

Chapter 0: Science and the Principles of Clear Thinking

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- **My goal - to give you example and practice in how a good scientist thinks and how we arrive at knowledge – Astronomy is just the setting.**
- The “Cosmic Perspectives” text does 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’y knowledge.

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** – explanations which require fewer modifications to current understanding and still agree with all observations, have been seen later to be 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, blind-faith-based, or business agendas at work.
- **There is ONE Reality.** Mental health requires we accept this and make our personal conception of reality as close to actual reality as possible. **Reality – that which ACTUALLY exists regardless of beliefs**
- 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 so go back and find a new Hypothesis
- Not testable? It’s not science. It remains mere “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 retreat to granting 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, plus more observations 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.

Be Patient...

- Because I feel this chapter is so vitally important to convey, I'll be saying the key ideas in many different ways as we go along.
- If you ***get it*** right away – congratulations! If not, maybe later on there'll be another way of saying it, later, which will click with you.
- OK, onward....!

One More Point Before We Launch...

- My greatest goal here to empower you. To help you learn trust in your own powers of thinking and judging truth.
- ...to see you learn to “***Trust in the Force, Luke!***”; the innate powers of clear thinking that Nature granted you.

Empowerment Means...

- I want to help you be armed against those who would try to command your obedience through fear, tribalism, and disrespecting your mind's ability to see, think, and defend your conclusions with fair evidence.
- To the extent this succeeds, you will have a more exciting, giving life to the rest of society.

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, so of COURSE 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.**

Each Species tends to be Distinguished by Having a Distinctive “Edge”

So, what makes us, *Homo sapiens*, good competitors for the resources necessary for life?

It's not our speed, our physical defenses, our camouflaged skin, spines, bad smell (well most of us anyway), etc.

Our Minds, of Course!

- The evidence says that minds are the perceptual internally experienced manifestation and result of the biochemistry of our physical BRAINS.
- Natural selection applied to humans means, we evolve better and better BRAINS!
- So...

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 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 be able to have this experience? Because your survival and well being, especially 10,000 years ago, 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 condescending 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 is a giant step towards correcting for them, towards being more open to seeing if you've fallen into one of those pitfalls.
- We **CAN** understand things – the progress of science and amazing speed of technology advance testifies to that.

Getting to the Light Bulb – Requires CARING

- Without **caring**, there is no learning. Why? Because making mental connections requires **focus** and hence *mental effort*, hence mental and physical **ENERGY. Raw Calories!**
- 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.

Nature decided that the most effective reward structure for accomplishing clear thinking...

- ...would involve both short term and long term reward 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. It feels good to indulge it!
- The **medium term reward** is the inherently pleasurable “light bulb experience” which comes from the successful satisfaction of that biological drive – it **feels** good! As it should - it's a concrete expression of your power to control your life.
- The **long-term reward** is successful coping. Engaging new understanding and see it pay off by successful actions.
- If you're not curious, learning will be extremely difficult. Use your native curiosity. It's fun!

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-ruling 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 favor from others, etc.)
- **For me - It's the touchstone of any rewarding human relationship.** If a person doesn't show this fundamental desire for clarity, I know the relationship will have major limitations.
- **If you meet such a person – treasure him or her! They're rare and uniquely enjoyable people to count as friends.**

It sounds so obvious, it's almost banal

- But yet, it's not. Too many people do not have a consistent desire for clarity.
- Very often, they fear what that clarity might confront them with.
- More – if one hasn't already cultivated this mental state, then making a sincere, new **commitment to clarity** can feel VERY frightening.

Committing to the Premise: “I just want to know the truth” – can feel terrifying

- To exaggerate just a little...
- The feeling is... ***“Yikes! You’re wanting me to commit 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 to examine. 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

The Blocks to Clarity

- We have the ability to deflect our awareness away from clarity, sensing when it will lead to conscious confrontation with truths which are uncomfortable.
- Most of us feel this temptation at times.
- When we habitually deflect our awareness like this, it becomes automated, it sinks beneath conscious awareness, saving us the energy of required by conscious awareness. **It becomes a habit.**

This is repression ...

- ...and now that it's unconscious, it's tough to break. Don't let it get to that point, if possible.
- But even if so, with practice and sincere desire, and perhaps help from skilled people, we can learn how it feels at the moment of deflection...
- And instead, put ourselves back in control by remaining focused on **wanting clarity of understanding - the truth - as your #1 priority.**
- We *can* break habits. It's an empowering experience!
- Alas, some feel unfortunate temptations – labelling oneself as a helpless victim can give relief from the fear of trying and not getting immediate success.

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

- We 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 explanation is this...
- It feels a lot like juggling, as we pay attention to all the juggled things as close to “at once” as our brain focus can muster.
- This is our 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”.

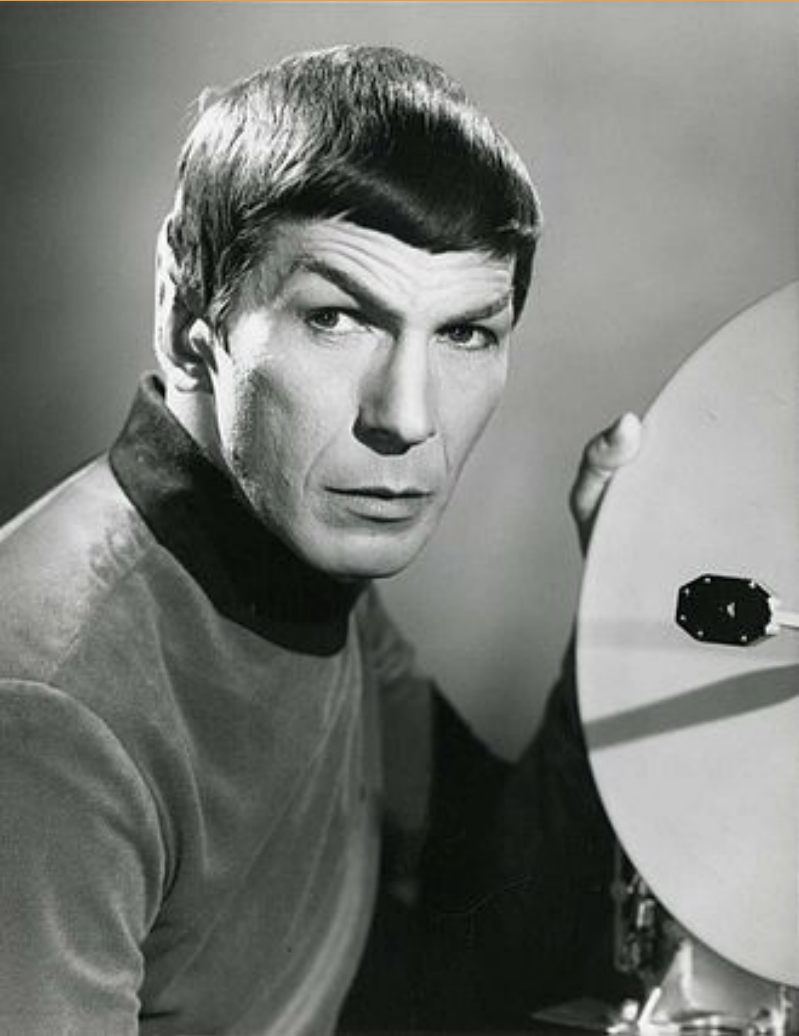
**If they are without contradiction and in harmony, there's a very different and more pleasing feeling that happens:
The beginning of "the Light Bulb" experience**

- But, to hold two things in focus at the same time takes mental ENERGY, takes FOCUS. Takes CARING. Takes WILL POWER and the DESIRE FOR CLARITY.
- Holding two things in focus at the same time takes more than twice the mental energy and will power 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 we don't do this mentally active cross-checking...

- Then we don't get the opportunity to find the logic or illogic of its connection with the rest of our 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 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



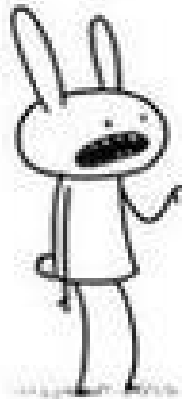
- It's a common but incorrect assumption that emotion and clear thinking are incompatible.
- Spock was a great character – but he's NOT who we should seek to embody.
- Psychologists wisely recognize that ***“In order to think clearly, you need to be able to feel deeply”*** – ***Nathaniel Branden***.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

Our Mind and our Senses – It's ALL We've Got. It's all ANYone's Got

- There **IS** no alternative to using our mind to discover where truth is. Think about it - How **could** there be?
- If there IS any reasonable alternative, I'd love to hear it. I see none.
- Trust a Guru? First, how would I KNOW he's the "true" Guru to trust? There are plenty of competing authoritarians out there, after all.
- Only you can make that decision. Try as we might, we simply cannot avoid the responsibility for thought and decisions.

**A mind filled with undigested, unchecked factoids is unable to judge the truth of new information. We get neither a “light bulb” nor a “clashing” experience. We get nothing...
The “light bulb” has been unscrewed!**

what the hell is that?



oh,
just my mind

Gurus, if they truly respect us...

- ...will encourage our sovereignty, encourage healthy skepticism, and our need to seek the experience of genuine understanding.
- Sadly, we have seen there are plenty of motivations for false gurus to try and turn people in exactly the opposite direction; towards blind obedience.
- It has resulted in ruthless violence and death to scientists, to women, and other innocents... both in the past, and the present.

The Authoritarian Mindset

- Rote memorization of undigested factoids? You'll get NO light bulb.
- No light bulb? Then no understanding has yet happened.
- Don't let yourself be intimidated, or seduced, into accepting the undigestable by "Authorities".
- Ask – ***“What reasoning, what evidence, makes you say so?” That includes confronting your teachers too!***

Institutional Abandonment of Critical Thinking

- There is a growing culture of intellectual abdication of this most important of teachings, in our institutions.
- Instead of championing and defending their members who demonstrate HOW clear thinking happens, and show there are valid tested standards for judging truth, they are instead so afraid someone might not like what is said, regardless of validity, that they pressure for betraying the very foundations of science (award winning science communicator **Neil deGrasse Tyson**).
- Texas schools are another example

“There is a cult of ignorance in the United States, and there always has been. The strain of anti-intellectualism has been a constant thread winding its way through our political and cultural life, nurtured by the false notion that democracy means that ‘My ignorance is just as good as your knowledge.’”

—Isaac Asimov, quoted in “America’s Cult of Ignorance and the Death of Expertise”

Realize the Sensitivity of my Task, of Teaching How We Gain Knowledge

- Without an instructor's deep respect for his students' minds' ability – and need - to grasp understanding, then knowledge degenerates instead into mere memorization of “factoids”, in superstar science communicator [Neil deGrasse Tyson's words](#).
- Higher education, in my youth, was a place where academic freedom meant the willingness to challenge ideas with evidence and reason, and let the evidence, not timidity, and not dogma, lead the verdict.

I Want You to Learn to Trust Your Own Mind's Powers

- ...not those who would try to commandeer your obedience through intimidation, fear, or seduction.
- The vast majority of scientists are secular humanists, and the U.S. is unusual among Western countries in being, among non-scientists, as strongly religious as it is.
- The antipathy towards science, which is growing much as it did in the Dark Ages, is a dangerous direction.
- The rise of “Fake News” together with the decline of cognitive ability are not coincidence

I welcome all students to my classes, and only ask all of us to share open mindedness; a sincere desire to grasp understanding within an atmosphere of academic freedom

- I respect and welcome all students. But ideas are not people, and all deserve to be examined, but not necessarily granted legitimacy. Some ideas are damaging to genuine human well being and therefore any valid system of ethics.
- And remember - no part of anyone's grade is determined by their belief system, nor will any exams have any personal questions about your beliefs.
- **Finally: All of my students need to respect their fellow students,** and not seek to shut down inquiry by forcing your personal wants at the expense of anyone else's.

An integrated mind of ideas that fit together without contradiction, vs. a jumble of disconnected and unusable factoids.

- We get a sharp feeling of dissonance when confronted with something that makes no sense...
- But!... ONLY if We have an integrated mind “all of a piece” to start with. That’s a vital fact often unappreciated.
- A person whose mind is filled with a jumble of undigested factoids gets neither a dissonance nor a light bulb when confronted with new ideas.
- He’s disabled his biological gift for grasping understanding, by not having first engaged **the desire for clarity at the start**
- There’s no easy solution. We’ll have to laboriously haul out and question all the undigested factoids and exert mental effort to get/ or not get/ the light bulb experience as we keep the wheat and toss the chaff

The “light bulb” vs “confirmation bias”

- Be alert to the felt internal distinction between these two. The “light bulb” proceeds from a place of curiosity and willingness to know whatever the truth is, even if it differs from your current thinking. When you “get it”, you experience the “light bulb”.
- Confirmation bias begins instead out of a place of anxiety, and then if what’s put before us agrees with our prejudice, we feel relief and some amount of momentary relaxation from the anxiety.
- These two experiences feel, and are, different.

There is

Only ONE

REALITY

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 self-contradictory, and self-disempowering**

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 just a person’s individual belief state (which certainly deserves a word label) need to come up with a new word.
- **Because “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”. This contention is easy to disprove, as we’ll see.

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).
- This obvious truth does not violate the validity of an objective external Reality, which is the ground underneath the basis of our individual PACORs.
- The goal of mental activity is to get our PACOR to be in as close and harmonious a relationship with the one true REALITY as possible. That is the goal of the process of science.
- Only then can you hope to think and act effectively in supporting your own life and happiness, and those you care about.

But In the Brave New America of Today...

- We are getting a look at how this destruction of your ability to think is done...
- ~Everything is labelled as “Fake News”, thereby discouraging us from trying to make the distinction between *real* and *fake*.
- Language is distorted to the breaking point, and delivered as if it is the honest truth.
- The “Big Lie” technique, so prominently used for Adolf Hitler’s propaganda machine by Josef Goebbels in 1930’s Germany, has returned to 21st Century America.

It's easy to disprove the false notion that *“There IS no Reality – Only Opinion”*

- Life requires constant maintenance and energy. It is a constant fight against the 2nd Law of Thermodynamics – a victory of **order** over **disorder** and decay.
- If we were lost in a delusion of unreality, with nothing but “opinions”, none demonstrably better than another, we'd fail, and one's survival (and one's opinions) would end.
- We **MUST** accept the responsibility for effortful, successful thought, if life is to be sustained. Mistakes will be made, but that does not invalidate that the mind clearly **can** grasp Reality, if nurtured properly.

This is even true in the realm of ethics

- Many would have you believe the notion that we should never judge cultural values, lest we be accused of “discrimination” and offend someone who may feel attached to them.
- But humans have a **specific nature**, driven genetically for optimal fitness in the real world. There are, therefore, specific requirements in order for optimum happiness and well-being, as individuals and as a society: **And these must be the proper framework for ethics.**

Many preference choices don't conflict with our ultimate welfare

- ...Chocolate or vanilla? Straight or rainbow? Black or white?, *etc.* and therefore are neither moral nor immoral.
- But it would be absurd to argue that we shouldn't "discriminate" against *e.g.* Nazi Germany fascism, feeling it is merely engaging in alternate cultural choices and we shouldn't be judgmental.

Another Great Celebrity Quote on Good Attitude Here...

- The famous British economist John Maynard Keynes, annoyed with someone criticizing his changed position on monetary policy, responded: ***“When my information changes, I alter my conclusions. What do YOU do, sir?”***
- *It’s been paraphrased: “When the facts change, I change my mind. What do YOU do, SIR?”*
- **Meaning: Don’t “self – identify” with knowledge outside your control. If the evidence and judgement currently say OK, then ride with it. Until and unless it proves to be false, then let go of it.**

“If you’re going to make a big jump in science, you’re very likely to be unqualified to succeed, by definition”

- James Watson, Nobel Prize winning discoverer of DNA

Think about that, there’s a big grain of truth there

You Will Learn as You Go

“Movies and pop culture get this all wrong. The idea of a single ‘Eureka!’ moment is a dangerous lie. It makes us feel inadequate since we haven’t had ours. It prevents people with seeds of good ideas from getting started.”

- Mark Zuckerberg

But Rick! – I'm a Free and Independent Human Being, and I Have the Right To Believe Exactly What I Want

- *Mother Nature* will respond.... “**Do you really think you can do so without consequences?**”
- Obviously, only you will decide what you believe, but... ***there are consequences*** to clinging to beliefs which go against the verdict of evidence and the Light Bulb in your own mind...
- Even if, in today's modern world, your very physical survival might not be at stake in quite the same way as it was in paleolithic times (because today, others will take care of you, if you don't).
- There are still consequences:

***"Every lie we tell
incurs a debt to the
truth. Sooner or later
that debt will be paid."***

- Valary Legasov, investigator of the
Chernobyl nuclear disaster

#1 - Anxiety

- **Anxiety** is your organism's signal that you are not in optimal contact with Reality. Contact with either the outer World, or the inner World, or both. It is persistent fear of a threat that is not identified.
- The fear may have an object which we genuinely want to know, but need help in identifying.
- But it is all too common that we have some complicity in avoiding the short-term pain of such awareness.
- We have the power, through habitual muscle tension (see Dr. Wilhem Reich and Dr. Alexander Lowen, and later psychologists), to block awareness through chronic muscle tensions, of thoughts we do not want to be aware of, including the awareness that we hold contradictions as beliefs, for reasons we may fear to look at.

Anxiety – (The Medical Dictionary)

- “... the fact that anxiety disorders often run in families indicates that children can **learn unhealthy attitudes and behaviors** from parents, as well as healthy ones”.
- Also “Clarifying the Nature of Anxiety and Depression” has this – “Anxiety tends to result in avoidance patterns and depression results in the **shutdown of psychological energy and exploration**. Unfortunately, in our modern context, these tendencies can often result in greater isolation, frustration and difficulty, leading to more negative emotion and thus completing the cycle.”

Contrast that with the exhilarating exchange...

- ...we might instead get if we challenge a scientist on a conclusion, and a lively uncovering of differing evidence and reasonings proceeds, leading to at least one, and maybe both, learning some valuable things.
- And both likely approaching closer to the truth.

Contrast the Break-Neck Speed of Scientific and Technological Progress...

- ...with the endless political and authoritarian dogma wars, frozen stuck for centuries.
- Why is this so? Because good scientists will quickly acknowledge when the evidence reveals their ideas to be in conflict with the evidence. They **learn**, and move on. Scientists **listen** to Reality.
- This is rarely so in politics and authoritarian areas, as the great Cornell University planetary scientist and science communicator **Carl Sagan** observed as well (see his quote on a later slide here).

Habitual Avoidance of Important Truths (Reality) Has Other Consequences too

- ... my inner self takes note – leading to lessened self-trust in my ability to think.
- ... the level of my life ambitions changes for the worse,
- ... a certain defensiveness emerges, in having any intellectual conversations at all.
- ... changes in my choice of friends. Rather than being stimulated by choosing to be around those who can inspire me to a higher level, I find myself more comfortable being around those to whom I can compare myself favorably.
- [Increased risk of coronary heart disease and cancer](#)
- ... and many others

“Unlike drugs, Cognitive Behavioral Therapy keeps working long after treatment is stopped,

- *... because it teaches thinking skills that people can continue to use.”* – from this excellent article by social psychologists [Lukianoff and Haidt \(2015\)](#) – dissecting the recent descent of American higher education due to a retreat from honoring the teaching of **Critical Thinking**. The causes are sociological and political, and frustratingly unchallenged by the administrations whose first duty should be to educate people towards independent adulthood.
- **See their book “[The Coddling of the American Mind](#)”** and this excellent [76 minute YouTube interview in 2019](#) moderated by best-selling author Malcom Gladwell, and [Professor Haidt’s talk at U. Colorado](#)

Physical Organic Damage and Anxiety

- While anxiety is the organism's signal that perceived threats are remaining unacknowledged and unidentified, emotions in general are mediated by brain chemicals, and it's possible that organic physical damage unrelated to thinking errors may predispose towards anxiety as well.
- However this is much less common than the psychological causes I am hoping to empower you by describing – see the **National Institute of Mental Health's (NIMH)** description of Anxiety ([here](#)) with the many studies showing “**talk therapy**” (improving your thinking) is much more successful than drugs. And don't forget the simple immediate therapy of [running](#).
- It may also be that any unacknowledged *Reality* is not due to repression through habitual avoidance, but instead because the relevant reality is very complex and despite sincere efforts at achieving clarity, is still elusive. And there are gradations too.

Chronic Anxiety Can Lead to Chronic Depression – a huge barrier to Critical Thinking

- I'm an admirer of the great [Robert Sapolsky](#) – Professor of biology and neuro-endocrinology at Stanford University.
- Here is an [excellent YouTube lecture to his Stanford students](#) on this subject, and its connection with [psycho-motor retardation](#), and chronic stress resulting from the chemical and psychological dimensions.

**How Much Does Mother
Nature Care About My
Opinion?**

Zero... that's how much!

- Mother Nature **doesn't** care about my opinion!
Nor anyone else's.
- She cares about only one thing –
- **What is TRUE**
- **It is WE who must learn and conform to Mother Nature. We must not expect Her to conform to our prejudices.**
- It's up to us to use our Mother Nature-given abilities to discover **what is true** as best we can accomplish, accepting the responsibility that we can make mistakes, and then as quickly as we can, acknowledge those mistakes so we can get on with getting it right.
- **It is arrogant for us to dictate to Mother Nature what is true, in violation of evidence.**

One of the Most Vivid Light-Bulb-Moments for Me...



In a crowded theater in 1985, seeing the premier of “Witness” ...

- In one scene Rachel (Kelly McGillis) says “*But Mr. Book (Harrison Ford), you said we’d be safe here!*” (after John Book discovers the killer he seeks is a colleague policeman, and things go bad) and he responds in a resounding voice:
- “*Well I was WRONG!*” while responding to the new Reality, with gusto and with action.
- I’d never heard such an admission made so undefensively, so naturally, so completely without apology, and with such enthusiastic willingness to instantly accept the new situation completely. No one in my childhood or neighborhood ever showed such an attitude.
- It made an impact on me!
- It’s OK to make mistakes. We WILL make them! I and you, and we all have, and will. Learn from them and move on, with exhilaration!

Is it rude to challenge belief systems?

- I'll ask a different way – Is college a place where a young person should expect that no idea will ever be presented which might lead them to re-evaluate their own current beliefs and possible prejudices?
- Are you sure you'll never learn anything importantly new for the rest of your life, but instead just details? And is that really a desirable place to be?
- Mother Nature challenges your beliefs at every moment - Disbelieve in the law of gravity and try to float off a tall building, and Nature will be very rude to you.
- A spirited inquiry into Truth is not rude, it's a delight. But only when both sides have Truth as their real goal, and not [confirmation bias](#)
- A good life will only be fully realized when you sincerely attempt to align yourself with what is evidence-based facts.

**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**

Now Hold On...

- A friend and professor in sociology advised me to take “The Matrix” slide out, as it calls up associations with Q-Anon, which I gather is a “conspiracy theory” group.
- Hey, I don’t believe in these “Conspiracy Theory” groups! But “**The Matrix**” was an interesting thought-provoking film and did have this convenient way to lift the scales from your eyes – a red pill.
- It’s just a fun common every-day reference.

PseudoScience ...

- When certain people use the trappings and jargon of science to lend an aura of credibility and high-mindedness to a **not-credible** body of thought, we call this a [pseudo-science](#).
- Tarot cards, pyramid power, past lives, homeopathy, astrology, water divining,... the list is almost endless!

From Carl Sagan...

“Pseudoscience differs from erroneous science. Science thrives on errors, cutting them away one by one. False conclusions are drawn all the time, but they are drawn tentatively. Hypotheses are framed so they are capable of being disproved. A succession of alternative hypotheses is confronted by experiment and observation. Science gropes and staggers toward improved understanding. Proprietary feelings are of course offended when a scientific hypothesis is disproved, but such disproofs are recognized as central to the scientific enterprise.”

(continued on next slide...)

“Pseudoscience is just the opposite. Hypotheses are often framed precisely so they are invulnerable to any experiment that offers a prospect of disproof, so even in principle they cannot be invalidated. Practitioners are defensive and wary. Skeptical scrutiny is opposed. When the pseudoscientific hypothesis fails to catch fire with scientists, conspiracies to suppress it are deduced”

***– Carl Sagan “The Demon Haunted World”
p. 37***

Astrology

- Astrology is an excellent place for us to pause and apply some science to a popular and astronomically relevant subject.
- It will illuminate some key ideas...
- A 2008 Harris poll found 31% of Americans believe in Astrology, and another 18% are “not sure”.
- That’s half of America!
- Amazing but true.

Yet, belief has nothing to do with it

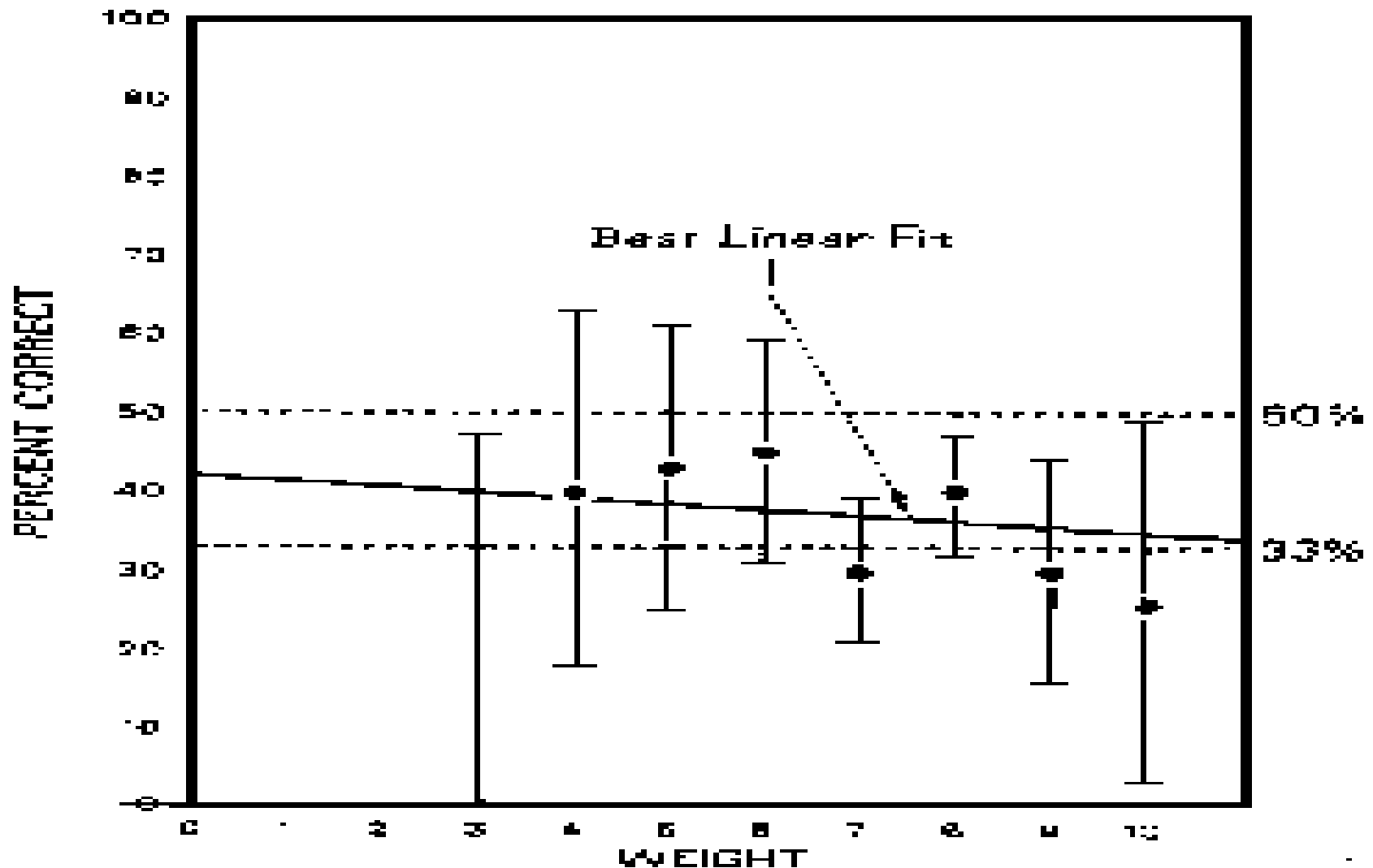
- Astrology begins with objectively knowable data, and so is testable and therefore within the reach of science to make a solid verdict.
- It's been tested many times. **It fails – completely. (see my link page later)** How interesting that so few astrology fans in my experience have any interest in this telltale fact. Psychology, rather than a desire to really know, seems to be what's going on.
- Consider [MacArthur Award winner Dr. Shawn Carlson's test of Astrology](#), with the help of astrologers, back at UCLA in the mid '80's

- **28 astrologers selected by their peers as the best astrologers, and 116 real people**
- For each client's chart, astrologers were provided three anonymous personality profiles - **one from the client and two others chosen at random** - and asked to choose the one that best matched the natal chart. All personality profiles came from real people and were compiled using questionnaires known as the **California Personality Inventory (CPI)**. The CPI, a widely used and scientifically accepted personality test, measures traits like aggressiveness, dominance, and femininity, etc, from a long series of multiple-choice questions the person themselves fills out.
- The graph showing resulting percentage correct vs. Weight for astrologers' first-place choices in CPI-profile natal-chart matching: The best linear fit of the data is consistent, within standard error, with the predicted line of zero slope. No significant tendency is shown for the astrologers to be more correct when they rate a CPI as more highly matching a natal chart. In fact, they were **LESS** correct.

- The study strenuously attempted to avoid anti-astrology bias by making sure astrologers were familiar with the CPI and by incorporating many of the astrologers' suggestions.
- At the same time, to prevent testers from inadvertently helping astrologers during the test, the project was designed to be double-blind, where neither astrologers nor testers knew any of the answers to the experimental questions.
- **Despite astrologers' expectations, the astrologers could correctly match on average only one of every three natal charts with the actually proper personality profile.**
- **This is the same proportion predicted by random chance.**

- In addition, astrologers in the study fell well short of their own prediction that they would correctly match one of every two natal charts provided, (which itself seems to show not much confidence... These *best of the best* astrologers, by their own judgment, only bet their Astrology would be correct just half the time?)
- **Even when astrologers expressed strong confidence in a particular match, they were not more likely to be correct, Carlson found.**
- **In fact, the MORE confident they were, the MORE often they were wrong.**

FIRST CHOICE



Weight = Confidence by the astrologers, that their guess of which person/chart matched was correct. High weight = high confidence. Notice that the more confident the astrologers were in picking the right astrological chart, the more often they were **WRONG**; bit fit line has negative slope.

Astrologers participated strongly in the design and execution of the experiment, but note their reaction to the results

- *"The astrologists' reactions so far have been pretty much what I expected," Carlson told the [SKEPTICAL INQUIRER](#). "The astrologists whom I didn't test are saying that the test was not fair because I did not test them. Of course, if I had tested them instead, and they had failed, then the astrologers I actually tested would now be saying that the test was not fair because I did not test **them**."*

"I attended an NCGR party - I was the only non-astrologer in the house" - Carlson

- *"... to discuss the research shortly after it was published. The discussion was, to put it politely, energetic. I have not yet received a serious scientific challenge to the paper."*
- The newsletter of the **American Federation of Astrologers Network** published a response in January (1986). *"I was very disappointed to see that it largely consists of **personal attacks**," Carlson said. He said its few substantive criticisms are attributable to ignorance of his experiment, of the CPI, and of basic scientific methodology*.

If You're an Astrology Believer

- ... here's where you can put into practice the proper mindset we've just talked about...
- Here's a [page on the science and evidence on whether astrology](#) actually works.
- Key take-away point: If there is no correlation (and no anti-correlation), then there is no basis to claim any cause/effect between planets and personalities.
- **And therefore: nothing needing explanation.**
- Feel no need to search for amazing, subtle, undiscovered mechanisms by which planets could affect personality. The time to do that, would be only if there were evidence of correlation.
- **No correlation means no justification for claiming natal astrology has any validity**

You might be thinking: “But “Correlation is not Necessarily Causation”

- True. But entirely misses the point. The point is an entirely different statement – Zero correlation is strong evidence that there is no causation involved.
- In other words - correlation is a bare minimum in order for causation to even be a possibility.
- So, yes - correlation does not prove causation – that’s true enough. But lack of correlation IS STRONG evidence there is no causation.

Natural vs. Paranormal

- If the mind works, then there's ONE Reality. Reality being that which actually exists. In other words, "the Natural".
- The idea of the paranormal provides no explanatory power. And postulating the paranormal de-motivates looking for a non-contradictory natural explanation.
- If we can't explain it yet, we work harder till we can. If the "paranormal", after rigorous testing, proves good, there may be more work to do to fill in the spaces between this and what is already well established.
- History shows the success of this work ethic.

“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

“Supernatural” is a claim that no natural explanation is ever possible for what you’re trying to explain; and that’s just arrogant

- **And it’s a statement that your brain doesn’t work.** If your brain doesn’t work, then you can make no positive statement about the Supernatural. It’s self contradictory to make any claim at all.
- This last point is key – to start with the claim that your mind cannot be trusted to find Truth, invalidates the very claim itself, since it is **said by a Mind you have begun the sentence by distrusting.**
- And realize that **“What can be asserted without evidence, can be rejected without evidence”** (C. Hitchens)
- Here’s a great TED talk on how a **“Haunted House” actually was a house with a carbon monoxide leak,** which mimics the symptoms people ascribe to “feeling haunted”.

“But Rick – I believe that Belief System #X is Completely True!”

- ...If someone says this, I will take them at their word... no argument from me that that is their belief.
- But if they make a statement about **EXTERNAL** reality, and so is accessible to all of us, so that their claim is: “*Belief System X is completely true and all other belief systems are False Beliefs!*”, then they must be bound by evidence and logic to demonstrate that contention if they want others to respect its supposed truth.
- And if you begin with the assumption that logic, reason, evidence have no validity – then you’ve really just forced yourself back into the more limited statement at top of the slide. I would say to them – “**Please, then, phrase it correctly**”.

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 with certainty*, 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 we **HAVE** proved something, is and must always remain – a fuzzy squishy “light bulb feeling” inside our 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, the rules that govern it.

- ... by observation, not by dogmatic fiat.
- And so “proofs” are usually not possible.
- I’ve been teaching these ideas for 34 years...
- And now, here in May 2020, I’ve just come to a [March 2020 interview of mathematical physicist Roger Penrose](#), commenting on something I’d not studied before: [Godel’s Incompleteness Theorem](#), and realize 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, many contend, is simply that the algorithms of “proof” are themselves outside of the system, and therefore complicate assessing their truth.
- I'll restate this in the way that I have for many years in front of my classrooms...

Healthy Development: We wake up one day when we're ~2 years old...

- And realize there's a world out there beyond our skin. Curiosity drives us to try to make sense of it, to make valid predictions, in order to survive and thrive.
- We form hypotheses and we test them and we can make mistakes. That's our algorithm. But there's nothing in evolutionary biology that enforces a wished-for infallibility in that enterprise. It's a good algo, but not infallible.

- As an older child, we delight in exploring our physical world, gathering facts about it.
- As an adolescent and teenager, we begin to think in terms of principles. We appreciate the wider world in which we must live, and are motivated to find the principles which are in harmony with designing a happy life.
- By late teens, while brains are not yet fully developed, we begin to understand the World does not owe us a living. That instead we must learn independence if we want full self-confidence, and that using our minds is the path to this.

As a Full Adult...

- We discover there are laws which govern existence – not only physics laws, but laws of human biology and the resulting human psychology. We have a specific nature.
- We learn that the path to a happy life comes from mastering the understanding of these laws, and accepting them.
- We learn that self-confidence is earned by “proofs in the pudding” successful thinking, and the perfecting of our skills.

Some of us fail along this path to maturity

- Slowed, delayed, even aborted development can happen.
- It can happen through tragic circumstances.
- Or it can happen through avoidance of proper developmental thinking.
- And it can happen, unfortunately, by choice.
- If we see ourselves as helpless victims, we fail to see the new choices we could make, and instead stay stuck.

The “algorithm” is Reason

- And it’s got a great track record. But infallibility seems the yearning of many philosophers, who have been driven anxious and depressed by Godel’s Incompleteness Theorems for nearly a century now.
- But scientists have moved on. They understand and accept the nature of this limitation – Nobel physicist Richard Feynman is a great example
- Evolutionary biology gave us a tool for understanding the World that is “*proof’s in the pudding*” good for our survival and thriving – and Natural Selection drives to nothing beyond that.

A Consequence:

- ...is what I've been describing...
- Accept that Nature may say you're wrong in a conclusion or belief.
- Accept it, and move on.
- Think. Keep an open mind, and accept that the “weight of evidence” has been shown by history to be our best guide, but not it is not effortlessly infallible.

Logical Fallacies

- A logical **fallacy** is a pattern of reasoning that is consistently wrong due to a flaw in the logical structure of the argument.
- A logical fallacy is contrasted with what we may call an informal fallacy, which may have a valid logical form, but be false due to the characteristics of its premises or its justification structure.
- Here's [a pretty good list of logical fallacies](#)

Logical Fallacy Examples:

- **Argumentum Ad Hominem:** “Your claim is wrong because you’re a jerk!”
- **Argument from Divine Appeal:** “We can take your land because God ordered it”
- **Argument from Consequence:** “Human-caused global warming must be false because otherwise it would be too costly for me, or trample my freedom”
- **Argument from Ignorance:** “You can’t PROVE humans evolved from simpler life forms because we weren’t there to see it, so it must be false”
- **Argument from Motives:** “Osama Bin Laden wanted us out of Afghanistan, so we MUST keep up the fight”
- **Argument from the Club:** “I’m right, and if you don’t agree I’m going to whack you with this lead pipe!”
- **Argument from the Bandwagon:** “2 billion people believe in the Tooth Fairy, they can’t all be wrong”
- **Argument from the Big Lie:** A claim is repeated so often and is so outrageous, no one would say such a thing unless it were true.
- **Argument from Authority:** Valuing authority badges over evidence or truth. “Dr. Nolthenius has a PhD, so he MUST be right!”
- **Argument from Missing Bad Premise:** “When did you stop beating your wife?” (assumes you ever STARTED beating your wife in the first place).
- **Argument from irresponsibility:** “Yeah I was absent Monday, but you can’t ding my attendance record - I was too hung over from partying!”
- **Argument from Effort:** “I deserve an A, because I worked hard on that assignment!”
- **Argument from Equivocation:** Using a term deliberately in a way the audience will understand differently than the truth, like Clinton’s defense in the Monica Lewinsky affair
- **Argument from Stereotyping:** “Women are better housecleaners than men”
- **Guilt by Association:** “He’s a Republican, so you can’t trust anything he says”
- **Lying with Statistics:** “Gas prices are cheap! As a percentage of the National Debt, gas is far cheaper now than 50 years ago”.

Science is – Asking Nature Herself What is True

- We're all scientists (if we know what's good for us!)
- 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 feelings or your fears, 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**.

Confronted with Uncomfortable Truths?

- We'll first respond (as every healthy human does) by experiencing our feelings about that truth.
- Now take those feelings and place them off to one side, and then ask the key questions...
- Is this true? What's the evidence? Does it fit with well-verified knowledge I have or can gather? How can I energize and raise my awareness and engage my **Desire for Clarity** here?

But some of us are stranded on the path of personal growth

- We may instead react only from our feelings, feelings which may proceed from our biases and be unconcerned with truth.
- Pause and ask yourself how often you've seen examples around you of exactly this?

“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)

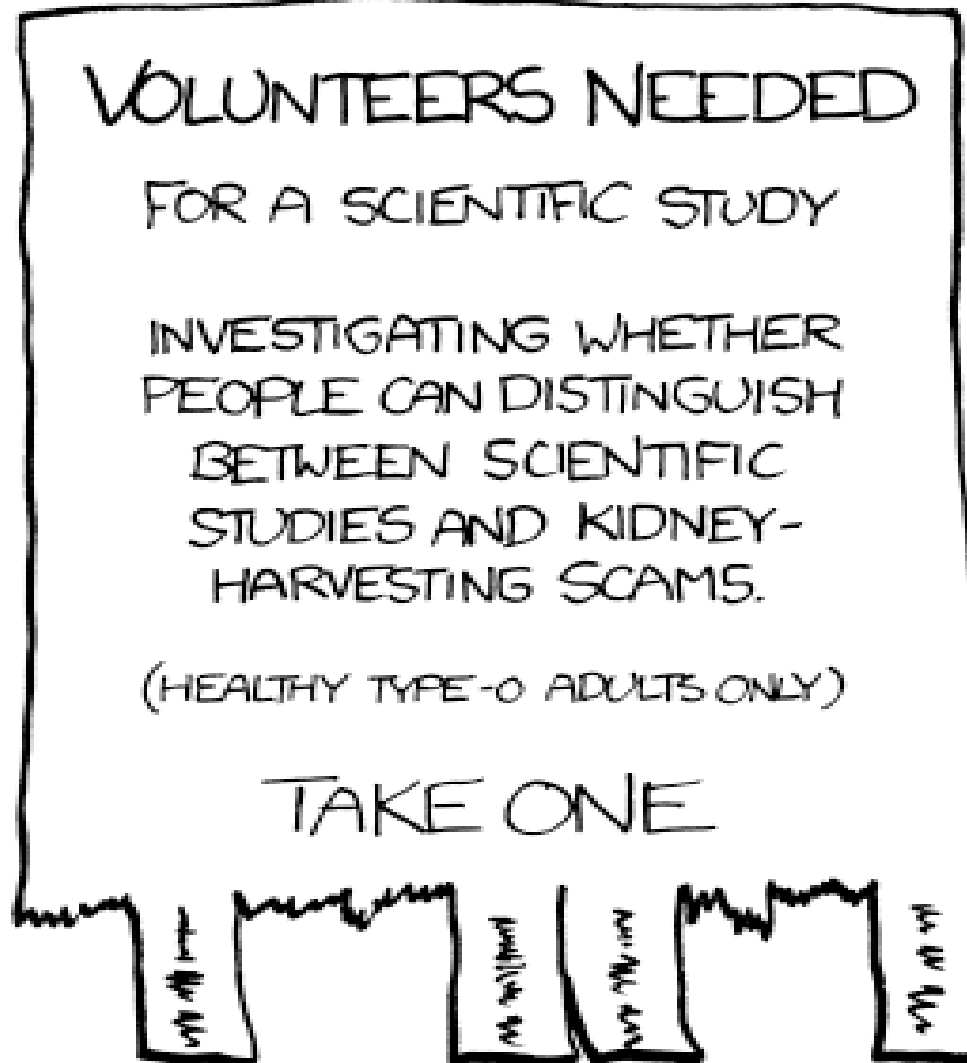
The Wisdom of Non-Attachment

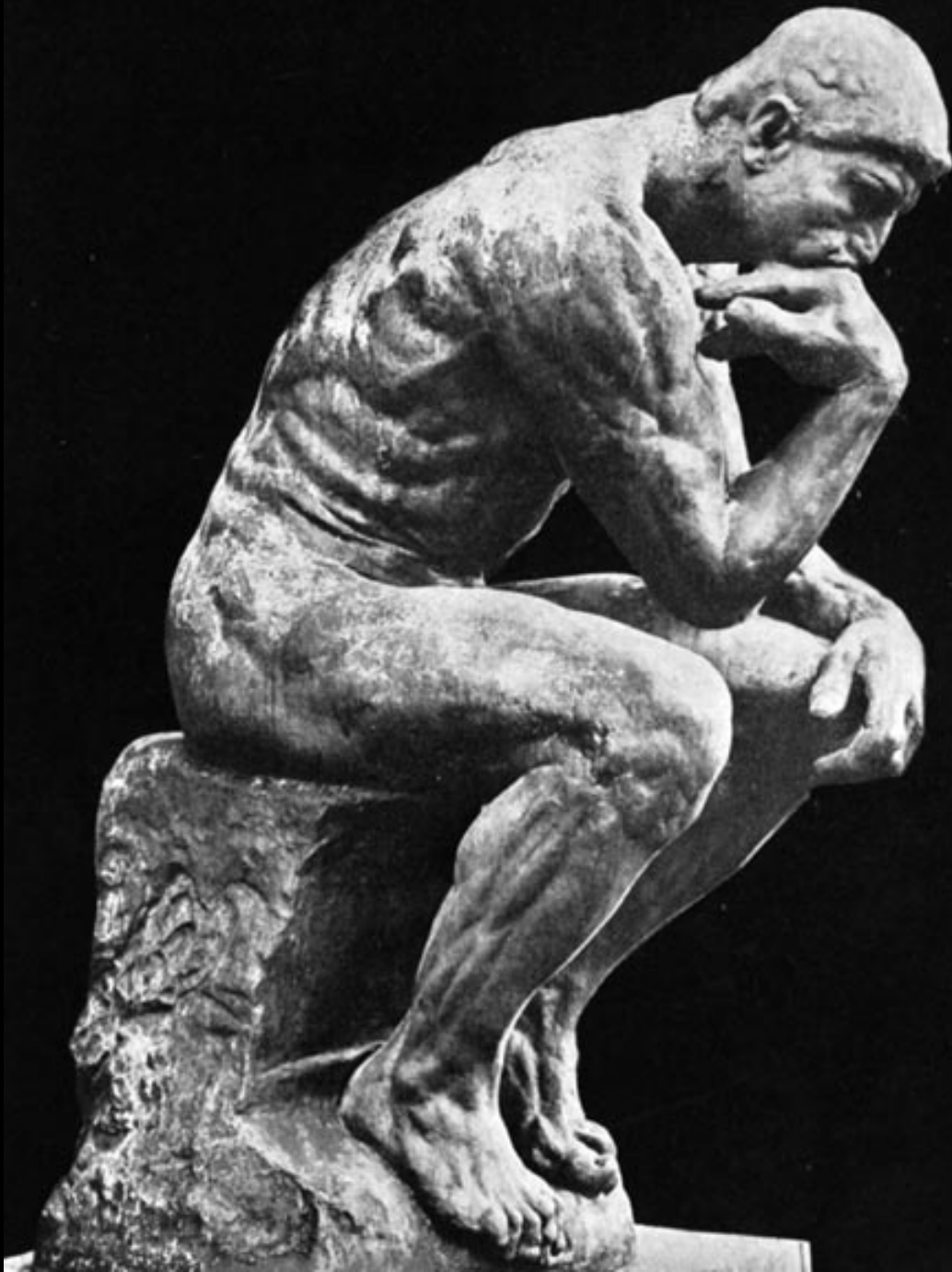
- If an idea I have held is wrong, I can let go easily because I never let it **DEFINE** me in the first place. I judge the idea, not the idea judge me.
- Pause and appreciate the power of that statement!
- The great spiritual insights of Taoism and Zen, recognize the inner peace that comes from non-attachment (non-attachment is not indifference!). Appreciate the value of focused awareness with deliberate deflection 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.
- 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.
- Genuine understanding takes effort, takes careful investigation, even perhaps advances in technology... **it takes time, be patient!**

Being Awake and Aware is a Good Thing!





**A good place
to be!**

Not a good place



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. While you may feel more practiced at one over the others, there's no real evidence of widespread hard-wired dysfunction in the other modes. In fact, accepting that fate can dis-empower you and even be condescending.
- Rarely will people struggle to master what they've already been told is impossible for them.

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



Peter Sellers George C. Scott

STREET

Dr. Strangelove

Dr. How I Learned to Stop Worrying And Love The Bomb

...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 prejudices, 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



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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](#)
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**...and Dr. Emily Shuckburgh – climate scientist
and head of the British Antarctic Survey**





**Or Dava
Newman,
MIT Professor of
Astronautics**

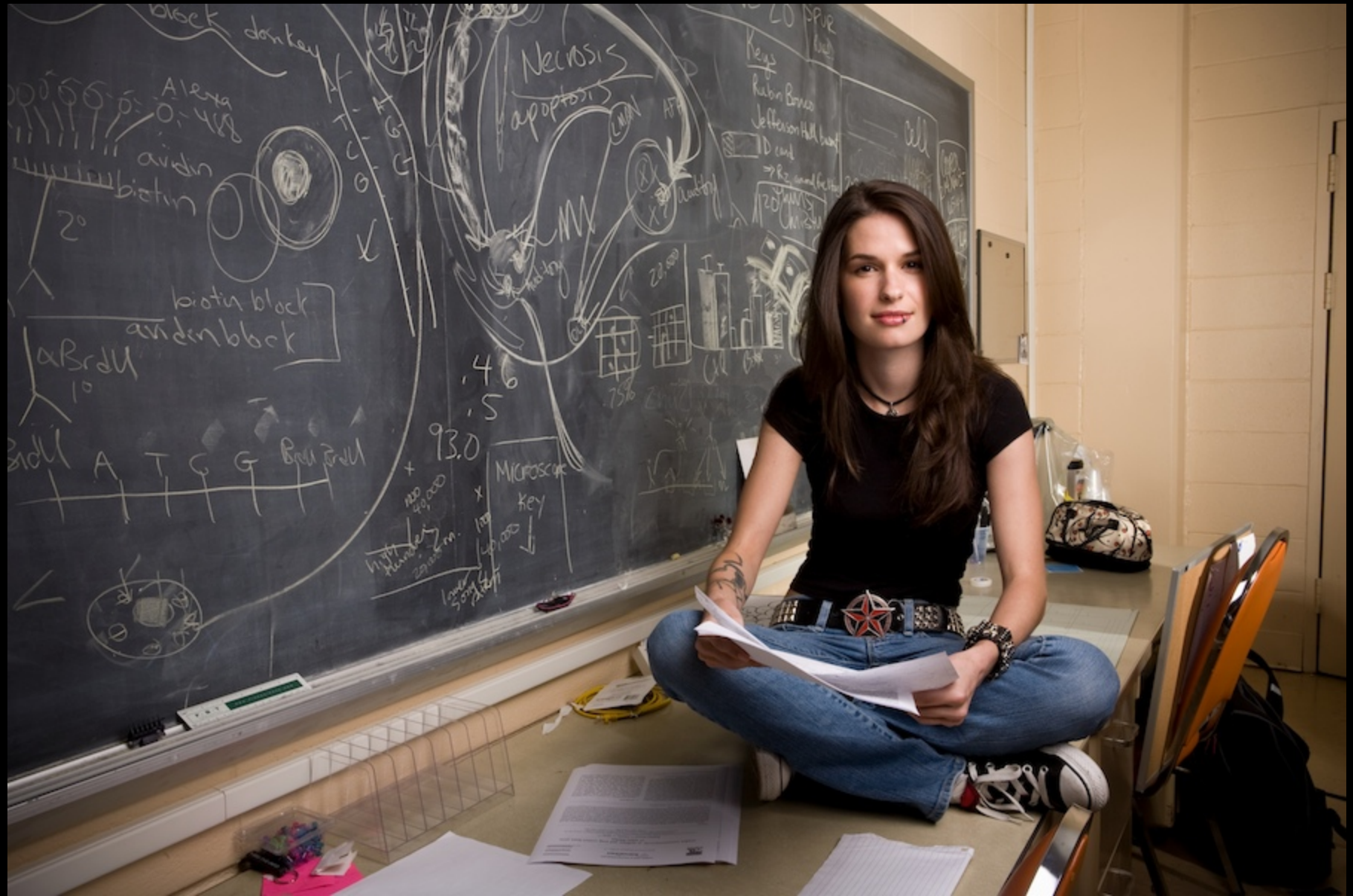
Or these guys... er, wait – those are actors



Particle physicist Tom Haine - Johns Hopkins University



Or Cara Santa Maria – nationally known science writer, with a Graduate degree in Neuroscience



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



Or Prof. Silvia Torres-Peimbert –
IAU (International Astronomical
Union) President and specialist in
the chemistry of nebulae



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 therefore **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 hypothesis 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! (and really irritating!)
- 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, while self-consistent, 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 doesn't mean they can't still be ruled against, on the illogic of the defining characteristics of the supernatural beings... they can be self-contradictory to the very meaning of the defining words used)

2. Predictions Should Be Specific

- By this, we mean that the hypothesis must be defined and must have de-limited 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”*
- In other words, 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 seeking to give credibility to what is, in fact, **incredible**

3. Predictions Should Ideally be Unique

- In other words, your hypothesis must have at least one do-able test whose result is not predicted by any other conceived explanation. Then, if it passes this test, you will have much better confidence this indeed appears to 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 what the Truth is, not over-concerned with 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...
- But note – “most likely”: Nature isn't obliged to obey your notions of simplicity. Still, 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
- Don't expect "***proof by loud assertion***" to carry weight with thinking people. Recent politics is a warning sign.
- 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 – hey, good luck with that!

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 – 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. As true psychologically as physically.**
- If you DO something, even something which in fact does not medically alter the problem, but yet you believe it might, then your organism dials down the pain signal to some extent.
- Your stress levels will reduce as well, improving your cortisol levels (chronic stress is a well-verified danger to physical health) and helping you, in fact, to heal to some extent.
- Both of these effects are part of **The Placebo Effect.**
- **But if what you did does not in fact address the cause, your pain will eventually 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.

	<i>Adverse health effect</i>	<i>No effect</i>
<i>Plastics Industry funded</i>	0	12
<i>Government funded</i>	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 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 of one 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.

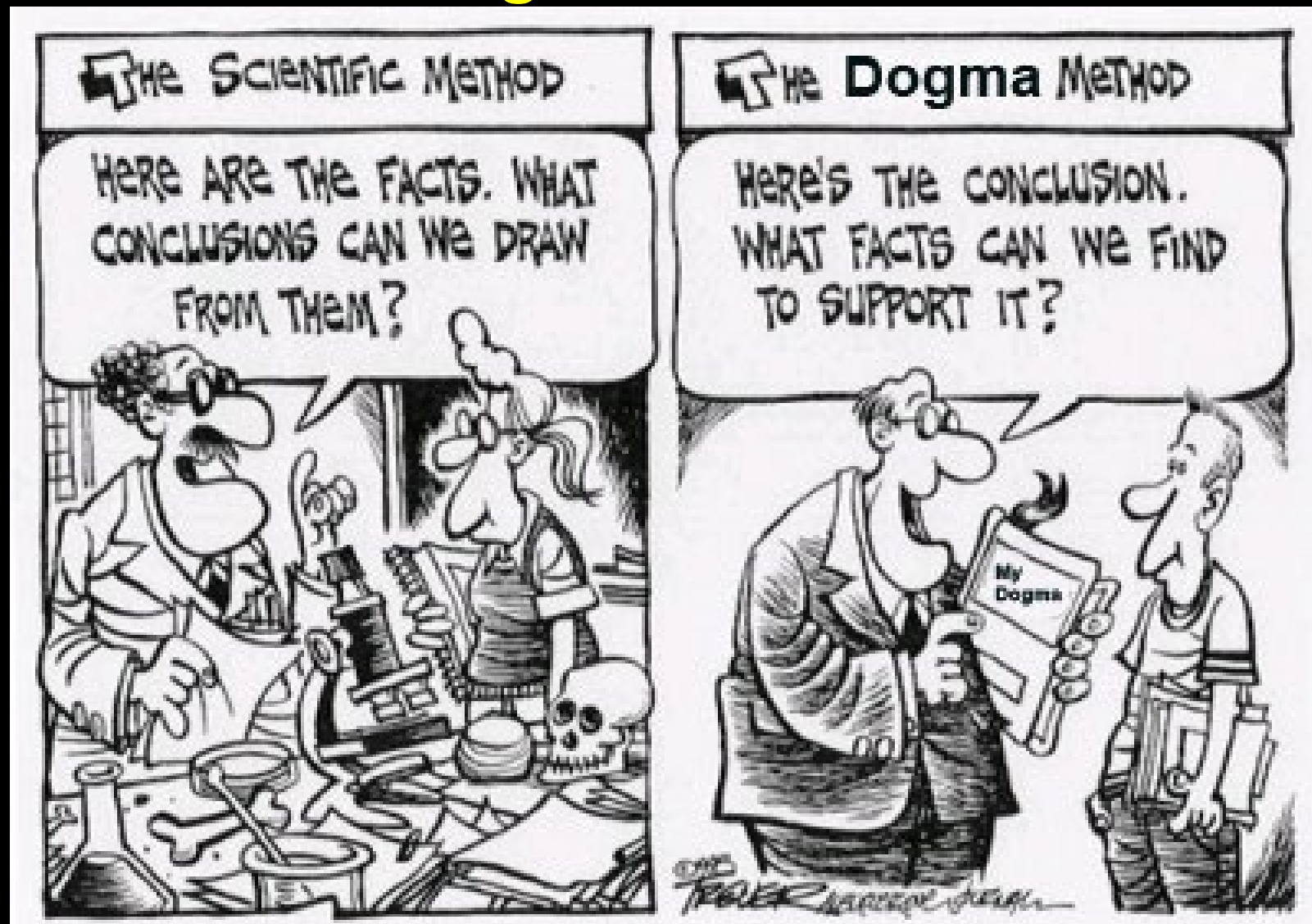
Suppose We're Evaluating a Claim on Climate Change – a Current Issue Full of Well-Publicized but Worthless Claims from Ideologically-driven Interests

- 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 suspect too 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](https://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

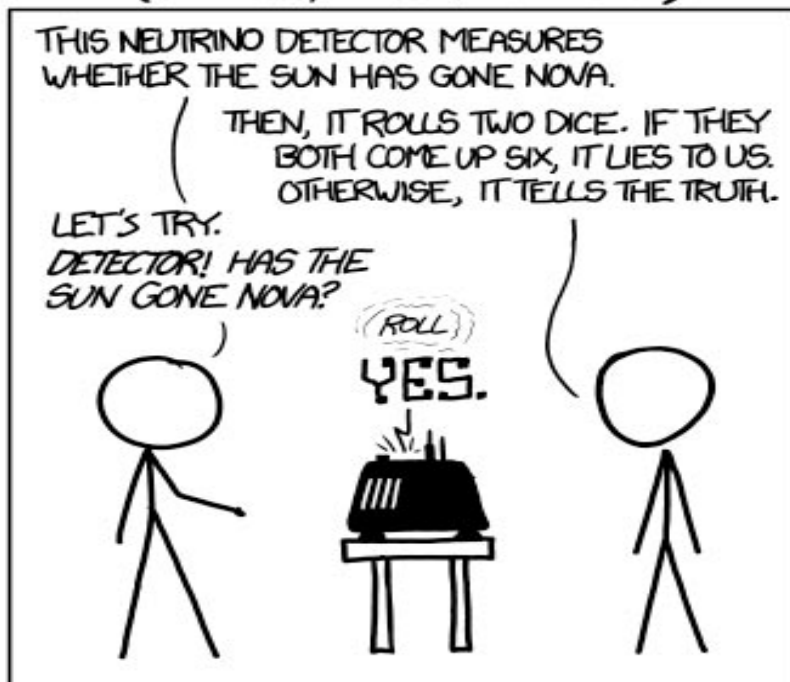
- In order to assign a “weight of evidence” quantitatively in a scientific investigation - a probability for a conclusion to be correct, given certain evidence, Bayes Theorem is central.
- [Bayes Theorem](#) relates the probabilities of conclusions given the probabilities of prior building blocks within 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](#)

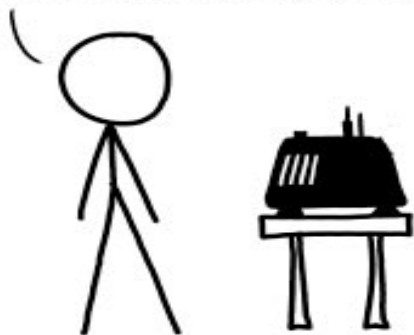
Frequentists vs. Bayesians

DID THE SUN JUST EXPLODE?
(IT'S NIGHT, SO WE'RE NOT SURE.)



FREQUENTIST STATISTICIAN:

THE PROBABILITY OF THIS RESULT HAPPENING BY CHANCE IS $\frac{1}{36} = 0.027$.
SINCE $p < 0.05$, I CONCLUDE THAT THE SUN HAS EXPLODED.



BAYESIAN STATISTICIAN:

BET YOU \$50 IT HASN'T.



Nerd-humor.
(You have to realize the “neutrino detector” keeps the rolled dice hidden)

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.
- Don’t be fooled by the politically motivated “False Balance” you see so often on network media. Example; they interview a scientist on a new discovery in a field that is politically charged – and then feel obligated (or pressured by advertisers) to give equal time to a shill from a special interest group posing as an expert, but in fact is spreading falsehoods now aided by the media.

Martian canals – seeing what you want to see? The eye/brain thought it saw little hints of dark spots which the brain connected into “canals”. HST 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)



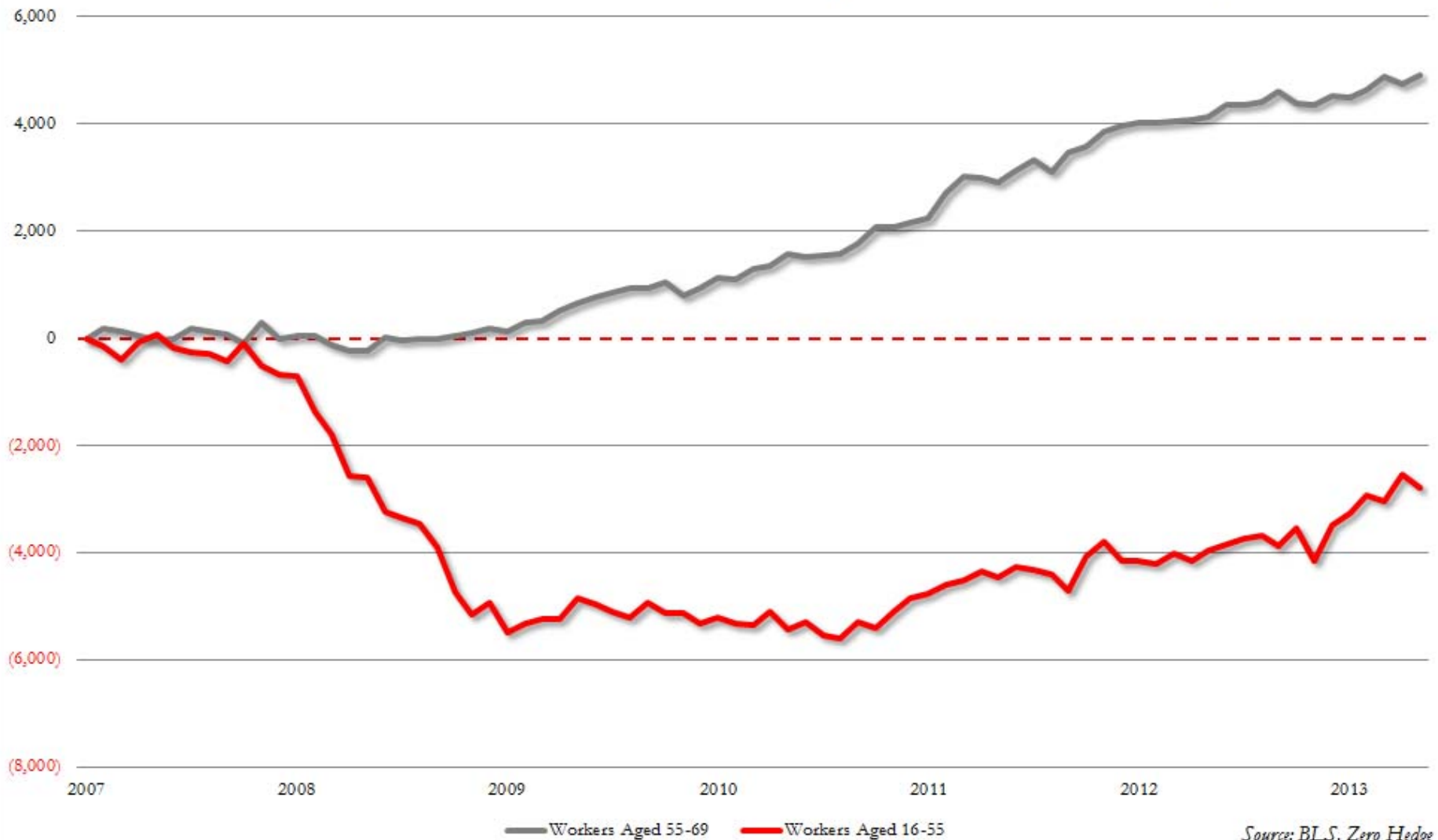


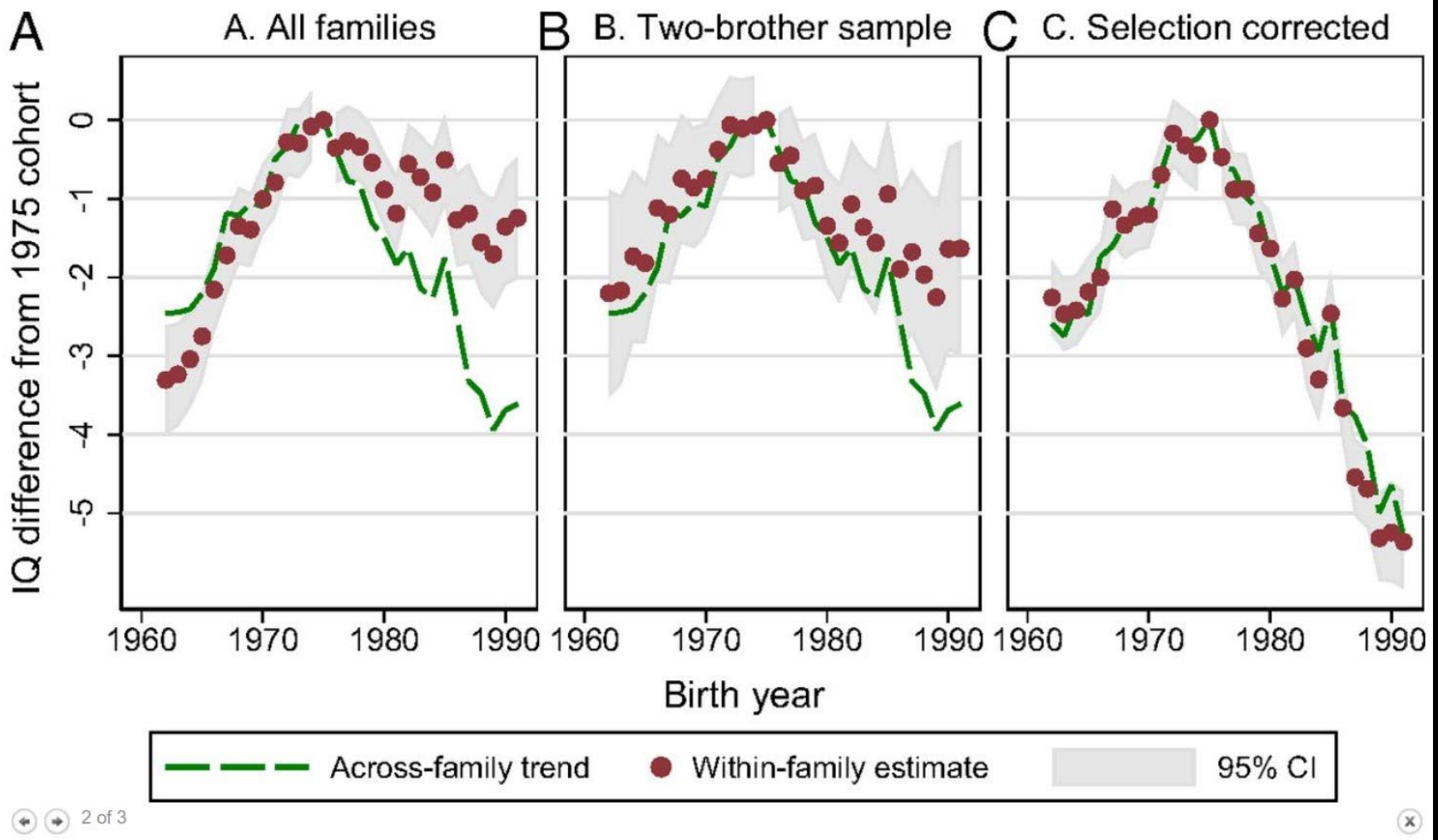
Clear Thinking – It's How to Get a Job Too

- According to many recent studies, American schools give students a very inflated notion of their competence.
- There are political motivations, as well as well-meaning but misguided attempts at raising self-esteem which encourage this inflation.
- But in fact, genuine self esteem can only come from knowing you are well-anchored to reality and confident in the proper use of your mind. Self esteem doesn't require perfection, only that you have earned trust in your **method** of awareness and gaining skills.
- In today's job market, the ways of those "old fashioned" schools of yester-year are more in demand by employers. Inflated notions and inflated grades don't go very far with those who are paying real money for real results.

Since the Great Recession – Younger Workers Not being Hired Near as Much

Cumulative Workers Added: 54 and Younger vs 55 and Older ('000s)





Disturbingly related, perhaps, is that IQ scores for people born after 1975 are progressively worsening (**panel C**) (Bratsberg and Rogeberg 2018). *“Our results remain consistent with a number of proposed hypotheses of IQ decline: changes in educational exposure or quality, changing media exposure, worsening nutrition or health, social spillovers from increased immigration...”*

But there are other reasons for the disturbing trend, and its continuation

- Haidt, Lukianoff, and Skenazy (2019), [interviewed by Malcom Gladwell](#) detail in their books how parents, overprotective during the critical early brain development years, and the failure of educational administrators to stand up for Critical Thinking ideals that used to be taken for granted, are producing an epidemic of anxiety and depression in those born after 1995.

This trend of progressively dropping intelligence in youth is continuing today

- *“By all the markers of development, an 18 year old of today (2019) is at the level of a 15 year old of 30 years ago”* – social psychologist Jonathan Haidt ([26 minutes in](#)), from [Professor of psychology Jean Twenge](#), leading him and co-author Gregory Lukianoff to recommend in [their book](#) that *“college campuses not admit 18 year olds – that a gap year after leaving their parents is necessary now... They’re not ready for it.”*
- What we’re now seeing, they agree, is that this is now spilling over into the workplace, and that the *“nightmare”* experienced by employers from the newly hired *“call out”* generation, is resulting in a shift in who gets hired, away from the Ivy League and West coast institutions, and instead towards colleges less affected by this phenomenon.
- Freedom of speech and scientific method are being dishonored, they find (at time **1:11:15** [into this interview](#)). The goal of knowing the world as it really is, is not being honored.

I've been involved in college education all my adult life; over 40 years

- The decline in standards is real. Bright people with gifts to share are becoming discouraged from college teaching, as time and effort is wasted trying to reduce gifted unique professors into interchangeable teaching widgets.
- This further degrades the very thing so many young people really need and have not had – **mentors**, good examples of “thinking on your feet”.
- The declines in both IQ and in respect for science, are correlated ([Hambrick and Marquardt 2020](#)) with the rise and power of “fake news”, and the policy makers who encourage it.

On the Subject of Choosing Your Life's Work

- When I think of mistakes I've made along the way, it always comes back to this imperative...
- **Think of what you can do with your life that will surround you with QUALITY PEOPLE.** People who can inspire you, you can learn from, who are better than you in important ways. And follow your personality too – that's what science says.
- We need inspiration to make a real **Go** of life. Ideally we find it not only in great art, but in our present experiences with real people - People who have learned important truths that you may not yet have learned, who can teach you by living example.



Young people on mobile phones (stock image).

Credit: © akhenatonimages / Fotolia

Happiness is not a warm phone, according to a new study exploring the link between adolescent life satisfaction and screen time. Teens whose eyes are habitually glued to their smartphones are markedly unhappier, said study lead author and San Diego State University and professor of psychology Jean M. Twenge.

Forget the chattering distractions that the commercial interests want to hook you on, while they take your dollars and leave you endlessly unfulfilled –

That's right where the marketers want you... So you'll be primed to buy the "next big thing" in a new (vain) hope of finally being fulfilled. **Higher FaceBook use is correlated with lower emotional and physical health (2019)**

I can't help wondering...

- ...if this kind of research is related to other studies showing that poor mental skills when teenagers is predictive of later development of Alzheimer's Disease ([Huang et al. 2018](#)).
- We have a cultural problem. And the Great American Mind is in decline, as we descend into a new Dark Ages. [American students are fully 4 grade levels behind their Chinese counterparts in the language of Nature: mathematics.](#)
- Exercise your mind... use it, or lose it.



Children who grow up isolated from Nature have high rates of anxiety and depression. Happiness, at a primal level, comes from intimate awareness and connection with what is REAL. We're designed to operate best in **REALITY**. We know, conscious or not, when we're fooling ourselves, and it's an unhappy place. We relax and return to health, by simple focused awareness. Zen masters realized this centuries ago. Modern psychology agrees.

- *“Using data from 3,585 people collected across four cities in Europe, scientists from the Barcelona Institute for Global Health (also called IS Global) report a strong relationship between growing up away from the natural world and mental health in adulthood. Overall, they found a strong correlation between low exposure to nature during childhood and higher levels of nervousness and feelings of depression in adulthood. Co-author [Mark Nieuwenhuijsen](#), Ph.D., director of IS Global’s urban planning, environment and health initiative, tells Inverse that the relationship between nature and mental health remained strong, even when he adjusted for confounding factors.”* ([source](#))

The Universe Revealed by Science... IS Magical

- But Astrology and other pseudo-science? It's time to let go. It's the 21st century. Let's evolve...
- You want to go slack-jawed with awe? Ponder quantum mechanics, study modern cosmology, the Multi-Verse!
- Science is much MORE magical because it is Nature herself talking to us, not make-believe. When you see a great, inspiring film, isn't it much more inspiring if you learn it is a **true** story?
- And the best reason... science is just plain FUN.
- So: toss dogmatism, learn to be humble (Ask Her artfully, don't dictate to Mother Nature what she is and is not), enjoy the mysteries, and re-assume the responsibility of independent thought.
- Get comfortable with a certain amount of uncertainty, and give respect to ***the weight of evidence***,
- Be open minded... but....

Don't be so
open-minded
that your brain



falls out

Key Points from Chapter 0

- Evolution by Natural Selection has equipped to identify truth – the “light bulb” experience – because it has survival value. If we use it carefully, our brain WORKS!
- **Occam’s Razor** – explanations 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