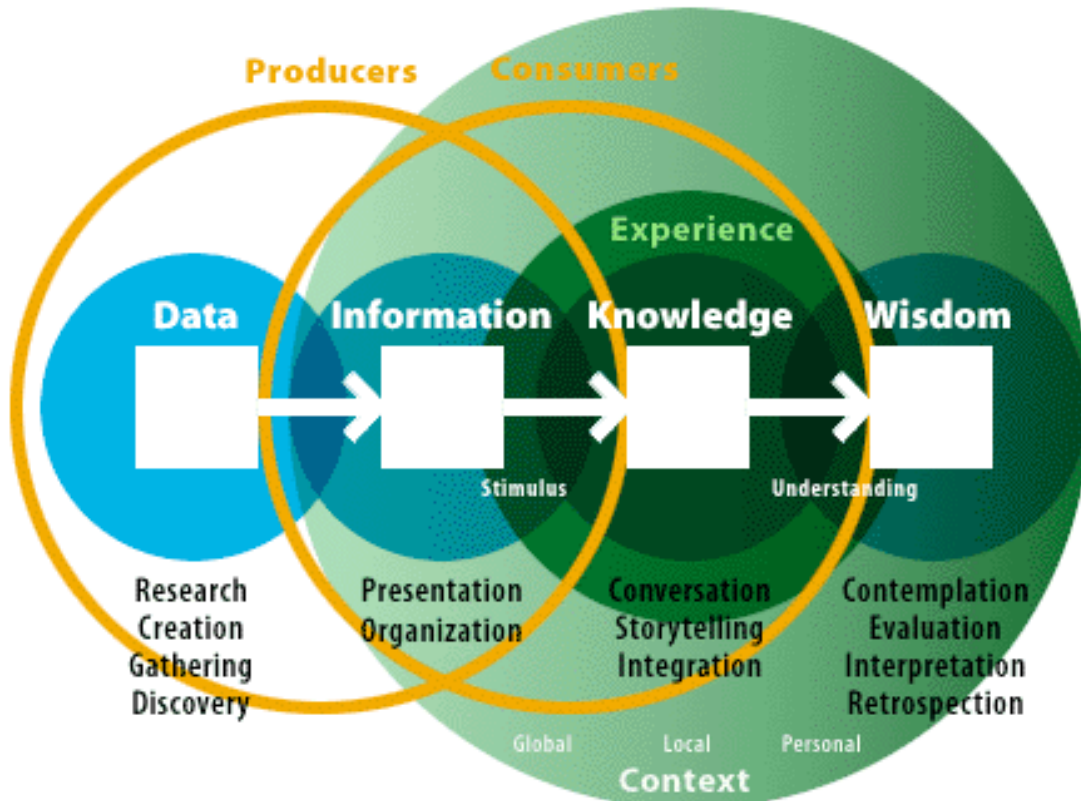


T1 – Transitions Towards “Truth” & Knowledge

Dear: With reference to the figure below,¹ I now want to address the topic Shedroff labeled as ‘Knowledge’. In this chapter, the main question that I want to address is: Given some claim to knowledge, how can we determine if that knowledge is “true”?



When I’m walking and get to “T”, I usually address the topic of “truth” (and more) with something similar to the following.

T: Testing for “truth” (via trial & error), building trust (via honesty, kindness, and tact), and making transitions (overcoming whatever is necessary, from timidity to terror): tricky, interrelated concepts.

¹ Copied from <http://www.nathan.com/thoughts/unified/index.html>. The figure is contained in an article by Nathan Shedroff entitled “Information Interaction Design: A Unified Field Theory of Design.”

When walking, I then usually spend whatever time is appropriate relating those “tricky, interrelated concepts” to whatever might be bothering me.

In this chapter, I want to begin trying to explain what I mean by the above – especially the concept of *testing for “truth”*. In the next chapter (T2, entitled “*Truth and Understanding*”), I’ll try to finish my explanation. And immediately I should explain that, in the above (and in the chapter titles), I put the word ‘truth’ in quotation marks, because the concept of truth is at least ambiguous and in some cases, misleading. To summarize what will take me quite a while to explain, I’ll just state: *religious truth isn’t real, scientific truth can’t be realized, and personal and social “truths” aren’t even truths – they’re just opinions.*

A similar summary was written a long time ago by one of the first Greek philosophers, Xenophanes (c.570 – c.475 BCE). You might recall that he also wrote:

If cattle and horses, or lions, had hands, or were able to draw with their feet and produce the words which men do, then horses would draw the forms of gods like horses, and cattle like cattle, and they would make the gods’ bodies the same shape as their own.

Undoubtedly the clerics disliked that “blasphemous” statement – and almost certainly they disliked, even more, his following even more penetrating statement (as translated by Karl Popper):

But as for certain truth, no man has known it, nor will he know it – neither of the gods nor yet of all the things of which I speak. And even if by chance he were to utter the final truth, he would himself not know it, for *all is but a woven web of guesses.*

I italicized Xenophanes’ phrase “all is but a woven web of guesses”, Dear, in hopes that, by the time that you’ve finished reading this and the next chapter, you might be tempted to memorize his penetrating assessment: *all is but a woven web of guesses.* And actually, I’d even expand on his statement with my own opinion: all is but a woven web of guesses and opinions.

To begin to try to explain what I mean by *religious truth isn’t real, scientific truth can’t be realized, and personal and social “truths” aren’t even truths – they’re just opinions* and to show you what Xenophanes seems to have meant by *all is but a woven web of guesses*, perhaps it would be useful to point out that one of the most important transitions in thought that has ever

occurred has been in the meaning of the word ‘truth’. This transition has slowly evolved over thousands of years – although the rate of change during the past few hundred years has increased substantially, at least in non-Islamic societies. A thousand-or-so years ago in Western societies (and still today in most Islamic societies), for the vast majority of people, “truth” was whatever the clerics said was “true”. In all dictatorships, similarly, “truth” is whatever propaganda the tyrants dictate.

The concept of “truth” promoted by dictators (either clerical or political) is consistent with the stupidity that the otherwise usually sensible (pragmatic) American philosopher William James (1842–1910) wrote in his 1907 book entitled *Pragmatism*:

The true is that which we ought to believe. That which we ought to believe is what is best for us to believe. Therefore, the true is that which is best for us to believe.

Rather than your accepting James’ silly premiss “the true is that which we ought to believe” (which is meaningless until the goal implied by ‘ought’ is specified!), I hope, Dear, that you’ll adopt a concept something similar to: the true is that which persists regardless of what anybody believes!

Yet, undoubtedly James’ premiss is eagerly promoted by all dictators, i.e., those who have amply demonstrated their willingness to show you that you “ought to believe” what they say – if you desire to survive. This is one way that “truth” and terror can be intertwined.

In fact and in contrast to James’ conclusion from his silly syllogism, sometimes it’s best “to believe” (or, at least, to profess belief) in what you suspect is false! For example, when parents are in control, it may be “best” for children to say that they believe in their parents’ god – if otherwise the parents will punish their children. Similarly, in societies in which the clerics or other tyrants rule, it may be “best” for people to say they believe whatever their dictators demand – if the people deem it “best” to avoid torture and to continue living. Stated differently, those who have gained power (such as parents over their children, clerics over their “flocks”, and dictators over their subjects) claim authority to define what’s “right”, what’s “best”, what people “ought to believe”, and what’s “true”.

Actually, when and where the clerics controlled (or still control) some society, they dictated (and still dictate) their “truth” not only in religion but

also in law and in science. Thus, during the Dark Ages [which for the Israelites started when they accepted the story about Moses using his Levite “storm troopers” to murder those who thought his religion was stupid, which for the Christians started when the Roman Emperor “Saint” Constantine (“the butcher”) used his army to murder those who thought Christianity was stupid, which for the Muslims started when Muhammad had his band of thieves murder those who thought Islam was stupid, and which for the Mormons started when Joseph Smith used his “Danites death squad” to murder those who thought his religion was stupid], the clerics simultaneously wore (and in most Islamic societies still wear) three hats: as priests, lawyers, and scientists.

Thereby, if the clerics (as priests) said or say that God talked to Moses, or that Jesus was the son of God, or that the angel Gabriel talked to Muhammad, or that some angel showed Joseph Smith where the golden plates were hidden, then that’s “the truth”. Or if the clerics (as lawyers) said or say that it’s okay to sell your daughter into slavery, or that dancing on Sunday is witchcraft, or that unbelievers should be killed, or that you can’t get into the highest heaven unless you practice polygamy, then that, too, is the “truth”. And if the clerics (as scientists) said or say that their god created the world in seven days, or that evil sprits cause illnesses, or that the Earth is at the center of the universe, or that miracles still occur, then regardless of any data to the contrary, that’s the “truth”. That is, again, according to the clerics, the “truth” is whatever they said (or still say) is “true”, be it in religion, law, or science.

After an enormous struggle (some of which I’ll sketch in the “excursion” Yx, dealing with “Your Indoctrination in the Mountainous God Lie”), at least some people wrestled ideas about law and justice from their clerics. Thus in Western societies, starting in Ancient Egypt, continuing through Europe’s Dark Ages, and in large measure responding to horrible injustices inflicted by the clerics on the people (including torture to obtain “true” confessions and then burning “the confessed sinners” at the stake), slowly a new concept of justice emerged, in which other than clerical lawyers would attempt to ascertain “the truth”. As a result, not only were the clerics forced to abandon their roles as lawyers but also a new idea of “truth” emerged, namely, “legal truth”.

But before commenting on the concept of “legal truth”, let me briefly mention the historical evolution of the concept of “scientific truth.” In this

* Go to other chapters *via*

case, too, the power to define “truth” was wrestled from the clerics only after long struggle, lasting thousands of years – and it’s not yet finished, even in our society. In the “excursions” **Y_x** and **Z_{0x}**, I’ll sketch some skirmishes of this continuing battle, some records of which can be found from Ancient Mesopotamia. As I’ll show you in the **X**-chapters, the battle continues today even in the U.S., e.g., with the nonsense promoted by various “religious fundamentalists” (including Mormons) about evolution, itself, and with the recent stupidities of Pope John Paul II, who cautioned against studying the initial “instant” of the Big Bang, because it was getting too close to studying “God”, doncha know (☺).

Which leads me to plead: surely to sanity it won’t be much longer until all such stupidities will end; surely to sanity the clerics of the world will soon no longer have the audacity to wear either legal or scientific hats; surely to sanity, all remaining clerics will soon just cringe in their corners wearing the only hat appropriate for their “profession”, i.e., dunce caps!

But pushing aside additional (and even-more-emotional) comments about historical transitions of the meaning of “truth”, what I hope you’ll see from the above, Dear, is that different meanings for the concept of “truth” have emerged from history, including, 1) “religious truth”, 2) “legal truth”, and 3) “scientific truth”. As I’ll get to later in this chapter, other commonly recognized “truths” are “logical truth” and/or “mathematical truth”. Also, some people argue that still another “truth” is “philosophical truth”, but others (such as I) would argue that any “truth” contained in any philosophy is actually an attempt to find “scientific truth” – or should be! In addition, some people argue that still other “truths” are “personal truths” and “social truths”, but I’ll argue that such aren’t even “truths”, just opinions – which people can undoubtedly hold “honestly” (e.g., that anyone with any sense of taste knows that it’s true that strawberry shakes are better than chocolate!), but they’re really just opinions, reflecting one’s sense of values.

And what I hope you’ll see from what follows, Dear, is that it’s really quite important that you distinguish among different meanings for “truth” and that, actually, there are only two types of “truth”, namely, for open *versus* closed systems. But before I try to explain what I mean, I want to remind you about some of what you already know about the above-listed three types of “truth”, viz., religious, legal, and scientific. I’ll get to “logical truth” and “mathematical truth” later in this and the next chapter, to “philosophical truth” in **W** & **Y** chapters, and to values and opinions in **V** & **X**.

* Go to other chapters *via*

Maybe “legal truth” (or “judicial truth”) is easiest to understand. In personal, interpersonal, and social justice, ‘truth’ basically means honesty. For example, Dear, if ever you’re called to court as a witness and told to “Put your left hand on the Bible, raise your right hand” and then asked “Do you swear to tell the truth, the whole truth, and nothing but the truth, so help you God?”, then if ever you become as cantankerous as a certain old grandfather, you would refuse to put your hand on the Bible, demand to know what “that damnable Black Book” is doing in a court of law, criticize the judge for violating the Constitutional separation of Church and State by permitting use of the Bible and reference to “God” in a court funded by taxpayers, and then add: “But, of course I promise to be honest.”

That is, Dear, you can’t guarantee that any of your statements are “true”: the most you can guarantee is to be honest. For example, if you were asked if it’s “true” that you saw the defendant strike the plaintiff with a baseball bat, then you could answer “Yes” or you could be honest and reply something similar to: “I clearly recall seeing someone who looked essentially identical to the defendant swing what seemed to be a baseball bat that I’m quite sure hit a person who looked essentially identical to the plaintiff.” To which the questioning attorney would probably respond, “Just answer the question ‘Yes’ or ‘No’,” in which case you might answer: “Sorry, I can’t do that; I promised to be honest.”

Stated differently, although “truth” is sought in legal matters, no one can ever be certain that “truth” is attained. Consistently, juries are instructed to try to ascertain “the truth” only “beyond a reasonable doubt.” If reasonable people on the jury (which contains quite an assumption!) unanimously conclude that the evidence in the case strongly suggests that “such and such” occurred, then that’s taken as sufficient “proof” that the “truth” of what happened is known. The defendant may then be punished for the alleged crime – and then, years later, new evidence may arise showing that what was previously identified to be “true” was more likely to be “false”.

Yet, as horrible as such instances are, our judicial system can’t do much about eliminating such blunders – although, as I’ve written in an earlier chapter, our judicial system could help minimize such “travesties of justice” by eliminating the unfairness in our legal system that permits people to “get the best lawyer that money can buy”. But setting that aside, let me summarize my main point about “truth” in any judicial system by saying that

* Go to other chapters *via*

“legal truth” doesn’t deal with what occurred in reality; only, at best, with honest reports and evidence that suggest what might have occurred, i.e., with estimates for the *probability* that some claim is “true”.

Perhaps it would be useful if I reminded you about probabilities. Toward that end, recall the following figure from Chapter **Ih** (dealing with “Hypotheses, Probabilities, and Evidence”).

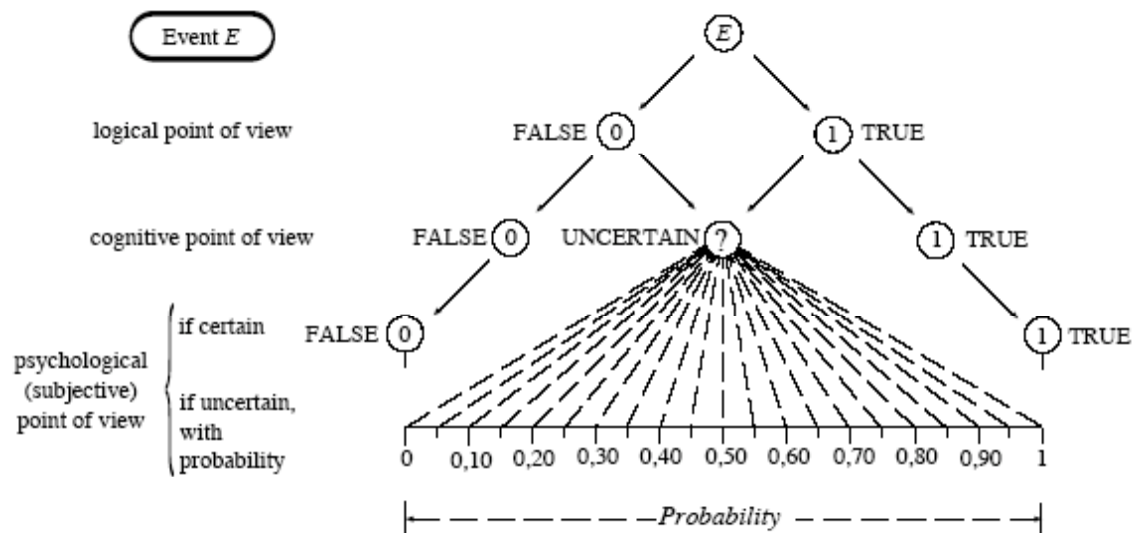


Figure 3.1: Certain and uncertain events [28].

For present purposes, I’d ask you to interpret the notes on the left-hand side of the above figure² roughly as follows.

- At the top of the figure, the “Event E” could be some event leading to a subsequent jury trial, or a theorem proposed by some mathematician, or a claim by some scientist to have discovered a new principle.
- At the next level, from the “logical point of view”, then as shown on the right-hand side of the figure, the event is either true or false (it did happen or it didn’t; the theorem was proved or it wasn’t, etc.).

² This is Figure 3.1 in a report by Giulio d’Agostini originally published as CERN Yellow Report 99-03, July 1999 (vi + 175 pages) under the title *Bayesian reasoning in high energy physics. Principles and applications*. It’s available at <http://public.lanl.gov/kmh/course/bayesian.html>. The reference that d’Agostini gives as the original source of the figure is “B. de Finetti, *Probabilita*, entry for *Enciclopedia Einaudi*, 1980”, who used commas in the measures of probability, whereas we use decimal points.

- At the next level, from the “cognitive point of view” (i.e., what we have the ability to know), maybe the event didn’t occur (e.g., the claim is “false”) or maybe it did (the claim is “true”), but if we’re honest, we’ll admit that we’re “uncertain” – we can’t even be certain that we exist; we may be simulations in some humongous computer game!
- Finally on the left-hand side of the figure, at the bottom, “from the psychological or the subjective (or the probabilistic) point of view”, if we are “certain” (which we can’t be!), then the event would be either “true” or “false” – but in reality, the best we’re able to do is determine the probability that “the event” (or some hypothesis) is “true”, with probabilities customarily quantified with numbers ranging from zero (“false”) to unity (“true”) [or from 0% to 100% (i.e., certainty) or from $-\infty$ to $+\infty$ if one desires to deal with the logarithms of probabilities (e.g., in “information theory” and in dealing with entropies)].

In **Ih**, I tried to show you how Bayes’ method can be used to estimate such probabilities, and in the next chapter (entitled “*Truth and Understanding*”) I’ll try to show you more – not just for cases in “legal truth” but also for cases in trying to estimate probabilities for “scientific truth”.

Now, though, I want to move on to cases of interpersonal justice. In many such cases, not only is it impossible to know “the truth”, sometimes it’s undesirable even to be honest! Instead, usually most desired are a little tact and a lot of kindness. For example, Dear, if your friend asked you if she “truly looked okay” at the party, then even the concept of “truth” is rather ridiculous: who are you (or anyone else) to say she “truly” looked “okay”? [Whatever that means!] What you could give is your honest opinion, but opinions are derived from our sense of values (e.g., your opinion that blue and green go well together) not necessarily from any “truth”. Further, your friend may not want even your “honest” opinion about how she looked – that is, your honest report of your thoughts when you saw her. Instead, she may want some reassurance and maybe some advice, in which case you might respond: “You looked great! I especially liked the way the color of your blouse highlighted your eyes when you wore that ribbon in your hair.” And if you wonder how you can tell what response is appropriate, then I’ll bet you already know the answer: by tactfully testing, i.e., by learning through trial and error (or “trial and success”!), which is the usual way we gain knowledge.

In cases of personal justice, finally, we usually have the best opportunity to achieve the “ideal” of “legal truth” – if people will “just” be honest with themselves! For example, Dear, if you will be “totally honest” with yourself, then there’s a good chance that you’ll get quite close to the “truth” about why you did poorly on that exam, or what you really like about a certain someone, or whether you believe in God, or similar. In contrast, you probably know many people who seem to be unable to be “truthful” even with themselves. They seem to be in a continuous “state of denial” about the “true reasons” for their behaviors, opinions, and beliefs.

And while I’m here, let me add a thought dealing with the coupling of personal and interpersonal justice, a thought that I picked up from the impressive movie “The Big Cahoutta.” Although I don’t remember the exact phrasing, I clearly remember the concept: if you want others to trust you, then begin by demonstrating that you’re honest with yourself. That is, as with charity, honesty should begin at home. In contrast, if others realize that you’re dishonest even with yourself, then expect them to doubt that you’ll be honest with them, i.e., expect them to distrust you.

Which, by the way, is a major reason why most scientific humanists generally distrust religious people: if religious people aren’t honest even with themselves (deluding themselves into “believing” that some invisible friend is with them, guiding, protecting, and even loving them, and who will reward them with an eternity of bliss if they’ll just slavishly do the clerics’ bidding), then what’s the probability that such people will be honest in dealing with others?! In turn, that thought leads me to something about trust that I recall when I’m walking and that no doubt you already know, but I’ve found that it’s worthwhile to frequently recall.

It’s this. In all interpersonal relationships, Dear, arguably there’s nothing more precious and nothing more fragile than trust. As for the value of trust, let me describe it this way: rather than accept Sin-leqe-unnini’s, or Homer’s, or Aristotle’s definition of a friend (definitions describing a friend as a “second self”), I would define a friend as someone I can trust. And the important point not to forget, Dear, is that trust can take a long time (weeks, months, years, decades!) to build, but can be shattered in an instant. Therefore, Dear, if you want a meaningful friendship, then above all else, guard against betraying your friend’s trust.

But enough of what you already know; let me now move on to something with which I suspect you're not so familiar, namely, “scientific truth” (i.e., “truth” in the case of “natural justice”). And I suggest that you're not so familiar with “scientific truth”, Dear, because nobody is! That is, for reasons that I'll try to explain, “scientific truth” is an illusion!

Now, Dear, you may think that I'm being silly, but actually, I'm serious. As examples, I wouldn't be surprised if a million-or-more experiments have already been performed to test if, in the limit of an “isolated mechanical systems” (i.e., in the absence of external forces and heat and mass sources), momentum and mass-energy are always conserved. And although not a single case of nonconservation of momentum or mass-energy has ever been observed, not only is it virtually impossible to perfectly isolate any system but also, and more significantly, “tomorrow is another day” and someone, sometime, somewhere, might uncover an unequivocal case in which “the law of the conservation of momentum” or “the law of conservation of mass-energy” is violated.

Thereby, Dear, please notice two points that I already mentioned in earlier chapters: 1) there's a huge difference between “legal laws” and “scientific laws” and 2) therefore, there's a good reason why the term “scientific law” is currently being abandoned. After I review those two points, I'll then turn to a third and the most important point, namely, 3) to understand why “scientific truth” is an impossibility, it's important to distinguish between different types of systems, “open” *versus* “closed” (with examples of “closed systems” being the assumed “isolated mechanical systems” mentioned in the previous paragraph).

Relative to the first two points, notice that in legal matters, “laws” are as unequivocal as lawmakers are capable of specifying them: if the speed limit is 65 mph, then that's “the law”; you can violate the law, but you should expect to pay the specified penalty for doing so. In science, in contrast, what previously were called “laws” (but are now called “principles”) have never been violated – but everyone and anyone was (and still is!) invited to try to do so. In fact, Dear, although you should expect to pay a penalty if you violate some “legal law”, yet in contrast, if you can demonstrate that you can violate some “scientific law” (such as the “laws” of mechanics or the “laws” of thermodynamics), then I essentially guarantee that you'll receive a substantial award, namely, the Nobel prize in physics!

There is thus such a dramatic difference between “legal laws” and what previously were called “scientific laws” that the term “scientific law” is now in the process of being replaced with the term “scientific principle”. Yet, although there is a dramatic difference between the results, there’s a critically important similarity between legal and scientific methods of investigation. In both, this critically important (and fundamental) method is to *rely on evidence* in an attempt to ascertain in legal cases if some law has been “upheld” or “broken” or to ascertain in scientific studies if some scientific principle has been “validated” or “invalidated”. In both instances, for both legal and scientific studies, we can’t determine if some claim is “true” (or “false”) – at best what we’re able to do is examine relevant evidence and then, from the evidence, try to discern how the evidence influences estimates of the probability that some claim is “true” (which simultaneously yields the probability that the claim is “false”, since it’s unity minus the probability that the claim is “true”). Stated differently (and more accurately): in reality, the best we can ascertain are probabilities.

Thereby, Dear, maybe you’re beginning to see why “scientific truth” is an illusion. But because there’s actually much more that I hope you’ll see, I need to try to make sure you understand the critically important difference between “open” *versus* “closed” systems. What I want to show you is that, actually, there are only two types of “truth”, namely, 1) “truth” in open systems (a “truth” that evidence might permit us to approach but that we can never be certain we’ve ascertained) and 2) “truth” in closed systems (a “truth” that we CAN “prove” is “true”, as in “logical truth” and “mathematical truth”, but that we can never be certain has anything to do with reality – although in some cases we can demonstrate that a “closed-system truth” is false for the open-system known as reality).

And although the distinction between “open” *versus* “closed” systems is critically important, Dear, fortunately it’s a trivially obvious concept. If in the following you find that you become confused, especially if you say to yourself something similar to “It can’t be this simple”, then please correct yourself: it IS that simple! After you see it, Dear, you should be able to explain it perfectly clearly to someone still in kindergarten. [It’s harder to explain it to someone who’s older – ‘cause they’re less trusting!]

To see the difference between open *versus* closed systems, first consider various systems with which you’re familiar, such as the educational system, the judicial system, the federal tax system, the human immune system, a

hospital, the human body, a tree, etc. The word ‘system’ is derived from the Greek prefix *syn* meaning “together” and the Greek verb *histanai* meaning “to set”, so literally, *system* means “set together”. In my copy of Webster’s dictionary, the first meaning listed for *system* is “a set or arrangement of things so related or connected as to form a unity or organic whole [a solar *system*, school *system*, *system* of highways]”, which is what more specifically should be identified as an *open system*. The second meaning listed in my dictionary for *system* is “a set of facts, principles, rules, etc. classified or arranged in a regular, orderly form so as to show a logical plan linking the various parts”, which is what more specifically should be identified as a *closed system*.

Let me try to make the difference between open and closed systems clearer. If you will, Dear, please mentally subdivide the entire “set” of things called “systems” into the following two subsets:

1. *Open systems* – those systems that, in some manner, interact with at least some part of their “environments”; i.e., in some manner or other, an open system exchanges “whatever” (mass, momentum, energy, electrical charge... ideas, money...) with what is external to what has been defined to be “the system” (e.g., an education system, a judicial system, the immune system, a hospital, science, etc.), and
2. *Closed systems* – those systems that are “complete unto themselves”, i.e., they don’t interact with their environments (e.g., any game such as monopoly, chess, baseball... word games, pure mathematics, etc.).

Thereby, a system is classified as “open” *versus* “closed” (or “interacting” vs. “isolated”, or “real” vs. “ideal”, respectively) relative to its interaction with its environment.

Again, the distinction between these two types of systems is the following. For *closed systems* (such as any game) all elements of the system and all rules of interactions among the elements are specified and fixed. In contrast, for *open systems* (such as the human body or a legal system) either the components of the system or the interactions among the components (or both) can vary, depending on interactions with the system’s environment.

For example, viewed as a system, the game of baseball is a closed system: in baseball, there’s a fixed number of players on each team (with the number

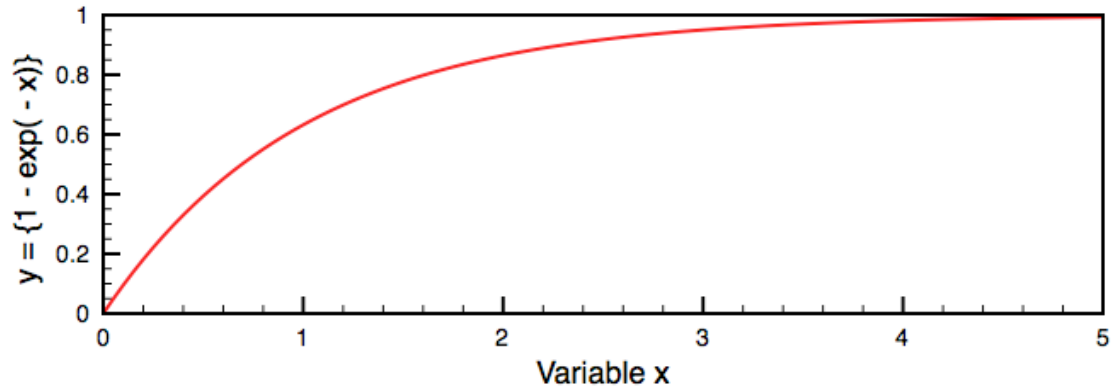
specified by league rules), the number of each team on the field is not to exceed nine, and so on, with all rules specified exactly and unchanging – no matter how fans yell at the umpires! In contrast, although there are a great number of rules and regulations in our legal system, any court (at least, any court in a democratic or “open” society) must be “open” to new evidence. As a case in point, if new evidence is available that demonstrates that the DNA on “the business end” of the baseball bat is not the alleged victim’s DNA, then the “umpire” (i.e., the judge) will make sure that the judicial system responds appropriately (i.e., to be “fair”, any judicial system must be an open system).

Again, Dear, the reason for calling your attention to the difference between open vs. closed systems is so you’ll see that, actually, there are only two types of “truths”: one for open systems and a second, quite distinct type of “truth”, applicable only for closed systems. To see what I mean, consider some examples.

First, consider any type of game (from checkers to baseball), and recall that all games are closed systems. If you then ask if a certain condition or rule in any particular game is “true”, then you can receive an unequivocal answer. Thus, in a game of checkers, if your checker reaches your opponents baseline, it’s “true” that it will be crowned a king. In baseball (at least according to the rules of the little-league in which I used to coach), the infield-fly rule is “true”. In poker it’s “true” that a flush always beats a straight, in bridge the ace of trump beats any card, and so on.

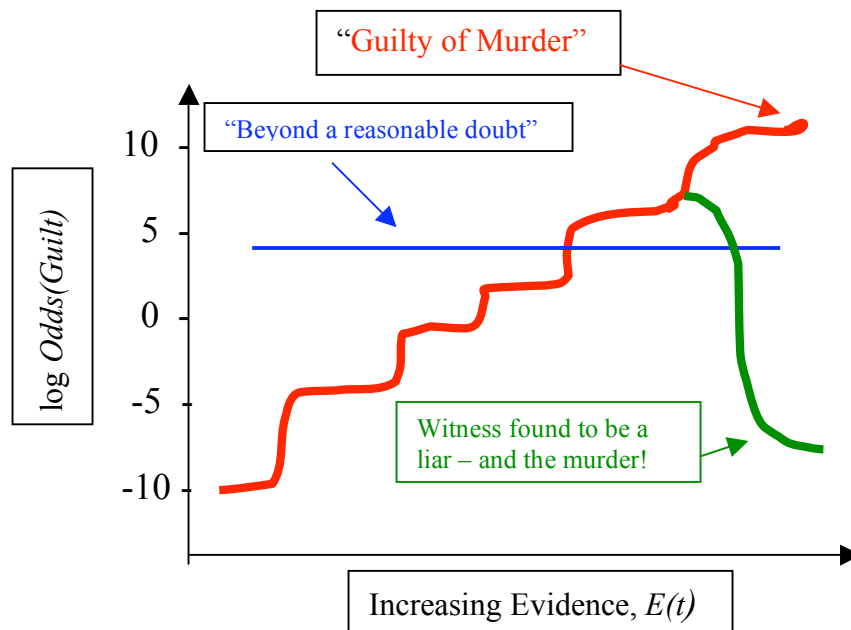
Now, for contrast, consider an open system, such as the human body, the judicial system in a democratic country, all of science, or for that matter (as far as we can tell) all of reality. In open systems, it’s impossible to unequivocally state that something is “true”. At best, we can obtain only estimates for the probability that some statement or claim or event is “true”; that is, in open systems, “truth” can be approached only asymptotically.

Perhaps it would be useful to remind you of the meaning of the word ‘asymptote’. In math, an asymptote is a line (or a surface or...) that can be approached as closely as desired, but is never reached. For example, on a two-dimensional graph, the curve $y = \{1 - \exp(-x)\}$ “asymptotically approaches” the value $y = 1$ as x becomes large, as shown below.



The word ‘asymptote’ is derived by negating (with the Greek prefix, *a*) the Greek word *symptotos*, meaning ‘self-intersecting’, in turn from *syn-*, meaning ‘together’, and *piptein*, meaning “to fall”; therefore, *asymptote* means “not falling together”. In this chapter, I’ll be using the word “asymptote” as it relates to ideas, e.g., the possibility that you’ll asymptotically become a model grandchild! (☺)

As a case in point, you might recall that back in Chapter **Ih**, dealing with “Hypotheses, Probabilities, and Evidence”, I went through an imagined trial to try to illustrate how jury members would use evidence to estimate the probability that a defendant was guilty of murder, $p(G)$, or simultaneously, the probability that he was innocent, $p(I) = 1 - p(G)$. Below is a replot of the resulting probability estimates.



Along the y-axis (or “ordinate”) of the above figure, I’ve plotted the probability that the defendant is guilty in terms of “odds” (that he’s guilty), with the “odds” of his guilt [$O(G)$] defined in terms of probability of his guilt [$p(G)$] *via* $O(G) = p(G)/p(I) = p(G)/\{1 - p(G)\}$. From the plot, notice how the values of the odds that he’s guilty steadily climbed (as more evidence accumulated), which if you’ll look again to see how the odds of his guilt is defined in terms of the probability of his guilt [$p(G)$], then you’ll see that the probability of his guilt was asymptotically approaching unity. For instance, when (near the top of the plot) $\log\{O(G)\} \sim 10$, i.e., $O(G) \sim 10^{10}$, then $p(G)$ is essentially $1 - 10^{-10} = 0.999999999$, i.e. very close to unity – but then later, it was found that the witness (the dead man’s former girlfriend) actually did the deed.

Again, Dear, for open systems, the best that we can obtain is only estimates for the probability that some statement or claim or event is “true”. That is, “truth” can be approached only asymptotically. In a particular criminal case, for example, the probability may be very close to unity that a specific person committed a specific crime, but again, we can’t be certain of this “truth”.

Similarly, it’s not “true” that the more you study for your exam, the better you’ll do on it – but it’s likely! And similarly, although I’m convinced from all accumulated data that the principle of momentum conservation is correct, yet I admit that someone may yet demonstrate that it’s not. Consequently, in general and for all of “reality”, because we never know what might be around the next bend in either space or time (or space-time), then if we’re honest with ourselves, we must admit that even our “most cherished truths” may not be “true”.

“Trivially obvious!”, exclaimed the impatient grandchild (abandoning any attempt to asymptotically approach the state of being a model grandchild).

“Maybe so in those cases,” responded the grandfather, “but then, consider some other examples.”

In particular, Dear, consider some closed systems, such as any storybook, all religions, and (as I’ll be showing you later) pure (as opposed to applied) mathematics. Within such systems (but only within closed systems!) “truth” can be stated unequivocally, i.e., with probability equal to unity.

For example, consider the following statements, which are undoubtedly “true” within the prescribed conditions of their closed systems. In pure (or “propositional”) math, $1+1 = 2$ – but in reality, Dear, if you get one hole in your jeans and then another hole, adjacent to the first, or if you combine 1 molecule of carbon dioxide and one molecule of water to yield one molecule of carbonic acid, then $1+1 = 1!$ In Euclidean geometry, two parallel lines never intersect – which, as I’ll be showing you, may be false in reality. Similarly, as in sundry books (as opposed to reality), Superman can be harmed only by kryptonite, God created the Earth and all life in six days, Jesus is the son of God, Muhammad received messages from the angel Gabriel, Joseph Smith got his messages from some another angel, and so on.

To prove that such statements are “true” in their closed systems is usually relatively simple. In pure math, for example, that $1+1 = 2$ and that parallel lines never intersect are taken as “axioms”.³ Similarly, in almost any Superman comic book you’ll find that his superhuman strength vanishes if he’s exposed to kryptonite. And to prove the “truth” that Jesus is the son of God (and the similar, silly, religious statements mentioned above), then just check the Bible, the Quran, and the Book of Mormon. I mean, haven’t you been taught ever since you were a baby that your “holy books” are “true”?!

“But,” asked a certain grandchild whose skepticism seems to be increasing more rapidly than her age, “Are such ‘truths’ really ‘true’ in reality?”

In response, Dear, I need to again ask for your patience: soon I’ll respond to the question about “truth”, in reality, of any claims to “truth” in closed systems (such as all religious claims). First, though, I want to repeat that, as far as we’ve been able to determine, reality is an open system (we can never know what’s around the next “bend” in space-time), and repeat that in open systems, “truth” can never be demonstrated, only (at best) approached asymptotically.

³ Dear: As I plan to outline in the “excursion” **Z₀x**, it has been a huge challenge to try to uncover the conditions under which such “axioms” have anything to do with reality. For example, in the case of “proving” that $1+1 = 2$ in pure math, Russell and Whitehead wrote a huge book (entitled *Principles of Mathematics*) – and there is now considerable doubt that they “proved” anything more than, as Russell later stated, the fundamental truth that there are three feet in a yard (i.e., $1+1 = 2$ is just a regurgitation of a definition). As for the “truth” that two parallel lines never intersect, this axiom (introduced by Euclid) troubled brilliant mathematicians for almost 2,000 years – and Einstein suggested that, in reality, it may not be true, i.e., space may be “non-Euclidean”.

In reality, in an open system, the best we can do is to use evidence to obtain estimates for the probability that any claim or statement or event is “true”, although with enough supporting evidence, we can gain the impression that we’re asymptotically approaching “truth.” Of course, in reality our universe may be a closed system, but no one knows if that’s “true”! Data suggest that our universe is expanding (and therefore it seems to be open), and maybe there are other “verses” (i.e., “multiverses”). In any case, though, important points for humans to realize include these: 1) no one knows if the universe is an open or closed system, 2) for each of us, our “universe of experiences” is certainly an open system (unless you know of someone who knows what everyone else is thinking and will do!), and 3) even if the universe were a closed system and even if some giant Jabberwock in the sky were in control (although no evidence supports such a proposition!), yet even the clerics tell us: “No one knows the mind of God,” and “God works in mysterious ways.” Therefore, even the clerics admit that, as far as humans are concerned, reality is an open system; i.e., no one can know what’s around the next bend in space-time!

Yet, in reality and thanks to the intelligence and diligence of heroic humans from whom we have inherited so much (from quilts and spoons to quantum mechanics!), knowledge isn’t so barren and tentative as I might have made it seem (or as the clerics suggest). For example, I suspect that the vast majority of scientists expect that “somewhere out there” resides “scientific truth”. I further suspect that the vast majority of scientists expects that some of this “scientific truth” has already been discovered, such as the principle of momentum conservation, the principles of thermodynamics, Darwin’s principle of evolution, Maxwell’s principles of electrodynamics, Einstein’s special theory of relativity (if not his general theory of relativity), and so on, some of which I plan to review in **Z₀x**.

That is, I suspect that essentially all scientists agree that it’s extremely unlikely that such “fundamental principles of science” are wrong – yet, no scientist worth her salt would offer any guarantee! Let me put it this way: most physicists would probably bet their month’s salary on the proposition that Maxwell’s equations of electrodynamics are “true”, many might bet their annual salary on it (provided there’s an appropriate return from their bet!), but I bet you’d be hard pressed to find any physicists who would wager their life-savings on it (or any other claim to “scientific truth”).

In reality, there’s no way to “prove” the “truth” of such scientific principles, just as there’s no way to “prove” the “truth” of somebody’s innocence or guilt of some crime. There are, however, unknown billions of ways to try to test, for example, the principle of momentum conservation, e.g., for the rest of your life, keep banging billiard balls together on a table (as friction-free as possible) to see if ever a case occurs when momentum fails to be conserved. Similarly, there are an unknown, large number of ways for a defense lawyer to try to demonstrate that her client is falsely accused (and for a prosecution lawyer to demonstrate that the defendant’s claim of innocence is untrue).

In contrast, for closed systems (as defined, for example, by rule books for games, comic books, “holy books”, or texts in pure mathematics) the way to test for “truth” is by checking against whatever “rules” define “the game”. As examples, in a rule book for the game of Bridge, you can find that the ace of trump beats all other cards; in Superman comic books, you can find that “according to the rules of the game”, Superman is invulnerable to everything except kryptonite; in the “holy books” of Christianity and Mormonism (but not in the similar “rule books” used in the religious games played by the Hindus, Jews, and Muslims), you can find the “truth” that Jesus is the son of God; and so on.

But again, Dear, in open systems (such as reality), no tests for “truth” are available – at best what we’re able to do is examine relevant evidence and then from the evidence, try to discern how the evidence influences our estimate of the probability that the claim is “true” (which simultaneously yields the probability that the claim is “false”, since the probability that it’s false is unity minus the probability that the claim is “true”). And I wrote “at best”, because “at worst”, for some claims (such as all religious claims) not only can’t we demonstrate that they’re “true”, we can’t even demonstrate that they’re NOT “true” – for reasons that I’ll now try to explain.

First, though, I should point out that, in reality, demonstrating that some proposition is “not true” (i.e., “falsifying” it) is not the same as demonstrating that it’s false! Such “black *versus* white” or “true *versus* false” views are appropriate only for closed systems (such as logic, pure math, games, religions, and so on). For open systems, in contrast (that is, again, in reality), the best that we can ascertain is the *probability* that some proposition or claim (or similar) is “true” or “false” (the latter being unity minus the probability that it’s “true”). Consequently, for open systems, to

demonstrate that a statement (or similar) is “not true”, that is, to “falsify” it, then “all” we need do is show that its probability of being true is less than unity – not that its probability is exactly zero (i.e., that it’s “false”).

Now, to explain what I meant by my claim that, in some cases, we can’t demonstrate that some statements aren’t true (i.e., that we can’t falsify them), I want to propose some hypotheses for your consideration. I think that these hypotheses are so strong that they could be classified as “fundamental principles”, but whereas I haven’t seen others make such a claim, I’ll relent and call them just “hypotheses” – or even just “obvious”! Simultaneously, I invite you to try to falsify them.

The first one is this: *if a statement contains no information (e.g., if it summarizes no data or if it’s meaningless), then it’s impossible to falsify the statement.* Stated more succinctly, the hypothesis is: *it’s impossible to falsify a claim that contains no information.*

Again, Dear, it’s important to notice that “falsifying” a hypothesis is different from demonstrating that it’s false. “Falsifying” means showing that it’s not “true” (i.e., that the probability that the hypothesis is true *is less than unity*). In contrast, if you can show a hypothesis is false, then you’re showing that the probability that it’s true *is exactly zero* – and in reality, that’s as difficult (and as impossible) as showing that a hypothesis is “true”!

Now, Dear, of course I can’t demonstrate to you that the above hypothesis is “true”. Yet, neither have I been able to falsify it – even though a method for doing so seems clear, namely, just take any of a huge number of statements that contain no information and then falsify at least one of them.

As an example, to try to show you what I mean by *it’s impossible to falsify a claim that contains no information*, I invite you to try to falsify the claim: “Hpf rcodyd”. Any luck? Why? Well, I claim that you can’t falsify the statement “Hpf rcodyd” because it contains no information.

How about another? Let me shift my fingers one key to the left on the keyboard and invite you to falsify the statement: “God exists.” Any luck? Why? Well, Dear, again I suggest that you can’t discern how to falsify “the God hypothesis” (or, better, “speculation”), because also it summarizes zero data. Therefore, any data that you might collect to falsify the speculation

that God exists will never conflict with the data used to generate this speculation – because there were none!

“So what?” responded the grandchild.

Well, Dear, “so” let me return to your (assumed) question: “Are such ‘truths’ [about Superman being weakened by kryptonite, about Jesus being the son of God, etc.] really ‘true’ in reality?” My response, Dear, is to repeat that it’s impossible to falsify claims that contain no information, e.g., that summarize no data, because any data collected in an attempt to falsify such statements will never be in conflict with the data summarized by such silliness – because there were none!

Similarly, just as I can’t falsify claims such as “God exists” or “Jesus is the son of God” or “the angel Gabriel conveyed Allah’s message to Muhammad” or “some angel told Joseph Smith where the golden plates were buried”, I also can’t falsify the statement “all invisible flying elephants are pink”. Someday, maybe somebody will collect data for the color of flying elephants (though I have my doubts about that), but even such data couldn’t be used to falsify the statement that “all invisible flying elephants are pink”. I can already hear the “defenders of the faith” arguing: “Oh sure, none of the flying elephants that you saw were pink, but our belief is that it’s the invisible flying elephants that are pink, and you have data for colors of only those flying elephants that are visible.”

If you’re thinking that the above is rather silly (and it is!), then let me mention another application of the stated hypothesis that isn’t quite so silly. It’s that, if you apply the hypothesis judiciously, you can avoid a lot of useless arguments. For example, suppose I said to you (in all seriousness) that strawberry milkshakes are tastier than chocolate shakes, Beethoven’s music is better than Mozart’s, and Obama is a more competent president than Bush was. Then to asymptotically approach being a better grandchild (☺), rather than once again arguing with me, I’d recommend that, in your typical tactful way, say something similar to: “Grampa, don’t be such a nut. Nobody can falsify such statements, because they contain no information. They’re all meaningless, since your words ‘tastier’ (as in tastier milkshake), ‘better’ (as in better music), and “more competent” aren’t defined in a manner that they can be objectively measured. Until you do so, you’re not making any claims; you’re just stating some of your values, and as is wisely said, there’s no accounting for poor taste.”

* Go to other chapters *via*

Now, Dear, before I comment further on the silliness of meaningless claims that contain no information, let me try to show you something else. Beyond the hypothesis that a statement that contains no information can't be falsified, please consider a second hypothesis (whose origin can probably be traced to the philosophers Rudolph Carnap and David Hume): *if in principle it's impossible to falsify a statement, then it contains no information.*

This second hypothesis may seem to be a corollary to the first (that a statement that contains no information can't be falsified), but unlike a theorem in geometry with its corollary, I can't “prove” that, in reality, this “corollary” is “true”.⁴ Also, Dear, please notice that this “second hypothesis” is NOT “if it's impossible to falsify a statement, then the statement contains no information” – such as statement is wrong: if it's impossible to falsify a statement, then that suggests that the statement is approaching “the truth”!

In the past, evidence has suggested that the second hypothesis isn't true: somebody made some statement (e.g., that the Moon was just a big rock in the sky, that the speed of light was large but finite, and so on) that nobody could see how to falsify – but to conclude that such statements contained no information would have been incorrect. The point is: in some cases (such as the two mentioned in the previous sentence) it's not that it's impossible to falsify a statement, it's that a suitable test can't be discerned. Consequently, to emphasize this point, the “second hypothesis” contains the words “in principle”, i.e., *if in principle it's impossible to falsify a statement, then it contains no information.*

I should add that, sometimes, it's difficult to know if you can't determine how to falsify a hypothesis because 1) such a test is, in principle, impossible, or because 2) developing a test is just too difficult. In some cases, however, someone is silly enough to make a statement that contains the assumption that it's impossible to test the validity of his statement. An example is in Pope John Paul's discussion about the existence God (which I quoted in one of the I-chapters): in his discussion, he explicitly included the statement that it was impossible to test for “God's” existence. As soon as he did that, then

⁴ Recall from math, Dear, that a ‘corollary’ (which in the US is pronounced “core-al-ree”, in Canada is pronounced “core-all-a-ree”, and in the UK is pronounced “co-rall-a-ree”) means “a proposition that follows from another that has been proved.”

application of the above “second hypothesis” – *if in principle it’s impossible to falsify a statement, then it contains no information* – leads to the conclusion that his concept of God contains zero information.

Yet, I should repeat the general idea that (as with all statements about reality) it’s impossible to demonstrate that the above second hypothesis is “true”. The “best” that can be done is to show 1) that in principle it can be falsified (specifically, by falsifying at least one statement that contains no information – have fun trying to do that!), and yet, 2) that although in principle it’s possible to falsify this “second hypothesis”, no one has yet been able to do so. Therefore, Dear, so long as that situation persists, one can continue to think that this “second hypothesis” is asymptotically approaching “truth”.

Now, Dear, I’m sorry to have taken so long to convey stuff that was probably obvious to you, but let me now show you some significant consequences of all this “obvious stuff”. In the above, I introduced two hypothesis that seem to be asymptotically approaching “truth” in this open-system known as reality; they’re repeated here:

- 1) *If a statement contains no information, then it’s impossible to falsify the statement, and (its apparent corollary)*
- 2) *If in principle it’s impossible to falsify a statement, then the statement contains no information.*

By the way, Dear, notice that implicit in these two hypotheses is the premiss: *information* is obtained from *reliable* data.

As applications of those two hypotheses, consider again the following statements: 1) Hpf rcodyd, 2) God exists, 3) Superman is vulnerable to kryptonite, 4) Jesus is the son of God, 5) The angel Gabriel conveyed Allah’s wishes to Muhammad, 6) Some angel conveyed the wishes of Jesus to Joseph Smith, and 7) All invisible flying elephants are pink. As I’ve already tried to demonstrate, although those statements are “true” within the closed systems in which they’re defined (save, perhaps, for “Hpf rcodyd”), yet in reality, none of these statements can be falsified – because none of the data collected to test these statements will be inconsistent with the data used to generate any of these statements, because, in turn, there were none. I now claim, consistent with the second hypothesis listed above, that the reason

why I can't falsify any of the listed statements is because they contain no information.

And if you say “So what?”, then my first response would be: “Dear, if a statement can't be falsified because it contains no information, then toss it in the trashcan of stupid statements!” Not only will there be no loss if all statements in the world that contain no information are tossed, enormous gains are potentially available: already in this world there are far too many statements for any single person to be able to consider – even though many of these statements do summarize some data. Therefore, the absolute minimum that we humans should do is discard all statements that contain no information! And as for how to “clean up” our ideas, the “principle” is simple: if it's impossible (in principle) to falsify a statement, then toss it – because the statement contains no information.

Moreover, I'd have several additional responses to your assumed question “So what?” Here, I'll just list and briefly explain some of these responses, each of which I'll try to explain in more detail in this and later chapters.

1. *The dishonesty of those who “believe” something is “true” based on “faith”.* This is the worst type of dishonesty: such people are dishonest even with themselves. Their dishonesty is to use the word “faith” to camouflage their “real reason” (or reasons) for their “belief”. I tried to explain some of what I mean by the above in the **I**-chapters (namely, **Ig** through **Ii**, dealing with faith, belief, trust, and confidence); in **X2** (dealing with “EXcavating Reasons”), I'll dig into some of the huge number of reasons for “believing” in “religious truths” (because the “believers” trusted that their parents told them the “truth”, because they enjoy the company of fellow “believers”, because they're afraid of dying, and on and on). Here, Dear, let me ask you to briefly consider just two examples of “faith”: i) if you have “faith” that the sun will return tomorrow, then think of the real reasons for your “belief”, ii) if you have “faith” that the Book of Mormon (or the Quran or the New Testament or the Torah or...) is “true”, then think of the real reasons for your “belief”.
2. *The nature of the game that all clerics have always played and are still playing.* The “game” is to drug people with the delusion that reality is a closed system. This can seem to be a “happy delusion” for “believers”, because in the game, everything appears to be “known” (the meaning of life, the purpose of living, the consequences of death, how everything fits

* Go to other chapters via

together in “a plan”, and so on.) The “double troubles” with the delusion are, however, first, that as far as we can tell, reality isn’t a closed system (which even the clerics acknowledge with their stupidities such as “No one knows the mind of God” and “God moves in mysterious ways”), and second, in their closed-system game (surprisingly similar to all illegal con games!), the clerics assign to themselves (surprise, surprise!) control over writing, preserving, and interpreting the rule books – which, of course, have always included paying the clerics for writing, preserving, and interpreting the rules!

3. *The fact that even some famous and otherwise competent philosophers have failed to show people how to extricate themselves from such nonsense.* For example, consider the following statement that Bertrand Russell wrote in his 1945 book entitled *History of Western Philosophy*:

I do not pretend to be able to prove that there is no God. I equally cannot prove that Satan is a fiction. The Christian God may exist; so may the gods of Olympus, or of ancient Egypt, or of Babylon. But no one of these hypotheses is more probable than any other: they lie outside the region of even probable knowledge, and therefore there is no reason to consider any of them. The fact that an opinion has been widely held is no evidence that it is not utterly absurd; indeed in view of the silliness of the majority of mankind, a widespread belief is more often likely to be foolish than sensible.

Rather than attempt to seduce the reader with his comment on “the silliness of the majority of mankind” (with which, nonetheless, it’s easy to agree!), Russell’s argument would have been stronger and, more significantly, he could have helped humanity (even more) to put an end to all religious nonsense, purging uninformative statements, by defending the “principles”: 1) *If a statement contains no information, then it’s impossible to falsify the statement*, and 2) *If in principle, it’s impossible to falsify a statement, then the statement contains no information.*

But in a sense, the above “principles” are somewhat silly, in that they deal with statements that contain no information. In contrast, the following principle deals with how we try to make sense of reality.

This principle is usually known as Popper’s principal (after the Austrian-born philosopher Hans Popper, who died in 1994 and about whom you can learn much by searching on the internet), but surely members of “the Vienna

school” (such as Rudolph Carnap) also deserve credit for recognizing the importance of the idea. In my own words, Popper’s principle is:

All objective knowledge is contained in falsifiable and tested hypotheses whose probabilities of validity asymptotically approach unity.

Another version of Popper’s principle could be:

In the open system known as reality, although “truth” can never be demonstrated, yet it can be approached via falsifiable hypotheses for which evidence from experimental tests suggest that their probabilities of validity asymptotically approach unity.

And I’m certain that even a certain argumentative grandchild isn’t going to say “Prove it!” – knowing that such an attack is unrealistic. Instead, the challenge is 1) to demonstrate that Popper’s principle is falsifiable, and 2) to determine if it has ever been falsified. That Popper’s principle is falsifiable is clear. Two methods to do so are: (1a) identify some hypothesis for which evidence suggests that the probability of the hypothesis being true approaches unity but simultaneously is invalid (which would be a neat trick if you could do it!) or (1b) find some knowledge contained in a hypothesis that in principle can’t be falsified (which would contradict “the second hypothesis”, from a few paragraphs earlier, i.e., if in principle it’s impossible to falsify a statement, then the statement contains no information). So, Dear, until you can 2) falsify Popper’s principle (and if you can, then not just your parents and grandparents will recognize your brilliance!), then it has a strong claim to be asymptotically approaching “truth”.

In case you don’t immediately see the power of Popper’s principle, let me add a couple of comments. I’ll put my first comment this way. After you’ve finished ~12 years in college, Dear, when you’re reviewing everything you’ve ever studied (which you’ll need to do in preparation for your final exam for your Ph.D.), then pause to notice that Popper’s principle has an amazingly good claim to be asymptotically approaching truth: whatever your specialized field of knowledge, all knowledge you acquired about reality will have been contained in refutable hypotheses not yet refuted. Further, for your Ph.D. thesis, to advance knowledge, you’ll need to give sound reasons and data supporting a refutable hypothesis of your own.

And my second comment is this: Popper’s principle puts another nail in the coffins of all religions, i.e., in their false claims of possessing anything but closed-system “truth”. To see this, notice a “corollary” of Popper’s principle (a corollary that, of course, can’t be demonstrated to be “true”, but it’s falsifiable and not yet falsified): *if any statement can be demonstrated to be “true”, then that demonstration simultaneously shows that the statement doesn’t refer to reality.*

“Phooey,” responded a certain grandchild, “I can prove that $1+1 = 2$, and that has plenty to do with reality.”

“Oh really?” inquired a certain grandfather. “Here, Dear, take this piece of silly putty in your left hand, take this other piece of silly putty in your right hand, now squish (or as you used to say, “squooosh”) your two hands together, and let’s see if you can tell me, with a straight face, that $1+1 = 2$.”

“But,” responded a grimaced-faced grandchild, with a single blob of silly putty squished between her two gucky hands, “the conditions of this demonstration violated the recognition (by monkeys, babies, and Aristotle) that things must be distinct: squishing two pieces of putty together ruined their distinctiveness.”

“Well, then, Dear grandchild, although I congratulate the monkeys and babies, I say phooey on Aristotle! Maybe in his closed-system view of reality (and therefore in the rules of the games of pure math and Aristotelian logic) things remain distinct, but reality isn’t required to play by such rules: if you squish two pieces of silly putty together, then $1+1 = 1$, if you get one hole in your jeans and then an adjacent hole, $1+1 = 1$, and if two stars or two black holes merge, then guess what: $1+1 = 1$.”

Again, Dear: if you can “prove” that some statement is “true”, then as near as we can tell, simultaneously you’re demonstrating that the statement doesn’t deal with reality.

For the case of mathematics, Einstein summarized it well:

As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.

And by the way, Dear, if the result $1+1 = 1$ bothers you (for cases such as when you “squosh” two pieces of silly putty together, get two adjacent holes in your jeans, or get two molecules such as carbon dioxide and water to react), then first let me give you some more examples of limitations in (pure) math and then try to show you “What the devil is going on?”

To introduce other examples, I’ll first ask you: if you have a piece of wood and then cut it in half, how many pieces of wood would you have? (Yes, Dear, sometimes $1+1 = 2$, or equivalently, sometimes $1 \div 2 = \frac{1}{2}$ and $2 \times \frac{1}{2} = 1$.) Now, though, if you have an elephant and cut it in half, then how many elephants do you have?!

Another example was recently given by Chris Lucas:⁵

It should be noted also that primal needs are not inter-changeable (i.e. having a surplus of air is no good if you have no water), so the usual economic technique of summing all resources to one ‘bottom-line’ cash ‘equivalent’ is an invalid way of accounting for these issues

[3 x (Air) + 0 x (Water) is not better than 1 x (Air) + 1 x (Water) !].

Now, turning to the question “what the devil is going on”, it’s important to appreciate, first, that “pure math” doesn’t deal with real objects but is an abstraction from reality. In reality (and in what’s called “applied math”), one apple plus one apple = 2 apples, one star plus one star = 2 stars, and so on, based both on agreement about the definitions of numbers (which you learned when you were three, by putting them in one-to-one correspondence with your fingers) and on the agreement (by all fish, monkeys, and babies) that things exist and are distinct, which as I tried to show you in Chapter **Ib2**, are the experimental bases of the scientific principles called ‘logic’.

But in pure math, Dear, one apple plus one apple is NOT equal to 2 apples, because in pure math, numbers are “pure”, meaning that they have no units (or dimensions). Thus, although in “applied math” $(1 \text{ apple}) + (1 \text{ apple}) = (2 \text{ apples})$, in “pure math”, $1+1 = 2$ is a statement about numbers, not about apples, stars, or anything else in reality.

⁵ Copied from the article by Chris Lucas entitled *Complexity Theory: Actions for a Better World*, available at <http://www.calresco.org/action.htm>.

Furthermore and significantly, in pure math addition has a definite meaning (of course). Once the numbers are defined (abstractly, without units) and once the meaning of “equals” is defined, then addition is defined *via* $1+1 = 2$. Consequently, Dear, when you were requested to squish (or, if you prefer, “squooosh”) two pieces of silly putty together, react two molecules, or consider the sum of two adjacent holes in your jeans and then asked if $1+1 = 2$, you could have replied (in your characteristically diplomatic way):

“Grandfather, don’t be so stupid! First, in pure math we deal with pure numbers, not numbers of holes, numbers of molecules, or numbers of pieces of silly putty. Second, in pure math, addition doesn’t mean ‘squoooshing’, ‘getting molecules to react’, or ‘figuring out the size of holes in jeans’. So your questions aren’t even questions in pure math, they’re questions in applied math, and if you want answers to such questions, then first define your operations of ‘squoooshing’, ‘reacting’, and ‘figuring out the size of holes in jeans’, then do those operations, and if you know anything about science, then determine if you’re right by performing some experiments!”

Sheesh. I don’t know why I waste my time writing this stuff, when obviously you know it already. And no doubt I’d be totally wasting my time (and yours) to point out that the reason why pure math is still so amazing useful in describing reality is because so many objects, in reality, do seem to satisfy the assumptions made in the construction of the idealized system called pure math.

Yet, maybe you haven’t already seen Popper’s generalizations of Einstein’s statement (“As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality”). Popper statement for science, which can be taken as another formulation of Popper’s principles, is:

In so far as a scientific statement speaks about reality, it must be falsifiable; and in so far as it is not falsifiable, it does not speak about reality.

More generally, in reality (as far as we can discern), we must deal with probabilities, and the best we can do (*via* experimentation) is asymptotically approach “the truth”.

Now, Dear, there’s still quite a bit more that I want to mention about “truth” (and “knowledge” and “understanding”), but in view of the length to which this chapter has already grown, I’ve decided to put the rest in a second T-chapter (T2, entitled “*Truth and Understanding*”) and here, to take a break. But before doing so, let me slip in a few additional comments on what I’ve tried to show you in this chapter T1 (dealing with “*Truth and Knowledge*”).

I started this chapter by showing you what I usually review for “T” when I’m walking:

T: Testing for “truth” (via trial & error), building trust (via honesty, kindness, and tact), and making transitions (overcoming whatever is necessary, from timidity to terror): tricky, interrelated concepts.

From what I tried to show you in this chapter, I hope you’ve gained at least a first impression of what I mean by “tricky, interrelated concepts”. Also, I tried to show you some “transitions”, including: 1) transitions from institutions (e.g., the church and the state) defining “the truth”, to individuals defining both the institutions and “the truth”, and 2) transitions from individuals defining “the truth”, to science searching for the truth – with reliance on experiments, data, reasoning, and on those hypotheses whose predictions are falsifiable but whose probable validities nonetheless continue to asymptotically approach unity. Some other points that I’ve tried to make are the following.

- In cases of justice (personal, interpersonal, and social), “truth” means honesty, and the “truth” is that honesty (as with charity) should begin at home: first be truthful with (and learn to trust) yourself. With others, trust (like a building) can take years to construct, requiring a careful combination of honesty, kindness, and tact, but (like the Twin Towers) can be destroyed in minutes by deception – and the taller the twin towers of truth and trust, the darker the shadows of suspicions and lies and the larger the targets for terrorism. Therefore, to minimize the impact of terrorizing transitions, “truth” and trust should be continuously tested *via* trial and error – and we hope, trial and success!
- In cases of natural justice (i.e., in science) “truth” can never be realized, just approached asymptotically by eliminating hypotheses whose probable validities are demonstrably less than unity. For each test, for each attempt to eliminate error, any approach to “truth” can be trusted

only as much as the data, and no progress is possible if it's impossible, in principle, to test a particular hypothesis – because such a hypothesis contains no information.

Bertrand Russell (1872–1970) wrote something similar in his essay “Philosophy for Laymen” in his book *Unpopular Essays*:

Knowledge is not so precise a concept as is commonly thought. Instead of saying “I know this”, we ought to say “I more-or-less know something more-or-less like this”. It is true that this proviso is hardly necessary as regards the multiplication table, but knowledge in practical affairs has not the certainty or the precision of arithmetic...

If you seek certainty, Dear, you can find it in various “holy books”. What you find, there, almost certainly won't be reliable, but it will be certain! On the other hand, if you want knowledge rather than certainty, then dig into books on science. You won't find certainty there – in fact, much uncertainty (as I'll try to show you in chapter U) – but you should be able to find some principles that seem to be asymptotically approaching “truth”.

And actually, you needn't dig into books on science. For example, in the 8 November 2007 issue of the *New York Times*, you can find:⁶

One form of training, however, has been shown to maintain and improve brain health – physical exercise. In humans, exercise improves what scientists call “executive function,” the set of abilities that allows you to select behavior that's appropriate to the situation, inhibit inappropriate behavior and focus on the job at hand in spite of distractions. Executive function includes basic functions like processing speed, response speed, and working memory...

In other words, Dear, there's fairly reliable knowledge that if you want your personal computer to work better – I mean your “true” personal computer – then it would be a good idea for you to get more exercise!

⁶ The article by Sandra Aamodt and Sam Wang is entitled “Exercise on the Brain”. It's available at <http://www.nytimes.com/2007/11/08/opinion/08aamodt.html?em&ex=1194670800&en=87671c1cea6447e9&ei=5087%0A>;