiative,”<sup>98</sup> begun under the Obama Administration. Such projects represent an historical turn away from a psychological focus and toward neuroscience, as our best chance to make progress in this area.

### 5.3 Objective Diagnosis

Once reliable brain computer models are commonplace, in partnership with advanced brain scanning methods they should make objective, non-invasive clinical diagnostic methods possible for the first time. I imagine this conversation in a future neurological clinic:

Patient: “Let me tell you what I think is wrong with me.”

Clinician: “Please don’t – we’ll locate the problem with these instruments. Like a blood test or an X-ray, they can produce an objective diagnosis without relying on what you think is wrong with you. In fact, your self-report would only confuse the process. Remember psychology?”

## 6 Appendices

### 6.1 Mind versus Brain

A trained actor can be given a list of symptoms of a *mind* dysfunction such as Asperger Syndrome, Posttraumatic stress disorder (PTSD)<sup>99</sup> or another mental dysfunction, rehearse for a while, then visit a psychologist, acquire the diagnosis and begin collecting disability payments. This is true because most psychological diagnoses rely entirely on *self-reporting*<sup>96</sup>, on what a person says about himself, consequently they’re very unreliable. (Those who doubt this should read about the Rosenhan Experiment<sup>100</sup>.)

It’s been suggested that some of the more popular and lucrative diagnoses (Asperger Syndrome<sup>101</sup> in particular) are given out based on credible acting performances rather than objective dysfunctions – but this can only be suggested, not established scientifically, because there are no laboratory tests that can *objectively* confirm or deny the presence of these conditions, or even their existence.

Our trained actor can be given a list of symptoms of a *brain* dysfunction such as a stroke or a tumor, rehearse for a while, then present himself at a medical clinic, but the outcome will not be the same – an actor cannot pretend to have a medical dysfunction, because medicine doesn’t rely on self-reporting, it relies on science.

That’s the difference between mind and brain, and between psychology and science.

### 6.2 Newtonian Gravitation

In a famous and probably fanciful anecdote, Isaac Newton<sup>20</sup> was said to be sitting under an apple tree when an apple hit him on the head and caused him to begin thinking about gravitation. By reflecting on the motions of small nearby masses and large distant ones, Newton arrived at what we now call Newtonian gravitation<sup>102</sup>, a relatively simple theory that describes the forces and motions of all massive objects, based on this equation<sup>103</sup>:

$$F = G \frac{m_1 m_2}{r^2} \tag{6.1}$$

Where:

- $F$  = force with units of Newtons.
- $G$  = the Gravitational Constant<sup>104</sup>.
- $m_1, m_2$  = masses of objects 1 and 2, kilograms.
- $r$  = distance between  $m_1$  and  $m_2$ , meters.

This is a very important equation in physics and, even though there is a more accurate gravitational treatment in modern relativity theory, this simple form is still used for problems involving velocities much less than that of light, and is central to the problem of calculating spacecraft trajectories.

Because this equation applies to all masses, it’s been subject to rigorous empirical testing, and because it’s expected to apply to all masses in the same way, it has resulted in new scientific discoveries like Dark Matter<sup>105</sup> and Dark Energy<sup>106</sup>, examples where applying Newton’s equation produced unexpected outcomes.

### 6.2.1 Relevance to Science

Newton's equation is an example of science at its best. It uses mathematics to make a clear, objective theoretical statement that can be empirically tested, compared to nature, and if this comparison were to fail, the theory would be regarded as falsified. Newton's theory applies to all masses in the universe, and it's easy to test in such a way that differently equipped observers are forced into agreement about its meaning and its effect on nature.

### 6.2.2 Comparison with Psychology

In science, a theory's credibility relies only on the degree to which it agrees with nature, with reality. A theory might be discarded, falsified, if a key theoretical test fails – if nature disagrees. Agreement between scientists is relatively easy, because all scientists can examine the same evidence, and science is steered, not by eminence, but by evidence.

In psychology, an idea's credibility relies on the number of votes cast by psychologists. An idea might be abandoned (without ever being falsified) in the same way – a count of votes among psychologists. Asperger Syndrome<sup>101</sup> acquired gravitas and acceptance by psychologists casting votes. It was abandoned the same way – after much public controversy it lost out in a vote of experts. Apart from panels of voting experts, agreement between psychologists is nonexistent, because psychology is steered by opinion and fads, not by evidence, and certainly not by science.

## References

- <sup>1</sup>[NOVA Science Now : “How does the Brain Work?”](#), Neil DeGrasse Tyson (51:53 to 52:23)
- <sup>2</sup>[Neil deGrasse Tyson](#) – Astrophysicist and science popularizer.
- <sup>3</sup>[Mind](#) – an abstraction representing the effects of the brain.
- <sup>4</sup>[Neuroscience](#) – the scientific study of the nervous system.
- <sup>5</sup>[Pseudoscience](#) – claims, beliefs and/or theories that assert scientific validity but that fail one or more of science's requirements.
- <sup>6</sup>[Falsifiability](#) – with respect to a theory, the falsifiability criterion means the theory can in principle be proven false in empirical tests.
- <sup>7</sup>[Criterion of falsifiability \(Britannica\)](#) – a definition of science that requires falsifiability.
- <sup>8</sup>[Karl Popper \(Britannica\)](#) – philosopher of science.
- <sup>9</sup>[Daubert v. Merrell Dow Pharmaceuticals, Inc.](#) – an influential U.S. Supreme Court ruling that changes the standards for scientific testimony.
- <sup>10</sup>[Daubert standard](#) – the prevailing U.S. standard for scientific expert testimony.
- <sup>11</sup>[McLean v. Arkansas Board of Education](#) – an influential legal ruling that relies on a definition of science.
- <sup>12</sup>[Royal Society](#), the oldest scientific organization in the world, dating to 1660 CE.
- <sup>13</sup>[Nullius in verba](#) – motto of the Royal Society.
- <sup>14</sup>[Royal Society : History](#) – includes an explanation of the Society's motto.
- <sup>15</sup>[Richard P. Feynman](#) – scientist and philosopher of science.
- <sup>16</sup>[Null hypothesis](#) – the scientific precept that there is no relationship between a cause and an effect until empirical evidence supports it.
- <sup>17</sup>[Argument from ignorance](#) – a logical error having to do with proof of a negative.
- <sup>18</sup>[Charles Darwin](#) – scientist, co-originator of the theory of natural selection.
- <sup>19</sup>[Cargo Cult Science](#) – Richard P. Feynman's 1974 Caltech commencement address.
- <sup>20</sup>[Isaac Newton](#) – very influential scientist.
- <sup>21</sup>[Newton's law of universal gravitation](#) – the gravitational theory that predated relativity.
- <sup>22</sup>[Astrology](#) – a pseudoscience that claims to link human and earthly affairs with the positions and movement of stars and planets.
- <sup>23</sup>[Aether](#) – also named quintessence, the hypothesized “fifth element”, after the classic four (earth, air, water, fire), and thought to compose the celestial spheres.
- <sup>24</sup>[Celestial spheres](#) – an early notion that stars and planets were attached to rigid spheres.
- <sup>25</sup>[Galileo Galilei](#) – very influential scientist and defendant in a famous battle with religious authority.
- <sup>26</sup>[New York Times: White House Confirms Reagans Follow Astrology, Up to a Point](#)
- <sup>27</sup>[Scientific revolution](#) – a label attached to the transition away from pre-scientific methods and philosophies in modern times.
- <sup>28</sup>[Astrology and science](#) – an account of the modern scientific falsification of astrology's claims.
- <sup>29</sup>[Astrology: Theoretical Obstacles](#) – modern physics can be used to show that astrology's claims are not possible.
- <sup>30</sup>[Galileo and the Telescope](#) – a description of Galileo's early telescopes.
- <sup>31</sup>[Cosmology](#) – study of the universe.
- <sup>32</sup>[Theory of relativity](#) – originating with Albert Einstein, the Special and General relativity theories explain much of macroscopic physics.
- <sup>33</sup>[Michelson–Morley experiment](#) – an important physics experiment that disproved the existence of aether.
- <sup>34</sup>[Luminiferous aether](#) – a hypothesized medium for the transmission of light, whose existence was contradicted by the Michelson-Morley experiment.
- <sup>35</sup>[Alchemy](#) – a system of beliefs and practices that predated modern chemistry.
- <sup>36</sup>[Philosopher's stone](#) – a hypothesized object or substance able (among other things) to turn base metals into gold, and whose pursuit was the goal of Alchemy.
- <sup>37</sup>[Robert Boyle](#) – said to be the first scientific chemist.
- <sup>38</sup>[Antoine Lavoisier](#) – French chemist and biologist.
- <sup>39</sup>[John Dalton](#) – English chemist, physicist, and meteorologist.
- <sup>40</sup>[Psychology](#) – study of mind and behavior.
- <sup>41</sup>[Psychiatry](#) – a quasi-medical specialty that treats mental disturbances.

- <sup>42</sup>[Clinical psychology](#) – psychological treatments applied in clinics.
- <sup>43</sup>[No Theory, No Science](#) – a detailed exposition of the reasons theories are essential to science.
- <sup>44</sup>[How the Mind Works](#) – an influential and controversial book by psychologist Steven Pinker.
- <sup>45</sup>[Steven Pinker](#) – Canadian-born psychologist and author.
- <sup>46</sup>[Special relativity](#) – the first of Albert Einstein’s two relativity theories, published in 1905.
- <sup>47</sup>[Replication](#) – an effort to validate a study by repeating it.
- <sup>48</sup>[Daniel Kahneman](#) – psychologist, Nobel Prizewinner (economics).
- <sup>49</sup>[A proposal to deal with questions about priming effects \(Daniel Kahnemann\)](#) – an influential letter by psychologist Daniel Kahnemann.
- <sup>50</sup>[Nobel laureate challenges psychologists to clean up their act](#) – an account of Daniel Kahnemann’s “Train wreck looming” warning to social psychologists.
- <sup>51</sup>[On the evidentiary emptiness of failed replications](#) – a remarkable article about replication by a Harvard University professor of psychology.
- <sup>52</sup>[Jason Mitchell](#) – Harvard University professor of psychology.
- <sup>53</sup>[Brian Nosek](#) – psychologist, head of the Center for Open Science.
- <sup>54</sup>[Center for Open Science](#) – an organization meant to “increase the openness, integrity, and reproducibility of scientific research.”
- <sup>55</sup>[Over half of psychology studies fail reproducibility test](#) – the outcome of an effort to replicate 98 psychological studies.
- <sup>56</sup>[Sigmund Freud](#) – very influential founder of psychoanalysis.
- <sup>57</sup>[Metapsychology](#) – a study of psychological theory as opposed to psychology itself.
- <sup>58</sup>[Karl Popper on The Line Between Science and Pseudoscience](#) – A summary of Popper’s evolving outlook on the definition of science.
- <sup>59</sup>[Sigmund Koch – Psychology’s Antihero](#) – an influential psychology critic and philosopher of science.
- <sup>60</sup>[Psychology: A Study of a Science](#) – editor: Sigmund Koch
- <sup>61</sup>[Cargo Cult Science](#) – a now-famous address by Richard P. Feynman about psychological and other kinds of pseudoscience.
- <sup>62</sup>[American Psychological Association](#) – a professional psychological organization.
- <sup>63</sup>[Ronald F. Levant](#) – past president of the American Psychological Association, critic of psychology’s unscientific practice.
- <sup>64</sup>[Evidence-based practice in psychology](#) – Levant, 2005.
- <sup>65</sup>[National Institute of Mental Health](#) – the primary U.S. government agency with responsibility for mental health issues.
- <sup>66</sup>[Transforming Diagnosis](#) – Thomas R. Insel, former NIMH director.
- <sup>67</sup>[NIMH funding to shift away from DSM categories](#) – an important change in the NIMH’s attitude toward science.
- <sup>68</sup>[Steven E. Hyman](#) – NIMH director (1996-2001).
- <sup>69</sup>[Joshua A. Gordon](#) – current (at time of writing) NIMH director.
- <sup>70</sup>[Drapetomania](#) – a faux mental illness diagnosis that presumed to explain why slaves ran away from their masters.
- <sup>71</sup>[Lobotomy](#) – a now-infamous invasive procedure meant to treat mental disorders.
- <sup>72</sup>[DSM](#) – the Diagnostic and Statistical Manual of Mental Disorders, psychology’s “Bible”.
- <sup>73</sup>[Conversion Therapy](#) – a discredited and dangerous clinical practice meant to change a person’s sexual orientation.
- <sup>74</sup>[House Democrats seek to ban gay conversion therapy nationwide](#)
- <sup>75</sup>[Refrigerator mother](#) – a phony psychological diagnosis.
- <sup>76</sup>[Recovered Memory Therapy](#) – a bogus therapy that claimed to uncover what were often fantasy memories.
- <sup>77</sup>[Family Airing Its Trauma to Aid Others](#) – an account of the Beth Rutherford virgin-rape episode.
- <sup>78</sup>[Asperger Syndrome](#) – an abandoned pseudoscientific diagnosis.
- <sup>79</sup>[Not Otherwise Specified \(NOS\)](#) – a mental illness “diagnosis” that was applied when no more specific description seemed appropriate. Its apparent purpose was to avoid having to tell people they weren’t mentally ill.
- <sup>80</sup>[DSM-5](#) – the current DSM version at the time of writing.
- <sup>81</sup>[Cognitive-Behavioral Therapy](#) – a very popular form of talk therapy.
- <sup>82</sup>[Cognitive-behavioral therapy versus other therapies: redux.](#) – a meta-analysis that finds no difference between CBT and other therapies.
- <sup>83</sup>[A component analysis of cognitive-behavioral treatment for depression](#) – this study found no difference between separately applied elements of CBT.
- <sup>84</sup>[Placebo](#) – a discussion of the Placebo Effect, in which an ineffective agent produces measurable results.
- <sup>85</sup>[Diagnosis of Asperger syndrome](#) – a description of Asperger Syndrome and its associated symptoms.
- <sup>86</sup>[Goldwater rule](#) – an informal name given to Section 7.3 of the American Psychiatric Association’s (APA) code of ethics, which declares it unethical to diagnose people not personally interviewed.
- <sup>87</sup>[The Benefits of Asperger’s Syndrome](#) – a listing of famous people given the Asperger Syndrome label.
- <sup>88</sup>[Rising autism numbers a challenge for public schools](#)
- <sup>89</sup>[Asperger’s Syndrome and obtaining social security disability benefits](#)
- <sup>90</sup>[DSM-V And How It Affects The Diagnosis Of Asperger’s Disorder](#)
- <sup>91</sup>[Diagnostic and Statistical Manual of Mental Disorders](#) – psychology’s “bible”.
- <sup>92</sup>[A Powerful Identity, a Vanishing Diagnosis](#) – about the abandonment of Asperger Syndrome.
- <sup>93</sup>[Catherine Lord, Ph.D.](#) – Professor of Psychology in Psychiatry and founding Director of the Center for Autism and the Developing Brain.
- <sup>94</sup>[Auburn Woman Sentenced to Prison for Fraud](#) – an egregious account of diagnosis fakery.
- <sup>95</sup>[Cognitive neuroscience](#) – an attempt to join neuroscience and psychology, with obvious drawbacks for both.
- <sup>96</sup>[Self-report inventory](#) – a summary of the problems associated with self-reporting in psychology.
- <sup>97</sup>[A Working Brain Model](#) – an ambitious computer simulation of part of a mammalian brain.
- <sup>98</sup>[The Brain Initiative](#) – an ambitious U.S. research program focusing on the brain.
- <sup>99</sup>[Posttraumatic stress disorder \(PTSD\)](#) – a dysfunction said to result from traumatic experiences.
- <sup>100</sup>[Rosenhan Experiment](#) – a now-famous experiment in which a group of mental health professionals gained admittance to a mental hospital by faking symptoms.
- <sup>101</sup>[Asperger syndrome](#) – an abandoned pseudoscientific diagnosis.
- <sup>102</sup>[Newton’s law of universal gravitation](#) – a fundamental part of pre-relativistic physics.
- <sup>103</sup>[Newton’s Equation : Modern Form](#)
- <sup>104</sup>[Gravitational constant](#) – an important physical constant.
- <sup>105</sup>[Dark matter](#) – a theory describing the anomalous motions of galaxies.

<sup>106</sup>[Dark Energy](#) – a theory describing an anomaly in the expansion of the universe.