How Do Intelligent Beings Acquire Competence and Knowledge? Principles of Clear Thinking

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- **We'll argue, that all evolutionary life is carbon based, and perfects it's competence, at least until they're quite technologically advanced, through the long process of Natural Selection. Let's examine that process…**

- Textbooks give a little on the *process* of science and clear thinking, but not near enough.
- So I wrote "Chapter 0" It's my own integration of a lifetime of learning on things mental, psychological, and biological on why and how we gain knowledge, any knowledge, not just science knowledge.

The Nature of Thinking Clearly

"The most incomprehensible thing about the universe is, it is comprehensible" – Albert Einstein

- In context, he almost certainly didn't mean this literally, but instead as dramatic emphasis.
- **Is it surprising that the Universe is comprehensible?**

No. Not Surprising at all. The Brain and Mind are products of evolution by Natural Selection, "Proofs in the pudding" they work, given proper operation by the owners

- Natural Selection is Simple… we are not all equally genetically gifted to solve the problems of survival.
- Those better able to survive and thrive tend to leave more descendants who, to some extent, genetically inherit this higher "fitness", and therefore leave more offspring, who then also inherit some aspects of this fitness as well.
- Thus, favorable traits tend to spread through the population, unfavorable traits tend to die out.
- **If our brains didn't work, we'd have long ago gone extinct.**

How do you Know when you've understood something?

- What is the actual experience of understanding?
- What are the experiential cues that signal understanding? After all…
- Without the cues, you'll never know if you're driving your organism life effectively. There needs to be that feedback.

The “Light Bulb” experience

- The “light bulb” – Too many of us did not have teachers or parents who pointed out how important it is to recognize it and to seek it.
- **It is the gold standard for a genuine grasp of Reality – it’s a biological response, correlated with brain chemistry and visible in functional MRI (fMRI) activity.**
- Why did we evolve to have this experience? Because your survival and well being, especially 10,000 years ago before Social Security, depended critically on arriving at correct understandings about the World.
- **The “light bulb” is as vital a biological signal as any other biological signal** – pain, pleasure, hunger, thirst, anxiety… without genuine understanding, you will fail at the challenges of life, no matter how many pats on the back you get telling you you’re a superstar.

The “Light Bulb” goes on…

…when new understanding is integrated into previous understanding in a non-contradictory way.

Reason – is the art of identifying truths and integrating them in a non-contradictory way into our knowledge base. Our brain evolved this capacity in the forward part of our gray matter; the “forebrain”

But, you may say… what of all the cognitive biases and pitfalls that psychologists say are so widespread?

- Yes, these biases and pitfalls indeed are out there. But knowing about them (as we'll see) is a giant step towards correcting for them, towards being more open to seeing if you've fallen into one of those pits.
- The astoundingly rapid progress of science testifies that we really CAN understand, and that reasoning works, even if not infallible.

Getting to the Light Bulb – Requires CARING, =ENERGY

- Without **caring**, there is no learning. Why? Because making mental connections requires **focus** and hence *mental effort*, hence mental and physical **ENERGY. Raw <u>Calories</u>!**
- Your brain has 2% of your mass, but uses 20% of your chemical energy. Organisms will not spend energy without a good reason – we are **parsimonious**. In the parlance of ecology, we are "optimal foragers" – constantly evolving so as to get what we want and need with the minimum expenditure of personal energy.
- Energy requires food and that (for most of our evolution) wasn't so easy to acquire as it is today. Hence, CARING about learning is essential for learning to happen.

I've Concluded: Nature decided that the most effective reward structure for accomplishing clear thinking…

- …would involve **short term, medium term, and long term** systems.
- Let's look at the Short-Term system first.
- How did Nature impel us to engage in the energy-consumptive activity of discovering valid knowledge, even before the survival value of that knowledge could take effect?

Curiosity; the Desire for Clarity…

- … is nature's built-in **short-term** motivation to exert that mental effort.
- If you're not curious, learning will be extremely difficult. Reconnect with your native curiosity (otherwise, in today's competitive world – you're *doomed*!)
- The **medium term reward** is the inherently pleasurable "**light bulb experience**" which comes from the satisfaction of that biological drive – it **feels** good! The "***ah hah*!"** moment. As it should - it's a concrete expression of your power to control your life.

The Long Term Reward…

- …is **successful coping** with Reality.
- At seeing the success of your thinking manifested in your life, you look back and put it all together into a conclusion…
- ….”this was a good strategy! Let’s do more of this!”

Cultivating the **Desire for Clarity**.

- Without a genuine, honest desire for clarity, it probably will not come.
- The **DESIRE for CLARITY** is the emotional evidence that you do indeed have truth as your #1 priority, over other regrettable but all-too-human temptations.
- In each conversation or mental activity – notice whether you **Desire Clarity**, or instead are more swayed by less useful motives (*e.g.* to avoid painful awarenesses, to prove you're right, to prop up a fragile ego, to manipulate or curry favor among others, etc.)

But Committing to the Premise: "I just want to know the truth" – <u>can feel terrifying</u>

- To exaggerate just a little…
- The feeling is… ***"<u>What?!</u> You're wanting me to <u>commit</u> to opening that Pandora's Box called Truth, without first knowing what's in it? Suppose what's in there forces me to confront aspects of myself, my life and my belief systems that I fear might shatter my fragile hold on self-value? I can't take that kind of risk!"***

Fear: Like Jumping off the Empire State Building

And yet – it's also like diving into a refreshing mountain lake

Getting in might be intimidating at first, and even a bit shocking

- But soon you're excited, and experiencing life with much more energy and self-confidence
- Enjoy the mystery of what you might discover, and let go of the notion you must never be shown wrong, lest your self-respect be shattered.
- Genuine self-respect isn't based on never being wrong. It's instead on what you DO when you discover you're wrong.

Now: What, actually, do you DO – to grasp understanding?

- You take all of the aspects of the issue to be grasped, and try to hold them all in focus at the ~same time. That's not quite possible, so a better description is this…
- It feels a lot like juggling, as you pay attention to all the juggled things as close to "at once" as your brain focus can muster.
- This is your mind's strategy for spotting contradictions.
- Hold two things in focus at the same time and if they contradict each other, you'll get a certain **mental experience** - a sensation of "clashing"

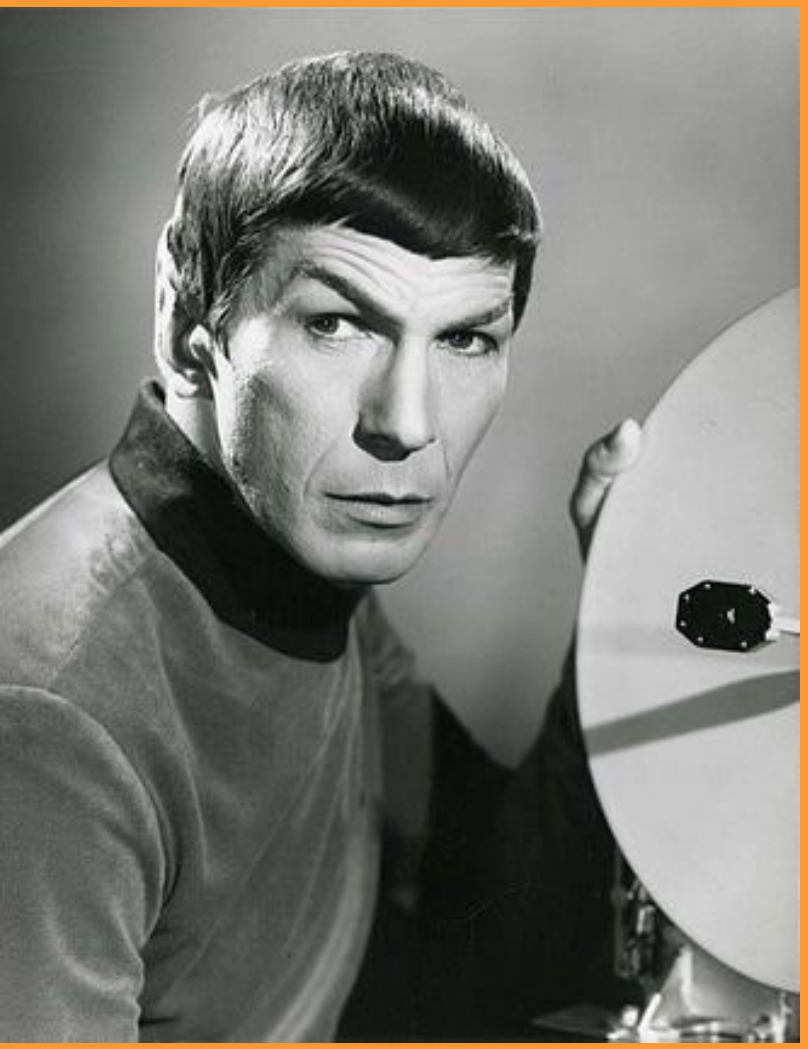
If they are without contradiction and in harmony, there's a very different and more pleasing feeling that happens: The beginning of the Light Bulb

- But, to hold two things in focus at the same time takes mental ENERGY, takes FOCUS. Takes CARING. Takes WILL POWER and the DESIRE to do so.
- Holding two things in focus at the same time, it feels to me, takes more than twice the mental energy and willpower of just one thing
- This is part of the problem, it's too tempting to not make the extra effort if **focus** is an unfamiliar experience.

If you don't do this mentally active cross-checking…

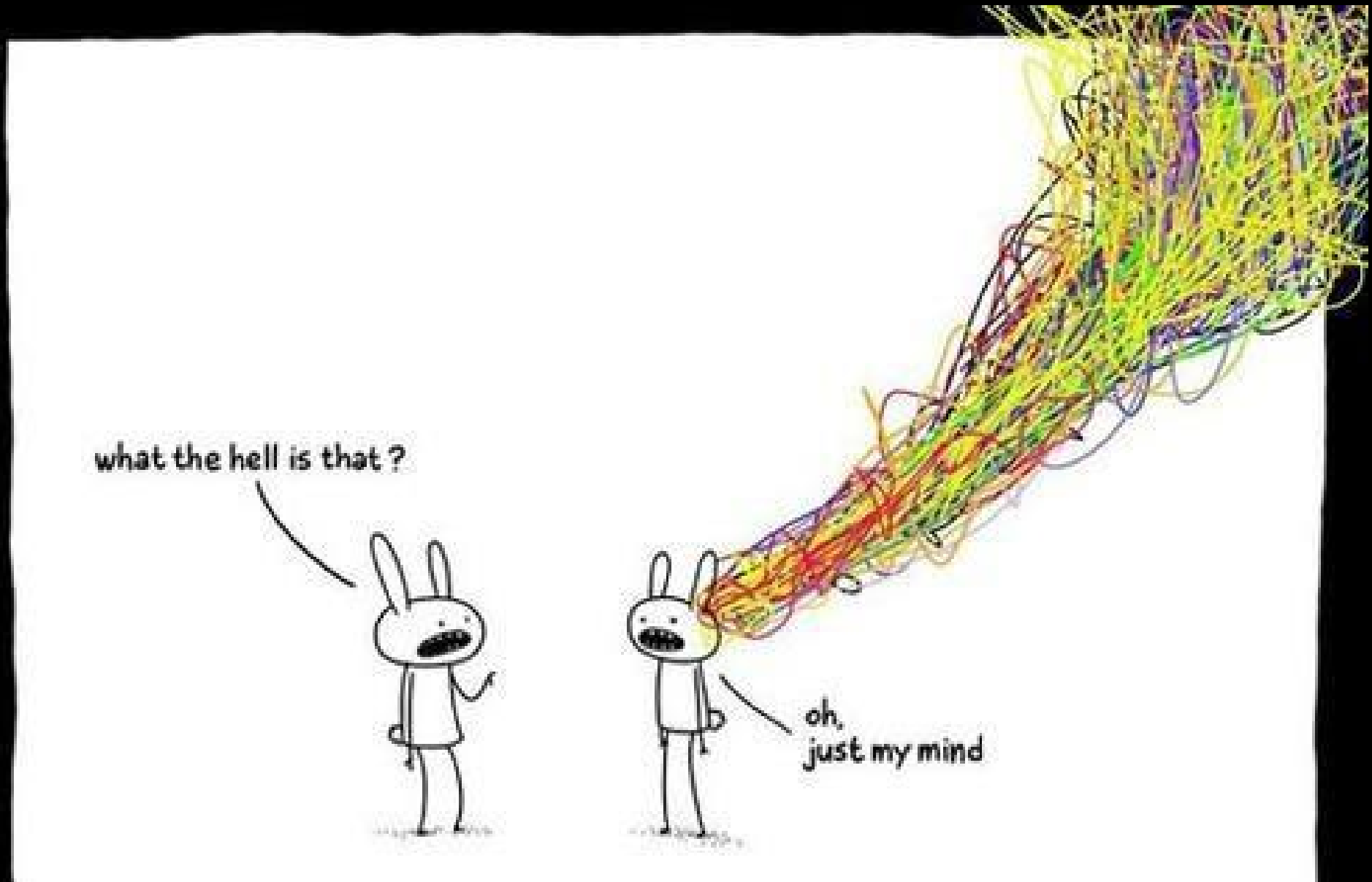
- …. Then you don't get the opportunity to find the logic or illogic of its connection with the rest of your assumptions or knowledge
- **This "juggling" must be learned by constant practice, till it becomes an automated habit**.
- As a **habit**, it takes much less mental energy to make happen.
- We may slip into saying those who master this are "more intelligent". But it's really just that they've practiced to the point of automation, so most of their energy is freed for other challenges.
- The evidence is that "intelligence" is a very fluid thing, and not the fixed IQ number we once thought long ago.
- My (and many others') personal experience, is that ***we raise our IQ's with practice in: Honoring the Desire for Clarity, in all things***

Emotion and Clear Thinking



- It's a common but incorrect assumption that emotion and clear thinking are at war.
- On the contrary: Spock is NOT who we should seek to embody.
- Psychologists wisely recognize that ***"In order to think clearly, you need to be able to feel deeply" – Nathaniel Branden.*** Because repression operates on both at the same time. Blocking awareness of thoughts is also to block their **meaning** to you – and so is to block awareness of what you feel.

A mind filled with undigested, unchecked factoids is unable to judge the truth of new information. The "light bulb" has been unscrewed!



The “light bulb” vs “confirmation bias”

- Be alert to the felt internal distinction between these two. The “light bulb” proceeds from a place of strong curiosity and willingness to know whatever the truth is, regardless of your current ideas. When you “get it”, you experience the “light bulb”.
- Confirmation bias begins out of a place of anxiety, and then if the thought put before you agrees with your prejudice, you feel a relief and some amount of relaxation from the fear. It’s not the “light bulb”.
- These two experiences are different and if you pay attention, they feel different too.

There is

Only ONE

REALITY

The MEANING of the word "Reality" was set Generations Ago by the Great Philosophers

- And, we NEED a word to designate the **objective, actual Truth of what really exists, independent of anyone's beliefs.**
- Those who want to re-define it as simply a person's individual belief state, need to come up with their OWN new word instead.
- **Hey! "R-E-A-L-I-T-Y" is already taken!**
- Because if they don't, they play into the hands of those who would have you believe there IS no Reality, only "opinion", leaving you a very short step away their ability to manipulate you.

My "Perception and Conception of Reality" = My "PACOR"

- We all have unique experiences and perhaps non-overlapping conclusions. We all have our own PACOR (a useful but awkward word I'll create here. An ugly word? Sorry – the beautiful word "REALITY" is already taken.)
- This obvious truth does not violate the usefulness of the notion of an objective external Reality, which is the ground underneath the basis of our individual PACORs.
- The goal of mental activity is to get your PACOR to be in as close and harmonious a relationship with the one true REALITY as possible. Only then can you hope to think and act with effectiveness in supporting your own life and happiness, and those you care about.

Reality = That Which Exists!

***"Reality is that which, when you stop believing in it, doesn't go away"* – Phillip K. Dick, author of "Blade Runner"**

- Everything that is real will fit together without actual contradiction, by logical necessity...
- Why? Because the alternative is - our brain doesn't work
- But if our brain doesn't work, **nothing** we say can be trusted, *including the claim there's more than ONE Reality*
- This is important - **Claiming multiple Realities is <u>self-contradictory, and self-disempowering</u>**

But Rick! What about Parallel Universes and the Many Worlds Interpretation (MWI) of Quantum Mechanics?!

- Sigh.
- We can get lost in the weeds here, in an area we still are only barely coming to work through.
- But I can say this. The “you” and “I” in this thread of the fabric still obey the laws of physics, biology, brain chemistry, and the rest, and always have, even if quantum entanglements diverge copies into multiple later threads – those too obey QM and all the rest. “Real” may have more nuance if MWI is true, agreed.

So. Do you want the red pill, or the blue pill?

- *"You take the blue pill", Morpheus says, "and the story ends. You wake up in your bed and you believe whatever you want to believe. You take the red pill - you stay in wonderland and I show you how deep the rabbit hole goes. Remember, All I am offering is the truth. Nothing more."*

- **Take the Red Pill. It leads to a life that's fun and exciting, and successful in ways that count**

"I do not feel obliged to believe that the same God who has endowed us with sense, reason, and intellect has intended us to forego their use."

- Galileo

Systems: Open, and Closed

- A “closed” system is one in which **we** invent the primary building axioms and building blocks of that system. **All** of them. **We** make the rules.
- Examples are language, and mathematics.
- Within a closed system, you can do proofs*, since the boundaries of the system are defined by us, and so are known.
- *However, there’s a big proviso here. The very **appreciation** that you HAVE proved something, is and must always remain – a fuzzy squishy “light bulb feeling” inside your own brain, and THAT will always remain only indicative of validity by all the “proof’s in the pudding” arguments I’ve given before. It’s not “provable” as an absolute certainty of infallibility. Nature gave us reasoning, but it’s not a no-effort guarantee of infallibility.

But REALITY is NOT defined by us, it is OBSERVED by us, and we have to DISCOVER as much of it as we can, and to try on, to test out, rules that govern it.

- … by observation, not by dogmatic fiat.
- And so final "proofs" are usually not possible.
- I'd been teaching these ideas for 34 years…
- And then in May 2020, I come to a March 2020 interview of mathematical physicist Roger Penrose, commenting on something I'd not studied before: Godel's Incompleteness Theorem, and realized that these ideas I've been presenting are the essence of his central Incompleteness Theorem

Godel's Incompleteness Theorems

- …state that within a logical system, not all true statements are provable. The Wiki article linked may seem forbiddingly formal and difficult.
- However, the interpretation, I'll suggest, is simply that the algorithms of "proof" are themselves outside of the system, and therefore complicate assessing their truth.
- They rely on your FEELING the light bulb of understanding on seeing the evidence, and that takes commitment and personal growth…

Science: Is Asking Nature Herself What is True

- In nearly all areas, we're all scientists (or should be)
- Clear thinking is a skill and a good habit… and it's exciting and fun too.
- It feels so good to let go of all those filters to knowing, filters having to do with your fears or tribalism, and simplifying your priority to just:

***What Is The Truth*?**

Now, how you emotionally **feel** about that truth is also an important question. But it's a very different one and it should be asked at a different time. Not when you're trying to figure out ***WHAT*** the truth ***IS***.

"IN SCIENCE IT OFTEN HAPPENS THAT SCIENTISTS SAY, 'YOU KNOW THAT'S A REALLY GOOD ARGUMENT; MY POSITION IS MISTAKEN,' AND THEN THEY WOULD ACTUALLY CHANGE THEIR MINDS AND YOU NEVER HEAR THAT OLD VIEW FROM THEM AGAIN. THEY REALLY DO IT. IT DOESN'T HAPPEN AS OFTEN AS IT SHOULD, BECAUSE SCIENTISTS ARE HUMAN AND CHANGE IS SOMETIMES PAINFUL. BUT IT HAPPENS EVERY DAY. I CANNOT RECALL THE LAST TIME SOMETHING LIKE THAT HAPPENED IN POLITICS OR RELIGION." — CARL SAGAN

”After I give lectures - on almost any subject - I am often asked, *'Do you believe in UFOs?'.* I'm always struck by how the question is phrased, the suggestion that this is a matter of belief and not evidence. I'm almost never asked, *'How good is the evidence that UFOs are alien spaceships?'."*

- Carl Sagan, "The Demon Haunted World", p.78

Nobel physics laureate Richard Feynman, after his elegant and unexpected public demonstration of the flawed "O" rings as cause of the 1986 Challenger Space Shuttle Disaster to a knowing but embarrassed NASA panel in front of TV cameras and the press… had this great quote:

For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.

(Richard Feynman)

izquotes.com

The Wisdom of Non-Attachment

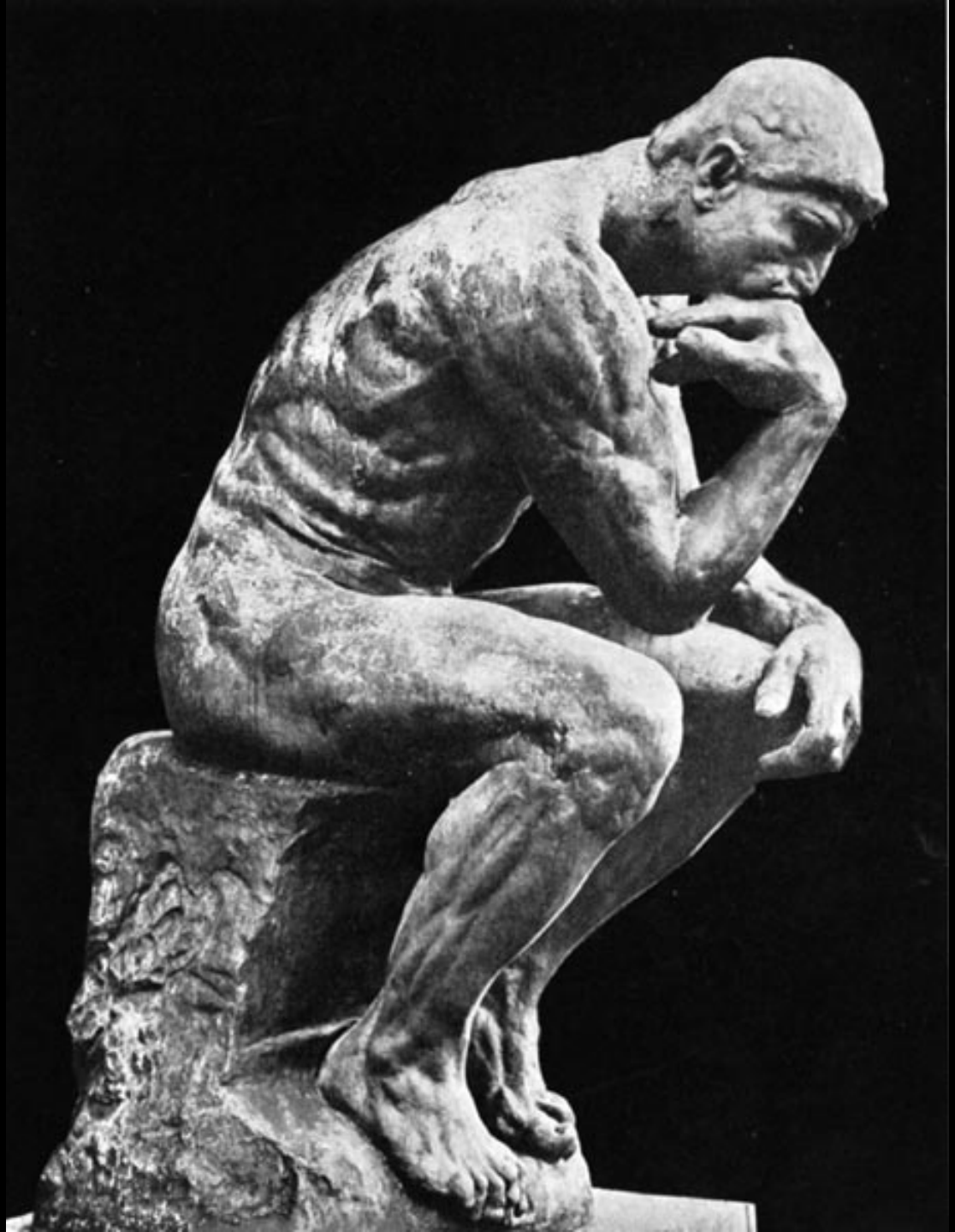
- **If an idea you held is wrong, you can let go easily because you never let it DEFINE you in the first place.**
- Pause and appreciate the power of that statement!
- The great spiritual insights of Taoism and Zen, recognize the inner peace that comes from non-attachment (non-attachment is not indifference!). Focused awareness with letting go of critical self-judgment and egotism.
- For more, see my essay "On Teaching", also linked on my home page.

It's OK to acknowledge *"I don't know"*

- Be clear on what you have understood, what you know to be false, and what is still not understood by you.
- Don't be so quick to grasp at a false explanation just to have an explanation. Being able to firmly put an idea into the category *"I need more thought, more investigation to make a judgment for this one*", is a necessary and relieving thing to do.
- Since genuine understanding takes effort, takes careful investigation, takes perhaps advances in technology… **it takes time, takes patience!**

Being Awake and Aware is a Good Thing!

Good!



Not good

3 Primary Modes of Representing Reality in Internal Experience

- **Visual (pictures, movies)**
- **Auditory (sounds)**
- **Kinesthetic (a visceral sensation using your proprioceptive system)**
- Practice all three. Ponder the best mode for the job at hand.
- Don’t accept the popular notion that you are hopelessly wired into some one favored mode and the world must bend to you. That’s a rather condescending (and disproven) notion.

What Science is, and Is Not

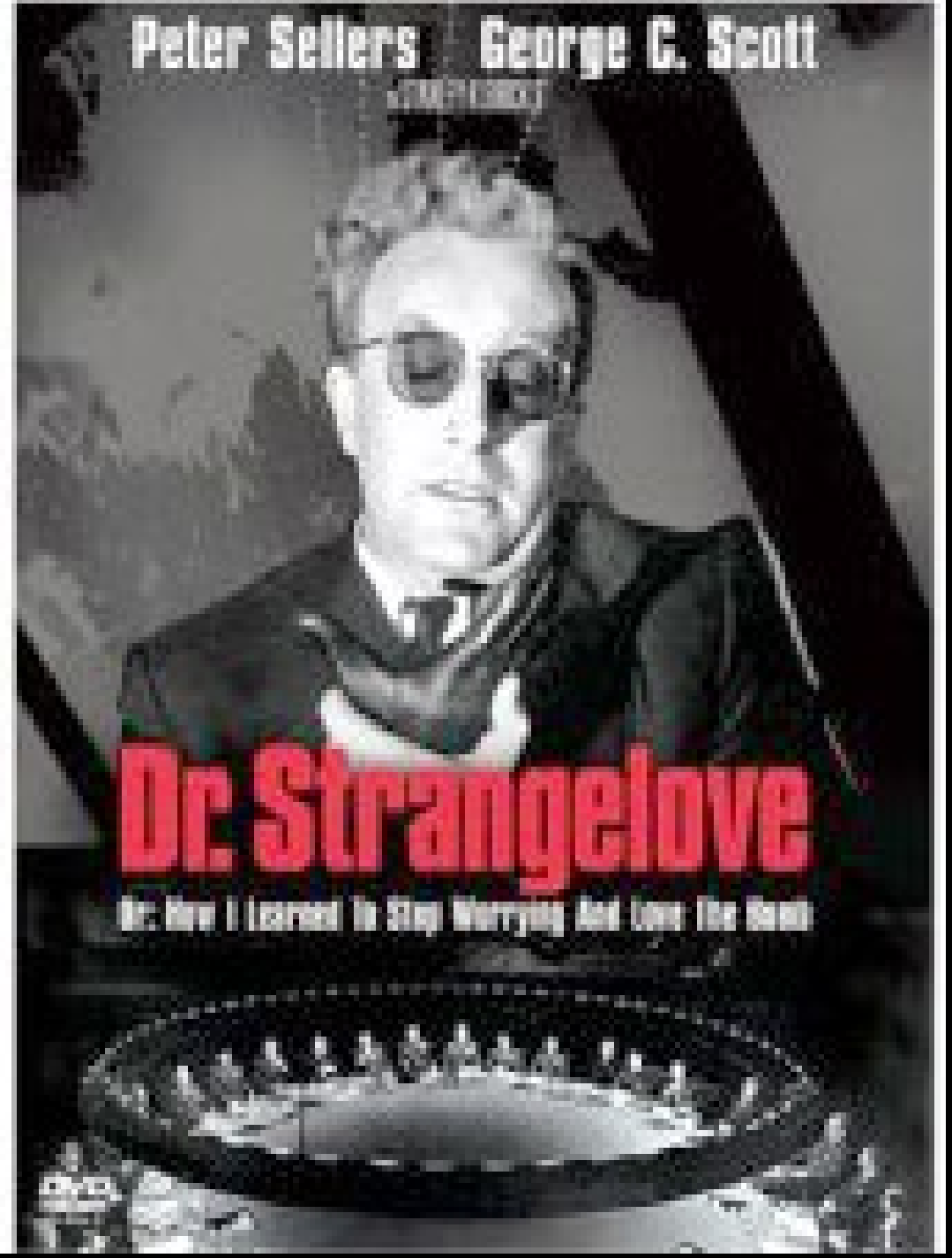
- First; don't confuse "science" with individuals who are job classified as scientists! For example, corporate science can often be an oxymoron. See here
- Here's a link to a good examination of popular stereotypes of scientists
- Science: It's not nerdy factoids, or geeks in white lab coats…

…or big equations

$$\frac{\partial \rho}{\partial t} + \frac{\mathbf{p}}{m} \cdot \nabla_{\mathbf{x}} \rho + \mathbf{F} \cdot \nabla_{\mathbf{p}} \rho = 0.$$

$$\frac{d\rho}{dt} = \frac{\partial \rho}{\partial t} + \sum_{i=1}^{d} \left(\frac{\partial \rho}{\partial q^i} \dot{q}^i + \frac{\partial \rho}{\partial p_i} \dot{p}_i \right) = 0.$$

…or Hollywood stereotypes



…or Evil Doers…

…The Essence is Very Simple

- **It's asking Mother Nature herself what is the truth about things, rather than your wishes or agendas, and being willing to accept Her answer.**
- The ***Art*** of Science is to find how to ask Her as carefully and revealingly as you can muster
- This is as true in "soft" sciences as "hard" sciences.
- Even in a tricky and subtle science like psychology, if your sincere top priority is to know the truth, you can buckle down and handle the challenges of confronting your biases and self-made blind spots, at least to a significant extent.

Scientists: They're regular, fun, and, good people! Like my astronomer friend Stephane (Queens University, Canada)…

…and this geneticist, who's a Harvard professor, and a rock star with an award from Billboard magazine

Profile: Pardis Sabeti

By night she's a rocker. By day, she's a Harvard geneticist tracking the evolution of the human genome.

The Musical Geneticist

Find out more from the woman who says the key to her success is that she "sticks around things" she loves. Read highlights or the full interview.

Ask the Expert

Pardis Sabeti of the Broad Institute answers viewer questions about her life, music, and scientific research.

Watch the Segment

Watch the program July 2 on PBS, or come back beginning July 3 to watch it online here.

- Links & Books
- Transcript
- Participants
- Send Feedback
- Join the Discussion

…and Dr. Emily Shuckburgh – climate scientist and head of the British Antarctic Survey

Or Dava Newman, MIT Professor of Astronautics

Or these guys… er, wait – those are actors

Particle physicist Tom Haine - Johns Hopkins University

Or Prof. Beth Brown – NASA astrophysicist who specialized in the high energy universe using satellite missions

Steps of the Scientific Method

- We always begin with
- **1. Observations**… then the brain/mind will look for patterns, to form questions about why this pattern happens
- From a set of observed phenomena, we…
- **2. Form a hypothesis**. A hypothesis is a mechanism which, if true, can reasonably account for the observations.

For too many non-scientists, this is where the process ends

- They like their hypothesis, and they cling to it, even self-identify with it, if it relates to their favored psychological or political/philosophical bent.
- But science wants (and you should want) to know not if it's likable, but if it is true. Science asks Nature if the hypothesis is true, by identifying **tests: looking for logical, observable consequences of the hypothesis**

The essence of science is identifying how to TEST your hypothesis to see if it's in conflict with Observed Reality

- We ask "well, IF this hypothesis **X** is true, then we ought to be able to see **Y**."
- And we then ponder what experiment could most convincingly reveal **Y**, or conversely, show that **Y** absolutely is not part of Nature, and so **X** can be ruled out.

The Scientific Method – The most efficient way we've found to get the "Light Bulb" experience of genuine understanding

Rock star Nobel Prize winning physicist and speaker, the late Dr. **Richard Feynman – an entertaining 9 minute YouTube on The Scientific Method**

- *"Science is what we do to avoid fooling ourselves"* – Richard Feynman
- Test and test again. Ask Nature herself if your hypthesis is valid. If it fails even once, then you've "**RULED it OUT**". Time to find a new hypothesis.
- But if it passes every test put to it, a hypothesis graduates to the status of a **THEORY**

A Theory …

- Needs to be taken seriously as a contender for Truth
- It's no longer a guess, it's no longer an arm-chair speculation, it's already passed every reality-based test we've put it through. So it's got to be on the "short list" of contenders for final Truth
- The popular press confuses the term "theory" with "hypothesis", as in "*Oh, that's just a theory*". Wrong! But, understandable I suppose because we love short words full of vowels and not long awkward ones
- Even scientists sometimes get sloppy here, as in "String Theory", which is in fact only a hypothesis which not only hasn't been tested, it may be untestable!

What is a GOOD Hypothesis?

- **1. First and foremost, it must be FALSIFIABLE**. In other words, if it is false, there must be an observational test which shows it is false, even if the test is technologically too difficult at the moment.
- This is where hypothesizing supernatural beings who are omnipotent and all-knowing and yet also undetectable and boundary-less, fail. Such vague supernatural hypotheses are not falsifiable (which does not mean they cannot still be ruled out, on the illogic of the supposed defining characteristics of the supernatural beings. **They can be self-contradictory to the very meaning of the defining words used**)

2. Predictions Should Be <u>Specific</u>

- By this, we mean that the hypothesis must be <u>defined</u> and must have <u>de-limited</u> characteristics.
- ***"If correct, this hypothesis predicts you will see THIS"*** rather than *"If correct, you should maybe see something kinda similar to this sort of thing here"*
- To put it loosely, **your hypothesis must SAY something.**
- If the hypothesis never gets farther than vague, flowery language, it's just too pat, too conveniently untestable. It can be excuse to give credibility to what is, in fact, **in**credible

3. Predictions Should Ideally be Unique

- In other words, your hypothesis has at least one do-able test whose result is not predicted by any other conceivable explanation. Then, if it passes this test, you will have some confidence this may in fact be ***the*** correct explanation.
- Uniqueness may or may not be possible, but it's exciting to other scientists if it is – we all want to do work which really advances our knowledge and rules out wrong ideas.

Characteristics of a Good Scientist

- He should accept the Reality of an objective world beyond himself, accept that Reality is not just a figment of his imagination
- He should have an over-riding **Desire for Clarity of Understanding**
- He should have strong curiosity of how things work
- His #1 priority is first, to discover the Truth is, not how he feels about it
- He should accept gracefully that he may not be emotionally comfortable with all his scientific conclusions, and that that is no reason to reject their truth.

Occam's Razor

- ***"Given two or more ideas, all of which are consistent with current observations, the one which is simplest (least conflicts with current best evidence) is most likely to be true"***

- It's not foolproof, but it has proven to be an efficient guide to finding decent hypotheses…
- Note – "most likely": Nature isn't obliged to obey your notions of simplicity. But it's shown by experience to be the best bet for allocating scarce resources of scientific time and money to take as a good working hypothesis for what's right, until shown wrong.

Savage Chickens

by Doug Savage

Sagan's Corollary

"Extraordinary Claims Should Require Extraordinary Evidence" – Carl Sagan

Sagan's Corollary

- … is the best protection against getting pulled in by those who want you to buy into their (perhaps poorly motivated) belief system
- Example: The claim that climate change is NOT being caused by humans, when the evidence says so strongly that it is. Don't expect to be taken seriously unless you can SHOW why the evidence is either wrong, or badly mis-interpreted, and do so in some detail.
- Don't expect "***proof by loud assertion***" to carry weight with thinking people.
- Claim that the light in the sky you saw last night was a spaceship from another planet? You'd better show convincingly that all more conventional explanations fail. If all you have is your memory and no objective recorded evidence – you should expect heavy skepticism!

OK. Science in Every Day Action…So How Do You Evaluate the Validity of Claims You Hear Out There?

- Consider a medical claim - something that all of us, future scientists or not – will face regularly.
- Consider a claim that some sort of diet or nutrient will relieve your pain.
- We all confront this one, who hasn't had a pain and wanted to fix it?
- Here's what I do…

- First, I'd google it and find the most reputable link on the list, and read it.
- I'd search to find published science JOURNAL papers on this claim.
- I'd pay attention to whether the "journal" was a real and well respected medical journal, or instead was a "trade journal", which are outlets supported not by scientific societies, but profit-driven corporate money.
- If I could find nothing but blog sites, promotionals, and trade journal claims, I'd be pretty skeptical.

The Placebo Effect

- Pain is our organism's signal that something's wrong and we need to "up" our awareness and do something, identify and fix what's wrong.
- If you DO something, even something which in fact does not medically alter the problem, but you believe it will or likely will, or even just might… then your organism dials down the pain signal to some extent.
- Your stress levels may reduce as well, improving your cortisol levels (chronic stress is a well-verified danger to physical health) and helping you in fact heal to some extent perhaps.
- Both of these effects are part of **The Placebo Effect**
- **But if, in fact, your problem needs pharmaceutical or other real therapy to begin the healing process, your pain will come back later.**

If I found a study on this claim in a high-quality peer-reviewed science journal, like JAMA or NEJM…

- I'd look to see if the study had a large sample of patients
- I'd look to see if it was placebo-controlled. This is vitally important for any malady based on pain perception especially.
- I'd look to see if it was "double blind", so neither patient nor doctor knew if they were getting the real stuff until after the study was over, to further guard against psychological influences from the physician on the patient.
- And, I'd look to see how the study was funded. If it was funded through private profit-oriented corporations, I'd have to look closer
- If all of these were satisfied, and it showed a real effect, I'd tend to accept it.

Industry-Sponsored "Science" Can Instead Be Agenda-driven Non-science

Independent Science Shows Harmful Effects from BPA, while Industry Science Shows None

A recently-published review of scientific studies shows that, in the last 7 years (through November 2005), 151 studies on the low-dose effects of BPA have been published.(37) None of the 12 studies funded by the chemical industry reported adverse effects at low levels, whereas 128 of 139 government-funded studies found adverse effects. These many studies were conducted in academic laboratories in the U.S. and abroad. Even the 12 industry-funded studies have flaws, however. Of the industry studies, two had their positive controls fail—an indication that the entire experiment had failed, not that BPA had not caused an adverse health effect.

	Adverse health effect	*No effect*
Plastics Industry funded	*0*	*12*
Government funded	*128*	*11*

Another industry study concluded BPA caused no adverse effect, but an independent analysis of the experiment's data by scientists convened by the National Toxicology Program of the U.S. Department of Health & Human Services concluded that in fact there was an adverse effect. Industry scientists had misreported their own results. The chemical industry relies on an incomplete review of scientific studies by an effort funded by the American Plastics Council at the Harvard Center for Risk Analysis. The panel funded by the American Plastics Council only considered 19 studies in concluding in 2004 that the weight of the evidence for low-dose effects of BPA was weak.(38) As of November 2005, there were 151 published studies on the low-dose effects of BPA.

So, does the new skin cream work?

	Result: Rash Got Better	Result: Rash Got Worse
Patients who did use the new skin cream	223	75
Patients who did not use the new skin cream	107	21

No

Result

	Rash Got Better	Rash Got Worse	
Patients who did use the new skin cream	223	75	=75%
Patients who did not use the new skin cream	107	21	=84%

Only 75% who used the cream got better, but 84% who did NOT use the skin cream got better! Now, for extra credit, how will the Big Pharma company who makes the skin cream spin these results?

If the substance wasn't patentable, there may legitimately be no group wanting to spend for a good large-scale study, even if it actually works. Profit, risk/reward, alas

- If it has a plausible, reasonable medical rationale for why it should work, and…
- If it's cheap, ***and if it's harmless***, I'd be willing to give it a try…
- I'd be careful to try to have no expectations either positive or negative, but instead to be neutral, as I waited to see if it relieved my symptoms.
- I'd try "serial trials"; going on it for a time, and then going off it. I'd do it several times, and see if my symptoms changed.

I'd avoid the ***"Rick swears by this stuff!"*** syndrome.

- Even if it seems to work, I'd remain open minded to evidence I'd fallen into the **Placebo Effect**. A sample size = 1 is hard to draw firm conclusions from!
- Still, there's many spices and herbs which have clear larger scale evidence of helping brain function and other benefits through the anti-oxidant mechanism, which is quite reasonable and not paranormal.
- One I just read today is on the memory and mood improvements from including the orange Indian spice turmeric (which has curcumin) in your diet (add black pepper and oils for better absorption). It's not the most flavorful spice in the whole world, but it does add nice color, and an earthiness to many dishes.

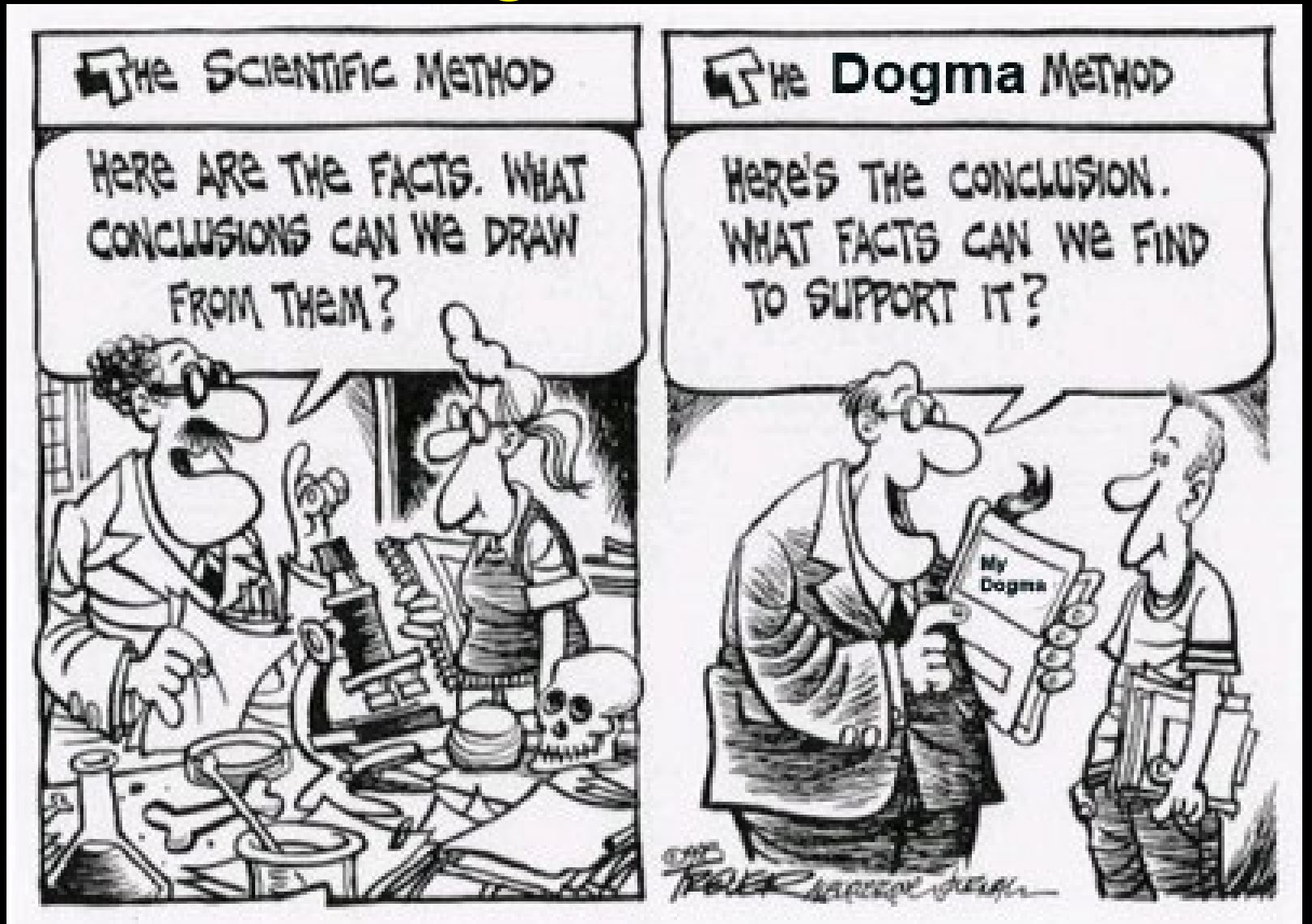
Suppose We're Evaluating a Claim on Climate Change – a Current Issue Full of Well-Publicized but Worthless Claims from Ideologically-driven Interests

- First, I'd look at the source of the claim: scientific journal? or instead fossil fuel corporate-sponsored "trade journal", right-wing "think tank", op/ed, or climate denial blog?…
- If any of the latter, and if it was along the expected direction of minimizing or denying human-caused climate change, I'd take note that this study probably was submitted to a real journal and rejected; the quality was not up to snuff.
- Authors will always want to have their work published in a real journal if at all possible, especially if corporations are paying the page charges.
- And I'd note the blatant conflicts of financial interests.

- If it was important and I didn't already know of conflicting evidence, I'd google to find other sources, most especially…
- …I'd look for it in scientific journals (Nature, GRL, PNAS…) and if THEY confirm the claim, I'd tend to accept it. If there were differing conclusions from other good studies, I'd stay agnostic for now.
- I'd look at the funding of the authors. It's rare not to see the funding agencies acknowledged at the end of a paper. If funded by right-wing or fossil fuel interests, I'd again be very skeptical.

- To help clarify, I'd google and look for other commentary on the paper, with preference to commentary or re-analysis by actual climate scientists.
- I'd look for entries especially in Realclimate.org, a blog run by climate scientists, and read the debate there, and follow up on relevant published citations.
- I'd look to see if the authors were employed in academia, where research tends far more to be unbiased and truth-oriented.
- If they were employed in private industry (where the profit-motive rules the decisions), I'd check to see what conflicts of interest there may be.

Don’t allow yourself to be manipulated, and don’t manipulate others. Be truth-driven, not Agenda-driven



At your Leisure, take a look at a Good Paper Published in a Peer-reviewed Scientific Journal

- Here's a cool one, on a high resolution search for planets around binary stars, The **TATOOINE Project**!

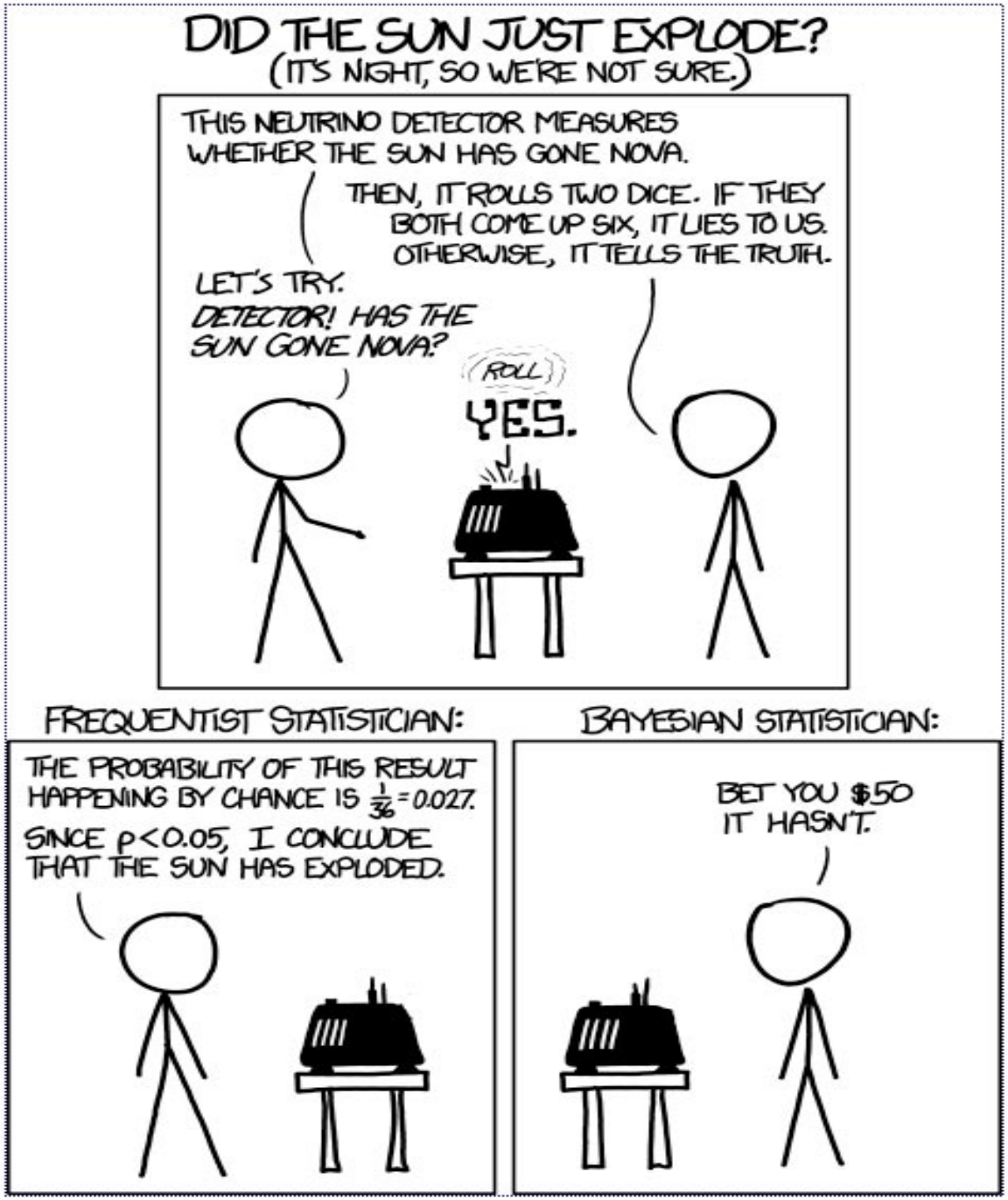
Bayes Theorem

- In order to assign a “weight of evidence” quantitatively in a scientific investigation - a probability for a conclusion to be correct, given certain evidence, Bayes Theorem is central.
- **Bayes Theorem** relates the probabilities of conclusions given the probabilities of prior building blocks within the hypothesis, and vice versa.
- It’s beyond the scope of this non-mathematical course to go further, but the theorem was first worked out by Thomas Bayes in 1763 (and independently by the great French mathematician Simone Laplace a few years later).
- With the advent of capable computers in the second half of the 20th century, it is now widely used in all of science, including astronomy.
- Proper use can give surprising results – Example: suppose a drug test gives 99% valid positive results for drug users, and 99% valid negative results for non-drug users. Suppose further than 0.5% of people are in fact drug users. So, assume a randomly selected person is tested and tests positive. What are the odds that he really is in fact a drug user?

You're perhaps thinking the answer is roughly 99%?

- The correct answer is: **33.5%**
- Surprised? Teased?
- If you like math, read here about the details of **Bayesian Statistics**.
- And here's a good compilation of links to astro and science-related importance of Bayesian Statistics

Frequentists vs. Bayesians



Nerd-humor. (You have to realize the "neutrino detector" keeps the rolled dice hidden). And you only lose $50 if you also die at dawn!

From “On Teaching”

- Please read my online essay “On Teaching”, which says more about my philosophy of teaching, and also about proper teaching of science. For here, we’ll just borrow a quick look…

- **BIAS**. What is BIASED teaching?

Unbiased = Accurately Aligned with the *Weight of Evidence*

- **BIASED teaching in science, is teaching which fails to present the actual "weight of evidence" for/against an idea. Whether by intent or by failure to prepare.**
- **"Unbiased" does NOT mean you give equal credibility to all ideas or all proponents of ideas in a given area. That's not "unbiased", it's cowardly and may also be abject "political correctness".**
- Classic modern example: Is today's global warming caused by human actions or not? A science-ignorant press, and poorly motivated instructors, may give you both sides as if there's a genuine scientific debate. – the truth is, the scientific debate was settled many decades ago – WE are causing global warming. ALL of it! The "other side" (~<2% of climate science workers) is largely funded by Big Oil and right-wing think tanks. See **The Politics and Science of Climate**

Martian canals – seeing what you want to see? The eye/brain in 1888 thought it saw little hints of dark spots which the brain connected into “canals”. Hubble Space Telescope shows otherwise

The “Face on Mars” – The Brain is a pattern-making organ. Don’t let flim-flam artists use this against you (next slide with better camera)

Consciousness – Not As Cosmic as You May Have Thought

- A lot of “New Age” pseudo-science on consciousness was given license to flourish by an old interpretation of Quantum Mechanics that is thankfully being abandoned.
- The “Copenhagen Interpretation of Quantum Mechanics” included the notion that conscious observation collapsed the Schrodinger Equation wave function into a discrete well-defined observation. It seems to give a kind of cosmic primacy to “consciousness”.
- Yet, physicists found it never made sense, and the alternative – the “Many Worlds” Interpretation (MWI), just had too many worlds to feel comfortable with.
- But now, we’re appreciating that this boggling interpretation actually is more parsimonious with basic quantum ideas, and the confirmation of Inflation and perhaps “Eternal Inflation” already brings an infinity of Universes, so MWI doesn’t seem so far-fetched now.
- ET Life and consciousness might, if one were of the “Copenhagen School”, be seen in a more limited way if MWI is true.

Don't be so open-minded that your brain falls  out

Key Points from Chapter 0

- Evolution by Natural Selection has equipped us to identify truth – the "light bulb" experience – because it has survival value. If we use it carefully, our brain WORKS!
- **Occam's Razor** – hypotheses which require fewer modifications to current understanding, and still agree with all observations, are more often correct.
- **Sagan's Corollary** – extraordinary claims rightfully require extraordinary evidence before they can be given credibility. Regard incredible claims with high skepticism unless and until the promoters provide extraordinary evidence. Beware of psychological or business agendas at work.
- **There is ONE Reality**. Our mental health requires we accept this and make our personal conception of reality as close to the one REAL reality as possible, or anxiety and lowered quality of life results.
- Deep awareness has great survival value, as at least some philosophical traditions recognize
- Science is a mindset. It places "What is the Truth?" as the #1 priority above all other considerations, and determines truth by ASKING NATURE HERSELF
- Pseudo-Sciences: fail the test of evidence, appeal to wishful thinking, do not have "What is the Truth?" as #1 priority.
- Mother Nature does not CARE about my, or your, opinion! She only cares what is TRUE
- Scientific Method: Observation -> Hypothesis -> Test with Observations. If passes all, it's a Theory. If not, it's false. Go back and find a new Hypothesis
- Not testable? It's not science. It remains "speculation" and can claim no likelihood of truth.
- Weight of Evidence: the criterion by which we assign the probability of an idea being true.
- Nature and so our well-being too, demands we be RIGHT as much as possible, not that we admit equal probability to any claim regardless of the evidence.
- Science can DISprove wrong ideas, but rarely can it PROVE the one and only correct one, because there may be refinements to the best current theory which have not yet been discovered and yet which agree with all observations made so far and more that are only later made.
- Claims that the human mind is incapable of grasping truth, and that Truth is only to be found in holy books, are self-contradictory. Blind faith leaves one at the mercy of whomever that faith has been invested in