

Table of Contents

Unit	Page
I. GOALS of this course	Page 03
A. INCREASE AWARENESS/ INTEREST IN SOLAR SYSTEM AND UNIVERSE	Page 03
B. INCREASE YOUR "SCIENTIFIC LITERACY"	Page 03
C. COSMIC PERSPECTIVE	Page 03
D. CONTRIBUTE TO YOUR PERSONAL GROWTH	Page 04
II. A Personal Statement on the Teaching	Page 05
A. my expertise	Page 05
B. lacks in American science education	Page 05
C. the question	Page 05
D. background understanding	Page 06
III. U.S. Scientific Illiteracy	Page 07
A. CULTURAL LITERACY	Page 07
B. SURVEYS	Page 08
IV. Science - a <u>Learning Process</u>	Page 09
A. DEFINITION	Page 09
B. A pragmatic pursuit	Page 09
C. FACTS	Page 09
D. THEORIES	Page 09
E. THE HEART OF SCIENCE	Page 10
F. THE SCIENTIFIC ATTITUDE	Page 11
G. On the Supernatural and the Nature of Miracles	Page 13
H. Science as it relates to other areas	Page 15
V. Critical Thinking (CT) Skills	Page 17
A. "Skillful, responsible thinking that facilitates good judgement"	Page 17
B. CT is <u>not</u> "black/white"	Page 17
C. EIGHT ASPECTS OF THINKING CRITICALLY	Page 18
D. Scholarship	Page 18
E. The Positive Personal and Societal Impact of encouraging CT	Page 19
F. Reflection	Page 20
VI. Pseudoscience/superstition/anti-intellectualism	Page 21
A. DEFINITION OF PSEUDOSCIENCE	Page 21
B. Hallmarks of Pseudoscience	Page 21
C. Contrasts with Science	Page 21
D. Some astronomically related examples & brief personal remarks	Page 23

VII. The Popularity of Pseudoscience	Page 24
A. How Superstition Won and Science Lost	Page 24
B. Weakness of television's science coverage	Page 24
C. Publishing industry criticized	Page 24
D. Examples of pseudoscience	Page 24
E. Survey results	Page 24
F. Willful rejection by individuals of medical science	Page 25
VIII. Dangers of Pseudoscience	Page 25
A. The First Danger	Page 25
B. The Second Danger	Page 26
C. The Third Danger	Page 28
IX. Non-psychological Reasons for the Acceptance of Pseudoscience	Page 29
A. "POST HOC, ERGO PROPTER HOC" FALLACY	Page 29
B. IGNORANCE OF PHILOSOPHY AND SCIENCE	Page 30
C. MISINFORMATION	Page 30
D. INNUMERACY	Page 30
X. Psychological Reasons for Acceptance of Pseudoscience	Page 32
A. Confusion of " <u>subjective reality</u> vs. <u>objective reality</u> "	Page 32
B. Memory selection effect	Page 32
C. Cold Reading	Page 33
D. Mental block	Page 33
E. Satisfaction of emotional need	Page 34
F. The Placebo Effect	Page 34
XI. Tests of Psychic Claims	Page 34
A. How does one go about testing?	Page 34
B. The Challenge of the Casino	Page 35
C. When one is unfamiliar with science	Page 35
D. Experimental tests and surveys	Page 35
List of Recommended Books	Page 37
(Outside Activity credit available; see Instructor)	

<p>Reasonable accommodations, including materials in an alternative format, will be made for individuals with disabilities when a minimum of five working days advance notice is given. For the general public, please contact the PCC information line at 748-4500 (TTY 748-4530); for PCC students, contact the appropriate campus Disabled Student Resources Office.</p>

I. GOALS of this course — These are my four goals for you. Are you willing to take them on for your own?

- A. INCREASE AWARENESS OF, AND INTEREST IN, THE SOLAR SYSTEM AND UNIVERSE of which we are but a humble part. This will involve
1. description
 2. natural processes
 3. origins
- B. INCREASE YOUR "SCIENTIFIC LITERACY"
1. surveys indicate about a 95% scientific illiteracy in America
 2. understand science as a learning process
 3. appreciate science's impact on the world
 - a. physical--material well being
 - b. mental--rationality applied to the study of nature, applicable in daily life and in many ways
 - c. historical--science and the advance of western civilization
 4. critical thinking is central to science--What is it?
 5. science vs. pseudoscience--There's a lot of misinformation and weak thinking masquerading as science in the public arena. Can you tell the intellectual "wheat" from the "chaff?"
 6. a close look at one major science - astronomy
 7. Math--"the language of science"
- C. INSTILL A "COSMIC PERSPECTIVE" on the human condition
1. "Spaceship Earth"
 2. "Good planets are hard to find."
 3. Two excerpts that help to relate this concept, first by philosopher Konstantin Kolenda¹ from an essay "The meaning of life" and the second by astronomer Carl Sagan from the conclusion of **COSMOS**.

Kolenda--*"There are times when we wonder about the meaning of our lives. When we compare ourselves to other entities inhabiting the cosmos, we appear insignificant. Suspended in space on our little planet, latecomers on the biological scene, we are but one form among the multitudes of living species. Uncertain of the fate of the earth, we are surrounded by countless stars and galaxies populating the mind-boggling cosmic spaces. Conscious of our fragility, mortality, and obvious dispensability in this vast universe, we sometimes suspect that Shakespeare's famous line, spoken by Macbeth, may after all be true: ultimately our lives are "full of sound and fury, signifying nothing."*

Sagan--*"For we are the local embodiment of a Cosmos grown to self-awareness. We have begun to contemplate our origins: starstuff pondering the stars; organized assemblages of ten billion billion billion atoms considering the evolution of atoms; tracing the long journey by which, here at least, consciousness arose. Our loyalties are to the species and the planet...Our obligation to survive is owed not just to ourselves, but also to that Cosmos, ancient and vast, from which we spring."*

4. Life is precious and fragile. From what we've learned of the universe, intelligent life may be extremely rare. We must value human life above all. In all the vastness of space, with its countless planets, there is surely no other human race anywhere. Anywhen. We are not just special; we are unique. In all the vastness of space there is no other YOU.
5. Historic, global impacts of science: overpopulation, faster travel and communications have in effect made Earth a much smaller place. Mutual economic dependency amongst the nations has increased considerably. Problems in one region of the world will have ramifications world-wide.
6. We are one planet--one species.
 - a. Astronauts are struck when they experience the reality that political boundaries not visible from space.
 - b. Biologists are struck by our genetic similarities. There is variation, but there are larger genetic

variation within racial groups than between racial groups. Racial differentiation is thought to be a recent development, in the last several tens of thousands of years

7. global issues: We are linked in many ways; we hang together or fall apart
 - a. overpopulation
 - b. human-caused environmental damage
 - c. world economy
 - d. food supply
 - e. water supply
 - f. energy supply
 - g. war or peace
 - (1) political & military questions
 - (a) proliferation of nuclear and other weapons of mass destruction
 - h. political & religious extremisms
 - i. Information and cultural exchange via the Internet and satellites
8. When one group of people represses or attacks another, we are all threatened. The dominators are just blowing holes in the compartments of Spaceship Earth.
9. more education → more awareness → more concern → more commitment to make a positive impact on our society, our world

D. CONTRIBUTE TO YOUR PERSONAL GROWTH THROUGH CRITICAL THINKING

1. good education can challenge: DE-ACCULTURATION—RE-ACCULTURATION. This word-pair refers to the personal challenge one will probably experience at some time during their formal education when one begins to learn that their prior understanding about some aspect of life is lacking, that there are better understandings that one gains through higher education..
 - a. from philosopher Joe Richard²: *"As college freshmen, they have spent 12 years in school, and they have never encountered the rules of evidence. It seems they have never had their minds body-slammed against the wall of reason. Students and logic have never met. (Hence the title of my course: "Introduction" to Logic and Critical Thinking.) Have these people never faced up to objections to their most basic beliefs? Bingo."*
2. see the world w/o filters, in less black/white terms, to be more reflective on one's experiences—in other words, become a "critical thinker"
 - a. be willing to admit error, change views
 - b. be aware of personal biases & assumptions not well founded that underlie your beliefs and attitudes
 - c. be aware of attitudes and beliefs that are held for emotionally supportive reasons -- ask whether you are deluding yourself, and why—this may be hard at times. You may not be ready yet. When will you be ready to grow?
 - d. question assertions given w/o adequate support, even when you are the "asserter"
 - e. Critical thinkers are reflective people who will put more thought into the questioning and development of their personal values. They will try to put themselves in other people's heads to figure where they're coming from, to borrow a phrase or two. I see a correspondence with the thinking and feeling done by compassionate people who are willing to "walk a mile in someone else's shoes" as opposed to standoffish moralistic judging and condemning others out of hand when differences are perceived. (See Unit VI. for more on critical thinking.)
3. Learn the "Scientific Attitude"—Open-mindedness v. skeptical (NOT closed-mindedness)
 - a. Open-mindedness means being willing to learn and understand
 - (1) the knowledge gained in formal education
 - (2) the perspectives, attitudes, and behavior of other people
 - (3) Open-mindedness fosters "open-heartedness"
 - b. Skepticism means a questioning attitude
 - (1) If you don't question claims and assertions, how will you fully understand them and satisfy yourself that they are worthy of your acceptance?
 - (2) Skepticism helps to prevent yourself from being taken by someone's false claim, taken of your money, your reputation, your grasp of reality, your health, your life.

- c. Skepticism is NOT Closed-mindedness
 - (1) Closed-mindedness fosters ignorance, self-delusion, and intolerance
- 4. transform yourself from passive "information buckets" to active learners
- 5. The above sections speak of the direct relation between the scientific attitude and the courageous, open, yet healthily skeptical attitude towards life that enables personal growth to rational, self-responsible adulthood. (See also the quote of theologian Gerald Larue at the end of Unit V., "Critical Thinking".)

II. Background and a Personal Statement on the Teaching of the Science of Astronomy

"...there is one simple rule for the university's activity: it need not concern itself with providing its students with experiences that are available in democratic society. They will have them in any event. It must provide them with experiences they cannot have there."

»Philosopher Allan Bloom, *The Closing of the American Mind*

A. I will use my expertise in terms of knowledge, philosophic and scientific understanding, experience, personality and personal outside interests and concerns, the textbook, labs, visual aids including slides, video, and computers to bring across to you the interest, importance and relevance of astronomy and science as well as help you attain the goals above.

B. I teach with an awareness of recommendations for vitally needed improvement in our teaching of science that have been made by many experts, panels, studies, and scientific and educational organizations. Here are the recommendations:

1. Teach science as a PROCESS, not just a collection of facts
2. Improve CRITICAL THINKING ability
3. more MATH
 - a. Without math, you will critically limit your comprehension.
 - b. It is an inextricable aspect of science.
 - c. Studies decisively demonstrate that MORE MATH IS THE KEY to future career success.
4. more HISTORIC, CULTURAL PERSPECTIVE on the subject
5. ETHICAL MATTERS as pertain to the subject (and its teaching)
6. SHOW INTERRELATIONSHIPS with other sciences
7. Stress THEORY, from which real understanding derives
8. more HANDS-ON EXPERIENCE, with COLLABORATIVE student LEARNING

"This report from The Nation's Report Card provides further information about students' lack of preparation in science, their apparent disinclination to enroll in challenging science courses, and the comparatively low achievement of black and Hispanic students, females, economically disadvantaged students, and non-college bound students."

Science Report Card, 1990

C. I also teach with guidance from asking myself the question, "What have I gained from my education in science?" I shouldn't be teaching if the answer is, "Not much." Actually, I feel very strongly that I have. It has positively impacted my character, my intellect, my emotional development, and certainly my grasp of life, of the world. The value of a good scientific knowledge base and having a good understanding of how science works, how it has impacted the world (that includes you and me) are too special and liberating to be kept to the

"Science is much more than a body of knowledge. It is a way of thinking. This is central to its success... We need wide appreciation of this kind of thinking. It works. It's an essential tool for a democracy in an age of change. Our task is not just to train more scientists but also to deepen public understanding of science."

astronomer Carl Sagan - (more on this thought by philosopher Paul Kurtz, Unit V. Section H.3.)

intelligentsia, as the Greeks did. I enjoy the sharing. I enrich these Introductory Notes with remarks and quotations of others that expand upon the beneficial, sometimes perhaps challenging, personal and societal impacts of science. Suppose on occasion you may find yourself in disagreement with something written here or presented in class. Don't delude yourself by dismissing my statement as just one man's (worthless, baseless) opinion. You will have lost an opportunity to learn something. If you want more clarification from me, raise the issue in class, or if you're not comfortable with that, before or after class, or if a more involved question or disagreement is involved, visit me at my office or drop an e-mail. Maybe from our disagreement, I'll have something to learn, too.

To be a critical thinker, to think like a scientist, is certainly part of being human, but it is something that studies show relatively few develop well on their own. It does take work. Formal education, particularly into graduate school, is the proven way to develop these thinking attitudes and skills. They are essential for personal growth and career success. I may challenge you with ideas — not to indoctrinate you, but to inculcate the skills, habits of mind, and attitudes by which you can avoid indoctrination — to think critically, creatively, and independently; not to be one in a flock of sheep. These are essential skills in a democracy in which we are responsible not only for our individual lives and families, but for our society as well.

D. I like to present not just a selection of astronomical facts, but a tapestry of background understanding that helps you to see how the specific facts relate. This background understanding will involve not only other sciences, but also history, philosophy, maybe even some psychology, and, of course, the major successful theories. Look at the course outline to see how I develop your understanding. I want you to go away from this course with not just a few threads of knowledge, but a whole fabric of understanding. *"...neuroscientists know that information is retained only if it is linked to other concepts and facts,*

Note during the semester, how the following goals are incorporated into this course.

"The skills a well educated college graduate should have"
by the Association of American Colleges,
as reported in *Pitt Magazine*, May 1988.

Thinking: The number one goal. This means not only the ability to identify perspectives, weigh evidence, and make wise decisions, but also learning how to think about thinking—to enjoy thinking.

Communicating: Equally critical to thinking. Speaking and writing with clarity and conviction.

Quantitative understanding: A grasp of numerical data—what numbers mean, how they can be manipulated—essential for our era. How else to decipher opinion polls, assess health risks, or cut a financial deal?

Familiar with scientific method: Understand the beauty, power, and coherence of nature's fundamental principles. It also enables students to separate fact from fancy when dealing with everything from losing weight to nuclear power.

A sense of history: One cannot be educated without knowing the perspectives offered by history.

Knowledge of foreign lands and cultures: Needed in our era of geopolitics and global marketplace.

Knowledge and a sense for aesthetics and art.

An understanding and development of worthy values.

A capacity for "study in depth." Being able to bring intense concentration and sustained energy to a specific intellectual problem.

BUT: A college education provides only the beginning of accomplishment of all these goals.

like nodes in a spider web."³

Especially for education majors: See "What's Wrong with Science Education? Look at the Family.", by Raymond Eve, *Skeptical Inquirer*, Spring 1991, pp. 296-299 in the Magazine Article List for a broader societal context of this problem.

"In an increasingly technology-oriented society, a basic understanding of science and mathematics is essential not only for those who pursue careers in scientific and technical fields but for all people. At present, however, not all students have access to quality instruction in these areas, and most adults have limited opportunities to develop a better understanding of the role of science. This results in a population ill-prepared to fulfill the needs of a technically competent work force or to exercise their full rights and responsibilities of citizenship in a modern democracy."

The National Science Foundation

III. U.S. Scientific Illiteracy—and on the importance of being scientifically literate

- A. is an aspect of the concept of CULTURAL LITERACY resulting in great part from lowered educational requirements during the 1970s in math and science
1. The noted comedian/composer/author Steve Allen wrote a very serious book called **Dumbth** after seeing a report on television on the deplorable lack of geographic awareness of high school students in Miami. That's in Florida, by the way. 42% could not say where London is! Then he became aware of other surveys, like the one in 1984, just 9 years after the approximately 10 year war with Vietnam, that showed that $\frac{3}{4}$ of American high school students could *not* locate Vietnam on a map! AND that about 1 out of 3 of them did not even know that we had ever been at war with Vietnam!!!
 2. And a 1982 survey of American high school students really made Allen go ballistic: "...25% *actually believed that the American landing on the moon had never occurred and was a matter of propaganda, fake photography, or CIA machinations.*"⁴
 3. and from Dr. E.D. Hirsch, Jr in his notable book on American society and education⁵

"To be culturally literate is to possess the basic information needed to thrive in the modern world. (Emphasis added.) *The breadth of that information is great, extending over the major domains of human activity from sports to science. It is by no means confined to 'culture' narrowly understood as an acquaintance with the arts. Nor is it confined to one social class. Quite the contrary. Cultural literacy constitutes the only sure avenue of opportunity for disadvantaged children, the only reliable way of combating the social determinism that now condemns them to remain in the same social and educational condition as their parents. That children from poor and illiterate homes tend to remain poor and illiterate is an unacceptable failure of our schools...*" (Question: But just how are teachers to overcome a poor (not just financially) home environment?)

4. Dr. Carl Sagan makes the following connections⁶
 - a. science education and global issues
 - b. sci ed and technical political issues
 - c. sci ed and technical products & jobs
 - d. sci ed and national security
 - e. sci ed and medicine and health
5. Pollsters at the 1999 meeting of the American Association for Public Opinion Research expressed their growing concern over the proliferation of surveys done on the Web. None of these surveys are scientific due to the fact that participants are self-selected. The publicity generated by these non-scientific surveys may drown out the legitimate surveys⁷.

6. Several cogent remarks on the societal importance of a scientifically literate populace...

We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology. This is a clear prescription for disaster. It's dangerous and stupid for us to remain ignorant about global warming, say, or ozone depletion, toxic and radioactive wastes, acid rain. Jobs and wages depend on science and technology...

"Public understanding of science is more central to our national security than half a dozen strategic weapons systems... the widespread adult ignorance and apathy about science and math, should sound an urgent alarm. —Carl Sagan

Too many Americans find themselves coping with life in the man-made world of today in much the same ignorance and superstition as their forerunners in the pristine world of nature.

"Say 'intellectual' and you may as well have said 'elitist.' American society has relegated book learning to second-class status - somewhere behind musclemen and Madonna.

"Americans pass this societal suspicion of things cerebral along to their children as effortlessly as dogs share fleas. The result is about as beneficial. If America is to retain its much-coveted status as the world's economic mover and shaker, it's going to have to change that.

"Americans can start by elevating education and knowledge to a place of relevance and respect in society."

—editorial in Arizona Daily Star, 9/26/92

The next generation must be better prepared for self-government. The citizen must have autonomous intelligence, ready to seek and face the truth, immune to wishful thinking and to external authority. That is the liberating objective of the teaching of mathematics and science in our schools. —Gerard Piel, Chairman Emeritus of Scientific American⁸

It's an essential aspect of the national health to have not just professional scientists...but to have a broad-gauge population of citizens who are not scientists but (who) are comfortable with science and can ask tough questions, make informed decisions and can (run for) Congress. —Carl Sagan⁹

B. Surveys of science knowledge and understanding, and science education

1. 19/20 scientifically illiterate!--from two surveys in 1980s by the Public Opinion Laboratory at Northern Illinois University.
 - a. example question: "Does the earth go around the sun or the sun around the earth?" 21% replied incorrectly; a further 7% said they didn't know. 45% correctly said it takes a year for earth to orbit the sun but 17% said one day, 2% said one month, 9% didn't know
 - b. This same survey was given to 400 graduating seniors at the U of A: Only 33% passed the literacy standard (AZ Daily Wildcat, Oct 10, 1991, p. 5)
2. A 1991 Gallup Poll claimed 47% of all Americans believe Earth to have formed within the past 10,000 years!¹⁰ This is an extreme underestimate not at all supported by scientific studies of our sun, earth, moon and solar system for over *two hundred years* now. Incontrovertible evidence indicates an age for the Earth of just over 4.5 *billion* years.
3. a survey of public acceptance of evolution as the best explanation of how humans came to be: Japan = 88% acceptance; U.S. = 55% acceptance
 - a. our low scores in biology and the lack of acceptance of evolution are due to continuing pressures from Christian fundamentalists who read Genesis as a science text.
4. The TIMSS report "Pursuing Excellence" in 1998.¹¹ (Third International Mathematics and Science Study--the first two dealt with 4th and 8th-grade students) This largest, and perhaps fairest, comparison of many of the world's major nations has clearly demonstrated what previous such studies have pointed to--that American students are not doing well in math and science by 12th grade to such a degree that causes concern for our economic status in the 21st century. Should we

be surprised? We're going to fill our minds with something. **If not the nourishment of science, philosophy, and mathematics, then it's going to be the mental junk food of pseudoscience and related forms of weak thinking.** Some details...

- a. U.S. 12th graders came in 19th of 21 countries in both science and math. Most Asian countries chose not to participate. (Inferring from other past comparative studies, we would have remained near the bottom of the list.)
- b. On AP students in math and science, math results showed our top students to be outperformed by 11 countries, were similar to those in four countries, and outperformed those in no countries. On the physics assessment, U.S. students were outperformed by those in 14 countries, were the same as those in one country, and outperformed those in no countries.

IV. Science - a Learning Process

- A. DEFINITION: Science is a naturalistic self-correcting process of investigation into how nature works. It is not just collecting facts. Its probing goes beyond the immediately apparent. This is in contrast to the ancient Aristotelian antecedent of science and its present-day intellectual descendant— pseudoscience. The innovative physicist Richard Feynman offered a couple of concise alternative ways to describe science:
 1. *"Science is a way of trying not to fool yourself,"*
 2. and, even more concise, *"Guess, then test."*
- B. A pragmatic pursuit of knowledge and understanding, not always so methodical
 1. With the goal of science being simply understanding, or truth, scientists do whatever works so long as it leads us to understanding/truth. This is why it is difficult to relay to laymen what the so-called "Scientific Method" really is. Though much scientific work is methodical, its practice typically involves different approaches to a problem in a not-always-organized manner. Nevertheless, the term "Scientific Method" is not useless. You might say there is a "method to our madness." Science is as pragmatic as plumbing. For more on the scientific method (and plumbing, see "Heart of Science" below, Unit IV.E.1.
 2. The basic requirement is that ideas proposed to explain things ("hypotheses") be testable. Testing is the only way we know that our ideas are well-based and not just imagination, speculation, emotion- based, or wishful, thinking.? (See "Heart of Science" below.)
- C. **FACTS**
 1. INFORMATION from observations of nature
 2. " " Experiments in laboratories
 3. "The best" facts ↔ uncertainty in factual knowledge
 - a. based upon our best measurements
 - b. error bars & statistics
 - c. future discoveries & refinements
- D. **THEORIES**
 1. IDEAS that EXPLAIN, SHOW INTERRELATIONSHIPS among seemingly ISOLATED FACTS, MAKE SENSE of things, SHOW "CAUSE AND EFFECT"
 2. related terms
 - a. scientific speculation — a preliminary, untested attempt to theorize
 - b. hypothesis — more thought out than speculation, perhaps tested successfully with some new evidence, but with more testing still called for
 - c. model - roughly equivalent to theory, a term used more when computers are involved ("computer models") to bring to bear equations which can simulate some phenomenon
 - (1) NOTE: When attempting to "model" nature, scientists start out with the simplest model

and then add complexity as needed to improve the model's consistency with nature

(a) examples: synthetic spectra, stellar models, Planck's Laws applied to stars

3. uncertainty in the ory
 - a. Based upon BEST FACTS; if BEST FACTS CHANGE, may have to change theory
 - (1) e.g. origin of moon, origin of life
 - b. Based upon assumptions, which, however reasonable at the time, may later be shown to be lacking
 - (1) Newtonian absolute frame of reference vs. Einstein's relativity
 - c. Even outdated theories will probably still have some validity
 - (1) flat earth theory (works in Kansas)
 - (2) geocentric theory (still the immediate impression; when we begin to learn the sky and its motions, the terms and concepts that immediately come to mind are geocentric)

E. **THE HEART OF SCIENCE - on the relation between facts and theories**

1. Theories are tested by checking for the consistency of their predictions with the best available evidence. (Remember Feynman's "Guess, then test?")

Remember my comment that science is as pragmatic as plumbing? The plumber arrives at your home to size up the problem (gathers evidence and hypothesizes as to what's wrong). Then applying the principles which he/she has learned through training and experience, a solution to the problem is tried (hypothesis is tested). If it doesn't work, the plumber revises the hypothesis, or throws it out and tries an entirely different approach. After several cycles of "guessing then testing," eventually the truth comes out, that is, the plumber has fixed your problem. I know this is a mundane comparative example of one of the greatest human inventions ever, but, if you remember the aspects involved in plumbing, you have a general grasp of how science is done. How many other areas of human activity has been influenced by scientific thought? (Don't think too long on this; it would be much quicker to come up with a list of areas of human endeavors that have not been affected by science's results or thinking process.)

2. Evidence is of two kinds: already extant and obtained after the theory is formulated.
 - a. Example: The two first test of Einstein's new Theory of Relativity were the precession of Mercury's orbit (already extant) and the bending of light rays passing near a gravity source. (*post prediction*) The specific observational test was the measure of star light directions that passed near an eclipsed sun.) The bending of light rays was a novel, startling prediction and result and gathered most of the headlines of the day, but scientists were more impressed with Relativity's ability to predict/explain the precession of Mercury's orbit. Why? Because this characteristic of Mercury's orbit had perplexed scientists for over 200 years. The *post prediction* of starlight bending as it passed an eclipsed sun had not yet been pondered in any depth. As critical thinkers, scientists want to make sure all reasonable interpretations have been considered. (Note: in the next unit on "Critical Thinking," "considering alternative interpretations" is presented as one of the eight aspects of critical thinking)
3. THE MORAL OF THE INNKEEPER PROCRUSTES'S BED (The story is presented in class, on video or television)
 - a. Should inconsistencies arise between theoretical predictions and the best facts, facts so sure as to be incontrovertible, the hypothesis is adjusted or even replaced with a better alternative hypothesis.
 - b. The facts are not changed just to fit the theory. (Change the bed to fit the guest; don't distort those patients who don't fit the bed.)
 - c. In many situations the facts may not be all that certainly known. Here, both the facts and hypotheses remain in question. Facts can change or be discarded, but not merely because they don't fit our theoretical prediction.
 - d. The following is an excellent expansion on the The following is an excellent expansion on the Heart of Science by a Professor of Evolutionary Biology at the University of Arizona (Laferrière¹²)

"Scientists propose theories that represent their best explanations of certain phenomena given the information currently at hand. The authors of these theories must be willing to revise or replace them if new evidence accumulates that refutes previous ideas. True, scientists are all too human, having egos (and grants) to nurture, and often find it difficult to abandon methods they have used for years and with which they have grown comfortable. Sometimes theories survive longer than they should. In the long run, however, the factual evidence remains the ultimate criterion for deciding scientific controversies and must hold sway. Present-day biologists, for example, do not regard the Origin of Species as infallible and do not cite it to resolve disagreements among themselves; rather, they recognize that Darwin was right about some of his ideas and wrong about others. He was wrong not because he was stupid but because the information he needed to resolve certain problems was simply not available in his time. Herein lies the essence of the scientific method and the factor that has enabled science to progress so far and so quickly; the ability to adapt and grow with the acquisition of new knowledge.

"This of course is not to say that any theory is just as good as any other or that scientists are fickle creatures willing to abandon their theories as suits the convenience of the day. As knowledge accumulates through the years and new methods for gathering data develop, scientists gain progressively more information on which to base their ideas; the theories therefore become more accurate reflections of the true forces and properties that guide nature.

The Heart of Science

Hypotheses and theories make predictions. Those predictions are tested by comparing them with the facts.

Should inconsistencies arise between theoretical predictions and the best facts, facts so sure as to be incontrovertible, the hypothesis is adjusted or even replaced with a better alternative hypothesis.

The facts are not changed just to fit the theory.

"Theories are useful primarily because of their ability to generate predictions. Predictions must be tested by independent means; in other words, they cannot be evaluated using the same data used to generate the original theory. Then the argument would be circular. Experiments do more than simply generate data haphazardly; they are designed to gather the information needed to test predictions made by scientific theories. The more success a theory has in generating predictions that turn out to be supported by fresh evidence, the more valuable the theory and the more support it is likely to engender in the scientific community. If a theory proves incapable of generating predictions to explain certain phenomena, as Newtonian physics proved incapable of explaining certain minor perturbations in the orbit of Mercury, it must eventually be modified or replaced by a new theory, capable of offering satisfactory explanations."

The preceding is an excellent exposition of how science works. You might read it again.

F. THE SCIENTIFIC ATTITUDE: OPEN-MINDED, BUT SKEPTICAL

1. Applied to claims that are new and unusual
2. But: How much open-mindedness; how much skepticism?
3. "EXTRAORDINARY CLAIMS REQUIRE EXTRAORDINARY SUPPORT."
 - a. "lunch with a friend" allegory
4. Doubt as the essence of knowing: Author James Gleick¹³ offered this statement that gets to the true spirit of science, in describing genius/physicist Richard Feynman, "He believed in the primacy of doubt, not as a blemish upon our ability to know, but as the essence of knowing."
5. Philosopher Paul Kurtz¹⁴:

"The totalitarian societies of our time have invested vast sums in technical research and have achieved a high level of scientific competence in certain fields, but the scientific outlook has not prevailed in them. Merely training people to be scientific specialists is not enough. A culture can be full of scientific technicians, yet still be dominated by the irrational. (Instructor note: a prime such societal example--Nazi Germany.) We must distinguish science as a narrow technical enterprise from the scientific attitude. It is here that I think we have not established an important goal. Unfortunately, to have scientific credentials in one field does not mean that a person will incorporate a scientific attitude into other parts of his life."

"...If we are to meet the growth of irrationality, we need to develop an appreciation for the scientific attitude as part of culture. We must make it clear that the key methodological principle of science is that one is not justified in affirming a truth claim unless one can support it by evidence or reason. It is not enough to be inwardly convinced of the truth of one's beliefs. They must at some point be objectively verifiable by impartial investigators. (emphasis added) A belief that is warranted is not so because it is 'subjectively true', as Kierkegaard thought; if it is true, it is so because it has been confirmed by a community of inquirers. To believe validly that something is true is to relate one's beliefs to a rational justification; it is to make a claim about the world, independent of one's wishes. (emphasis added) Note: Kurtz's discussion is in regard to the distinction between "subjective reality" and "objective reality". See Unit IX. A., "Illusion, Subjective Reality, and the Personal Experience"

6. excerpt (left out of the movie) on skepticism from **CONTACT**, science fiction novel by Carl Sagan:

(scientist talking) "You're uncomfortable with scientific skepticism. But the reason it developed is that the world is complicated. It's subtle. Everybody's first idea isn't necessarily right. Also, people are capable of self-deception. Scientists, too..."

"So the way you avoid the mistakes, or at least reduce the chance that you'll make one, is to be skeptical. You test the ideas. You check them out by rigorous standards of evidence. I don't think there is such a thing as a received truth. But when you let the different opinions debate, when any skeptic can perform his or her own experiment to check some contention out, then the truth tends to emerge. That's the experience of the whole history of science."

7. Two kinds of skepticism (from Bunge¹⁵)
- a. methodological doubt--initial distrust of extraordinary claims, want to see the evidence and consider alternative explanations
 - (1) healthy scientific view which can lead to fruitful research and its results, knowledge and understanding
 - b. systematics skepticism--denies the possibility of any knowledge and therefore entails that truth is inaccessible and the search for it vain
 - (1) discourages inquiry, openness, and initiative which can lead to the same result as dogmatism and its acceptance, namely "the illusion of knowledge" (from historian Daniel Boorstin), stagnation, and worse.
8. an urging for self-doubt from biochemist Robert Shapiro¹⁶
- a. *"Ideally in science, the individual who makes an exciting discovery should play the devil's advocate. He himself should take the most skeptical view of the results, and make every reasonable effort to find a less exciting explanation for it. Only after such efforts have failed should he publicize it."*
 - (1) example: **The Jupiter Effect** authors
 - (2) example: cold fusion "discoverers"
9. and a sober, reflective, historical/cultural note on doubt from Richard¹⁷

"Doubt is the arch-offense, the mortal sin codified in the religious framework of our culture. To be a skeptic is to be a devil. It is to be an evil person. It is not nice to demand good reasons for believing X. Do we dare tell our students how many people have gone to the pyre, literally burned at the stake, because of their doubt, their wish to examine critically what has been taken as 'the established truth'? And if we told them, would they have the depth of soul to comprehend? Are these nice students of 20th

century mellow middle America capable of the intellectual passions that have moved human beings to great discovery and herculean achievement in the face of terror, persecution, censorship, torture and death reserved for those who dare quest for the light of simple truth?"

G. ON THE SUPERNATURAL AND THE NATURE OF MIRACLES

1. The universe is wondrous, mysterious, and truly awesome. And when we feel deeply the emotions of wonder and awe while contemplating the mystery of existence and the universe, our thoughts naturally go to God, God the Creator. In this respect, science has deepened many people's appreciation of God (and may yours' from this course), because for many the heavens reflect God's glory and thanks to science we humans now have a far, far better grasp of the heavens than did the writers of the holy books of the world's major religions. But yet science itself does not speak in the language of the theologian and leaves God out of the action. There is never in the process of doing science any attribution to any god, goddess, gods or goddesses. The reason for this omission is not due to some philosophical objection drilled into student scientists. It is simply because of the practical "real-world" nature of the pursuit. The key notion of the supernatural is that it is not part of the natural world and, by definition, is beyond human investigation and understanding. You can gain insight on this when you learn that the root meaning of the closely related word "occult" is "hidden." Science deals with physical reality, that which is demonstrably REAL, accessible, and can be studied in an objective, evidential manner. The supernatural may well exist in some form; after all, theoreticians are utilizing the concept of physical dimensions beyond the three that, along with time, characterize physical reality (Einstein's four dimensional space-time continuum). **Nevertheless, regardless of whether some supernatural state exists, human understanding took off when supernatural notions were set aside by the ancient Greek philosopher-scientists and nature was studied directly on its own terms.**

"True science teaches, above all, to doubt, and to be ignorant."

Philosopher Miguel de Unamuno (1864-1936)

Take epilepsy for example. Pre-scientific thought had it that epilepsy was an attack by one or more demons, a supernaturalistic notion. But whoever, to this day, saw one or more demons attacking their poor epileptic victim? Just what is a demon, anyway? Where might they be found for study? How many demons would it take to start an epileptic fit? What is the real, verifiable evidence, not just someone's say-so? These are the sorts of scientifically-minded questions one could use as the basis for their research program. But what do you do next? How do you collect the evidence? Study the evidence? You MUST do these or you can't come to any understanding of what a demon is. The closest we can get to studying demons is studying people who claim to believe in them or better yet, have claimed to have encountered them. (And if they really have had an encounter, how do you know the person wasn't being set upon by another human(s) with evil intent?) Demons, a supernaturalistic notion, are simply beyond scientific study. (But their believers aren't beyond investigation—I just recall that Jimmy Swaggert, a television evangelist popular during the 1980s, claimed to have physically fought with some. Maybe. But I suspect that if you started your study of demons with Jimmy Swaggert, all you would learn from the study would be Jimmy Swaggert's psychology or find people who mugged him. Our perception of reality is influenced by our *a priori* beliefs—See Unit X.A. "Objective v. Subjective Reality". But setting aside the demon "explanation" for epilepsy, the scientific approach has yielded real, verifiable understanding—a neurological disorder resulting from unwanted bursts of electrical misfirings by brain synapses—grounded solidly on evidence (brain scans). By bringing the subject into the realm of nature, we can do something about it. We empower ourselves. Scientific understanding of epilepsy and the brain has led to chemical treatments to ameliorate its effects, and, incidentally, erase the stigma that has historically been attributed to the condition by ignorant, superstitious people. This realization of empowerment has changed the world. Through science, we have made a world much more conducive to human health and welfare, though new challenges face us as well, but I digress.

About the term “supernatural explanation,” implied above with my demon example. Reflect on the term a moment and you will see that this term is an oxymoron. To say that something is supernatural means that, by definition, it is something that cannot be dissected and explained, based on evidence (necessarily from the physical world, right?) and reason. A logically consistent term would be “supernatural mystery”. Occasionally, pseudoscientific ideas arise from supernaturalistic thinking. For more on this, see the Unit VI., “Pseudoscience/superstition/anti-intellectualism”.

2. A thought on the mixing of the naturalistic with the supernaturalistic by Philosopher Mario Bunge¹⁸: *“It is possible to apply the scientific method to a nonscientific investigation, such as trying to measure the speed of ghosts or the intensity of the action of mind on matter. To yield knowledge, however, the scientific method must be accompanied by a scientific world-view: materialist, realist, rationalist, empiricist, and systemic.”* Hmm. Have you read much about ghosts? Did you ever read of any attempts to measure their speed? Any reference at all to their speed? Just wondered. So, this is a part of the scientific mind; it leaves out appeals to supernatural explanations. The supernatural can’t be studied and just doesn’t really yield useful understanding into the workings of the natural world. How would you react to a plumber who comes to your house (you already owe him money, just for that)—and he looks at your problem and says, “You got demons. Yeah, demons are in your pipes, alright. Here’s what you do. At midnight of the next full moon, light candles and this incense, say this chant for 40 minutes, then sing this song. The little beggars’ll be history. That’ll be \$100, thank you.”
3. On the nature of miracles
 - a. The philosopher’s perspective on the nature of miracles is that they are uncommon occurrences witnessed by individuals who could not understand them and who found these occurrences beneficial in some way to them. (Who’s heard of a bad miracle?) They reasonably enough feel grateful for them. Being grateful to chance or physical reality does appeal; they’re grateful to God, or whatever holy figure they most revere.
 - b. A noted British psychologist Nicholas Humphrey comments below on early 19th century philosopher David Hume’s succinct remarks on miracles¹⁹.

“Miracles are trouble. They’ve been a worry to philosophers who see more clearly than most the dilemma they put us in. David Hume in ‘Essays and Treatises on Several Subjects’ said ‘Ask yourself, which is more probable, the natural universe should, as it were, gone off the rails, or that the human beings involved have bent the facts.”

“When anyone tells me he saw a dead man restored to life, I immediately consider with myself: whether it be more probable that this person should either deceive or be deceived or that the fact which he relates should have really happened. I weigh the one miracle against the other.”

“Experience teaches us to trust the laws of nature. Experience also teaches us to trust our fellow human beings. So what are we to do when we can’t have it both ways?”

I would answer Humphrey’s question this way. If a person is unfamiliar with the power of natural law, he or she will not be so concerned about accepting the claim of a miracle, which implies a breaking of those laws. We humans break our man-made laws. Why can’t God break nature’s laws? He, She, It may have created the laws.

- c. The logician’s insight, with some help from the mathematician, helps us here by leading us to expect some miracles in life. That is, over a large enough sample (of people) over a long enough period of time, even low probability events will probably occur. Given: We have numerous experiences in life, some unusual, even odd to us. We either appreciate, don’t appreciate, or don’t care about these experiences. Further, we either understand these experiences, or we don’t. Logically, there will be a subset of experiences that we appreciate having had, and do not understand how they came about. Depending upon our intellectual background and degree of benefit we received from the experience, it is in this subset of human experiences that we may find miracles.

Napoleon to the mathematician Pierre Simon de Laplace: "You have written this huge book on the system of the world without once mentioning the author of the universe."

Laplace to Napoleon: "Sire, I had no need of that hypothesis."

Don't skip over this; reflect a moment...

"Men think it divine merely because they do not understand it. But if they called everything divine which they do not understand, why, there would be no end of divine things."

unknown Hippocratic writer, on epilepsy

H. Science as it relates to other areas—learning, myth, and society.

1. Scientific Assertions vs. Dogmatic Assertions

a. Scientific statements

- (1) are based upon fact and reason (logical application of natural principles). They may represent Truth, or they may not.
- (2) are NOT ABSOLUTE TRUTH, but rather the BEST WE CAN SAY AT THE TIME. They are open to correction.

b. Dogmatic statements

- (1) are based upon the authority granted to the source. These statements may in some ways be based upon experience (fact) and reason (logical thinking), but they may often be baseless assertions. They, too, may represent Truth, or they may not.
- (2) are asserted as correct already; they resist correction.

c. The key difference, to me at least, between scientific and dogmatic statements is the basis on which the receiver of the information is to accept the statements as truth. Scientific statements are accepted because the receiver understands their basis. Any skepticism can lead to testing until "the truth will out".

- (1) Scientific statements encourage critical thinking.
- (2) Dogmatic statements discourage critical thinking. They are to be accepted on the basis of the receiver's faith in the source.
- (3) Which way the student receives truth statements, depends upon emotional factors, acculturation factors, prior beliefs and educational level.

d. Note for yourself in this course and others how much you willingly accept on the basis of your faith in Pima College and the professor versus how much you accept because you understand the supportive reasons (evidence, logic). You should note that even in this science course, in which I will try to make clear to you reasons so you will accept statements because you understand their basis; that you will willingly accept much on faith, either because 1) an assertion I give may not be important enough to check out on your own—you're too busy to be skeptical of everything, or 2) the supportive basis for an assertion may be beyond the level of a course for non-science majors at the Freshman, Sophomore level.

2. Scientific theory in contrast to myth

- a. When our interest turns to matters pertaining to the past, particularly the origins of things (sun, moon, earth, people, life etc.) we have since time immemorial discussed these in terms of stories that help us to arrive at a satisfying understanding of why the way things are and what our place in the world is. These stories, almost always comprised of heroic figures,

animals, and supernatural entities, are called myths. Occasionally, science is referred to as the “modern myth.” The basis of this assertion is that, like our ancestors we are trying to understand who we are and how we got here, only now we are doing this by learning through science what physical reality is.

- b. The first recorded myth is the Sumerian epic of *Gilgamesh*. It, like many myths, is rich in valuable insights into life, morality, etc. Further, they give us insights into the cultures of our past, from which we have culturally and intellectually descended. (An excellent reference: **Ancient Myth and Modern Life**²⁰, which looks at the prevalent middle-eastern myths and religions of 2-3 millennia ago which influenced the development of the Judeo-Christian religions.)
 - c. Myths are not properly to be understood in the black/white terms of true or false. A myth with humor or exaggerated drama or excessive supernatural element may well contain within its fictional structure great truths, just as with much fiction today. Furthermore, myths are often about a time before the advent of writing (which occurred at different times at different places) when human drama was played out, but not written out. That is, there could well be elements of actual (pre)historical events that provided the basis for the myths. For example, reading the Babylonian myth of Marduk, it is not hard to imagine that there could well have been an actual prehistoric human hero, who, in the retelling of the tales, was elevated to the creator god Marduk. And, more demonstrably, you should know the story of Troy, the discovery of which was a direct result of a man wondering if this city written of in the Greek mythological story, *The Odyssey*, might have actually existed.
 - d. The supernatural elements in mythological stories are obviously dramatic exaggerations, but this seems to be more obvious to people when reading the myths of someone else's culture or religion. The eminent late mythology scholar Joseph Campbell lamented about the widespread mistaking of metaphor for the message.
 - e. With points 1-4 in mind, we see that myths are stories presenting truths in fictional form. Myths may stress truths, often through metaphor, of the human condition that resonate with our own experiences in life and hence act as great guides for our own pilgrimage through life. (And, of course, some myths may include both kinds of "truths".) In any case, it is not appropriate to revise myths. They come to us "as is". Their values and story lines may inspire modern rewrites, but it would not be legitimate to call the new versions by their old names. This is opposite to what we do in science, in which our best understandings, embodied in our current theories, are the result of a process of "survival of the fittest". When some older theory is later shown to be lacking, we changed it, or threw it out, replacing it altogether. (Example: The Comet Impact Theory to explain the origin of the planets.) Aside from some archaeological leads, no myth has ever presented any scientific understanding of physical reality beyond the general level of understanding of people at the time of the story's writing. To reject scientific theory (i.e., "best understanding at the present time"), as do the "scientific" creationists, in favor of conclusions about physical reality drawn from ancient myths, bespeaks a great lack of understanding as to what myths and science are.
3. Scientific Research – two kinds
- a. Basic Research: no goal other than to learn how nature works in some particular way; research determined by the researcher
 - b. Applied Research: has the goal of attaining some practical result, a better widget, a cure for a specific disease; research determined by the funder
 - c. Applied Research has been done for many laudable goals and you can imagine it is generally easier to "sell" to the public when tax payer-supported. Without an immediate, practical goal, Basic Research is harder to sell. But here's the problem: Applied Research is enabled by Basic Research. Technology follows from Applied Research, and societal benefits follow from the technological developments. Those same technological developments can open up new avenues for Basic Research, and the learning-benefit cycle continues to flourish. Though astronomy has historically offered important practical benefit, its practice today is that of Basic Research. But the knowledge from astronomy and related physics that has developed

many space technologies are having a return benefit on astronomy and physics. Consider the impact of the Hubble Space Telescope. High energy astrophysics has grown considerably as a field since we could launch detectors into space where we could at last observe the universe in high-energy ranges. The fundamental importance of Basic Research is brought out in the following excerpt by Arthur Kornberg, Professor Emeritus of Biochemistry, Stanford University School of Medicine²¹.

"The truly major discoveries that have altered the face of medicine—for example, x-rays, penicillin, recombinant DNA—have all come from the pursuit of curiosity about nature without relevance to medicine. The same can be said of great industrial inventions, which were haphazard at the outset and only later recognized for their commercial value. No matter how counter-intuitive it may seem—to the scientist as well as to the layman—the most sure and cost-effective route to discovery is through the creative activity of the scientist or inventor rather than the pursuit of a defined goal.

" Scientists working at a frontier of science or creating a new one must rely on intuition, serendipity, and a capacity to move quickly in new directions to exploit findings that emerge from their research and that of others."

- d. Be aware of "pork barrel" spending. The informed citizen should be aware that we have set up excellent funding methods for science in the U.S. However, the past decade or so has seen a rise in universities making attempts to bypass the normal funding approval system to go directly to congressional subcommittees to get funding for their pet projects. Not only are our congressional representatives not the best judges of specifically where science funding should go, but this practice leads to waste in federal spending because of the lack of coordination with other scientific projects.

V. Critical Thinking (CT)—weighing claims - evaluating information

- A. Simply put, CT is not "black/white", that is, oversimplified thinking, which is the hallmark of the underdeveloped mind and is more susceptible to general *a priori* attitudes and beliefs. For many, in fact, belief is a substitute for knowledge and understanding. The following quotation equally holds true today.

"We are too much accustomed to attribute to a single cause that which is the product of several, and the majority of our controversies come from that."

—Justus von Liebig (1803-1873)

- B. EIGHT ASPECTS OF THINKING CRITICALLY by Carole Wade and Carol Tavris²². (The authors have also written a college introductory psychology textbook organized around the following eight points.)
 1. Ask questions; be willing to wonder.
 2. Define the problem.
 3. Examine the evidence.
 4. Analyze assumptions and biases.
 5. Avoid emotional reasoning: "If I feel this way, it must be true."
 - a. William Gladstone (1809-1898) *"Men are apt to mistake the strength of their feeling for the strength of their argument. The heated mind resents the chill touch and relentless scrutiny of logic."*
 - b. Now consider this exchange between astronomer Carl Sagan and daytime television star Kathie Lee Gifford²³:

Sagan: "It was written by human beings 2600 years ago, the book of Genesis; why would we possibly imagine that this is an up-to-date summary of the best science? Clearly, it's not."

Gifford: "You can never argue with a human being who's had a personal experience of God touching their lives, no matter what you will ever say in terms of Science. They will know what is true in their own heart." Sagan's statement is objective, Gifford's subjective, reasoning emotionally. Both statements can be considered truth statements, yet nevertheless discordant in part because of the differing kinds of the truths they bespeak. Ignorance, particularly so when willful, plays a key role as well. Consider also Gifford's response in light of the material in Unit X., Section A., "Confusing Subjective Reality for Objective Reality; the Personal Experience". See also Unit VIII., "Dangers of Pseudoscience.", Sections B. and C.

6. Don't oversimplify. ("black/white thinking"—See more above and below.)
7. Consider other interpretations.
8. Tolerate uncertainty/admit ignorance.

C. What does it mean to think critically?

1. Two equally intelligent people can be equally articulate and informed, but not be equally good thinkers. If only one of them is thinking critically, that one will be better at analyzing and evaluating facts and opinions, sources and claims, options and alternatives, etc. The critical thinker will be a better problem-solver and decision-maker.
2. When we're thinking critically, we're using our knowledge and intelligence effectively to arrive at the most reasonable and justifiable position possible. When we're thinking uncritically, no matter how intelligent or knowledgeable we are, we'll make unreasonable decisions and arrive at unreasonable beliefs or take unjustifiable actions—*unless we are lucky and end up making the right choice for the wrong reasons!*
3. Just what do we do when we're thinking critically? To think critically is to think clearly, accurately and fairly while evaluating the reasons for accepting some belief or taking some action. The goal of thinking critically is simple: to guarantee, as far as possible, that one's beliefs and actions are justifiable and can withstand the test of rational analysis. To achieve this goal one must rigorously scrutinize one's own beliefs and actions as well as the beliefs and actions of others. What are the standards we use? This section "C" is from the "Skeptic's Dictionary" Web site. For more about the standards of the evaluation of evidence used by critical thinkers, go to that Web site given by this endnote²⁴.

D. Scholarship — An application of critical thinking

1. Begins with a willingness to work and think
 - a. Seeks authoritative information
 - b. Weighs the evidence
2. Not reading too much out of the data.
 - a. This requires both a general experience in processing information and a certain expertise in the relevant areas to the problem under investigation/examination.
 - b. It means paying attention to the details of the available facts and the uncertainties of those facts. Any inferences drawn from the information must take error and uncertainty assessments into account.
3. Objectivity
 - a. Seeks both supporting and refuting evidence and reasoning
 - b. Investigators often have some idea of what they consider the truth to be in some matter under investigation, but objective scholarship entails the processing of information unfiltered by any preconceptions. Being self-aware of one's biases (See critical thinking aspect #4 above.) is

"Mediocre spirits demand of science the same kind of certainty which it cannot give, a sort of religious satisfaction. Only the real, rare, true scientific minds can endure doubt, which is attached to all our knowledge."

Sigmund Freud, in a letter to his friend, princess Marie Bonaparte, toward the end of his life

important to objective scholarship. Without taking into account what scientists call “the personal equation” leads to a false advocacy scholarship, involving the breaking of the moral of Procrustes’ Inn — processing the information to fit the prior conception of Truth (in the form of hypothesis, theory, belief). (See Unit VI., Pseudoscience/Superstition/Anti-intellectualism.)

4. Comment — When we seek to know the academic credentials (degrees and schools) of someone making a questionable-sounding claim, it is because we recognize in college/university education, particularly post-graduate, a generally successful foundation for the learning of the skills relevant to scholarship. It is the persistent lack of scholarship by some that unfortunately fuels many controversies in our society. (This echoes Justis von Leibig’s quote above in this unit (VI.,B.1.)

E. The Positive Personal and Societal Impact of the encouragement and practice of CT

1. **Black/white → right/wrong → good/evil → us v. them** attitudes. In a world drawn closer by technology and strained by the many demands placed upon it by the rapidly growing human overpopulation, what is needed is compromise, tolerance, cooperation, respect, understanding, compassion--words missing from the vocabulary of the divisive "us versus them" ideologue, but which flow naturally from the critical thinker. How many examples are there of people, considering themselves as good, who single out others as being bad or evil? When people of this mind set gain political power, tragedy inevitably follows. You don’t have to look back in history for examples—look at contemporary politics here and elsewhere. A common example in the United States: Either the Bible must be accepted as true or rejected as false.
 - a. In a *Newsweek* “My Turn” column, a college student of Arabic ancestry writes on the negative attitudes she has perceived directed towards people of her shared ancestry. It relates well to this paragraph on the consequences of black/white thinking:²⁵
2. The black/white thinker is far more prone to refusing to question his/her own beliefs and willing to put a limit on inquiry and questioning in general in order to protect those beliefs. This attitude can lead to censorship of the arts and literature, even the practice of science and its education.
3. from *Newsweek*, "When Neo-Nazis Run Free; In eastern Germany, a new wave of racial violence", July 29, 1991, p. 34.

“The east (Germany) has given us a glimpse of the Germans we used to be 50 years ago. The authoritarian state taught people only to command and obey,” says Barbara John, a Berlin City commissioner. ‘Compromise and accommodation are unfortunately not yet part of the political culture.’”
Nor of black/white thinkers and ideologues generally, I should add.

4. from a letter to *Newsweek* in response to an article on the Nazi concentration camps, February, 1995 (two months before the horrifically effective anti-federal government bomb exploded in Oklahoma City, killing 168):

“The real lesson of Auschwitz is how frighteningly easy it is to rape, torture and murder your former friends and neighbors if you learn to think of them as subhuman. That was Hitler’s method, and it’s being used again in Bosnia and Rwanda. People who use platforms such as politics, religion and talk radio to provoke “us versus them” thinking create the same dangerous mentality. Whether it’s against immigrants, blacks, Jews, gays, abortion-clinic staffers or even the president, hate mongering can only fuel the fears of an intolerant society.”

What I wish to get across here is that education is important because it elevates us above a reptilian brain-level of response to the world. And with a rapidly growing population of humans straining a resource-limited planet shrunk by faster transportation and communication, I can’t think of a more noble purpose of education—the preservation of the species, learning how to save ourselves from our own follies.

- F. Further Reflection. Let's wrap up these units on Science and Critical Thinking, by returning to thoughts on personal growth, with this excerpt, by theologian and scholar of ancient middle eastern myths, Gerald Larue²⁶:

"Only as humans continue to seek will discovery of self come - not through pre-formulated responses, but through adventurous growth and freedom to probe.

In reality, the search is endless, for to say 'At last, I have found myself' terminates the quest. The joy is in the inquiry. The answer must always be partial, for once an answer is found, new questions arise; each new pinnacle presents another horizon. The meaning is, perhaps, in the desire to know, to grow, to reach towards one's potential, knowing always that the final answer, whatever it may be, lies beyond the grasp. The alternative is to abandon the search for meaning and to accept what someone else has said as the ultimate answer."

Do you see how Larue's statements on our personal process of learning, discovery and personal growth, exemplify the personal application of the process of science and the scientific attitude?

Before moving on to the next topic below, ponder this. A large fraction of students graduate from High School. A sizable minority of High School graduates go on to college. A very small minority of them take the philosophy course in logic and critical thinking. Consider how fundamentally inextricably important logic and critical thinking are to personal growth, the development of our intellect and personal values, and our roles in a career and as responsible citizens of a democracy. So, given all that, why is such a course on the intelligent use of your brain not required for graduation from high school? But what percentage of High Schools even offer such a course? Do you know the meaning of the term "infinitesimally small?" I thought we Americans were serious about education. Oh, really?

"There is much to recommend the notion of *teshuvah*. At the very least, it makes good sense that people who are forced to look inward on a regular basis and to atone—sincerely—for their wrongdoing will not be capable of gross inhumanity. But even more, the same teachings that cause people to turn inward for the purpose of rigorous self-examination will most likely cause them to cry out when others are oppressed...

"Just imagine—a world where all men and women are required to search their souls and to resolve that they will not repeat their sins. 'Then nation will not threaten nation, and mankind will not again know war.' Certainly, a worthy New Year's wish."

On the notion of "teshuvah" from "Selihot: Some Reflections" published by The United Synagogue of Conservative Judaism.

"So what do I teach my students? ...what cannot stand up to examination is illusion, mere self-satisfying prejudice. What is real can withstand the stab of the prying eye. What is true cannot be falsified by a test, no matter how fierce. I teach them that we must learn to relish examination and reflection. I tell them that if we care about creating a better future, if we care about truth and making new and great discoveries, then we must learn to exalt in criticism. To hold to beliefs and opinions untried by the purifying fire of critical analysis makes us bigots and hollow men."

philosopher Joseph Richard

VI. Pseudoscience/superstition/anti-intellectualism

- A. DEFINITION OF PSEUDOSCIENCE: Pseudoscience comprises claims about physical reality that
1. allege to be scientific,
 2. yet scientific investigation has shown to be weakly based or even refuted.
 3. Nevertheless, these claims continue to be believed in by segments of the populace.

B. Hallmarks of Pseudoscience

1. MISHANDLE DATA
 - a. astrologers ignore precession
 - b. "scientific creationists" cut off relevant magnetic field data in order to save their young earth claim
2. ERR IN REASONING
 - a. "scientific creationists" and their use of a *false dichotomy fallacy* (trying to force a problem into having an "either/or" choice of solutions) regarding the origin of life in arguing with scientists as if their idea and one scientific idea comprise the totality of ideas
 - (1) BUT: They ignore several alternate scientific theories. They also ignore countless other creation mythologies of other religious traditions, including those out of which the stories in Genesis descended.
 - (2) this allows them to then say that evidence they think is against evolution, is therefore positive evidence for the "only" alternative--"scientific creationism"
3. Points 1 and 2 can apply to science as well. The difference is in frequency of occurrence.

C. Contrasts with Science

1. Pseudoscience does not push beyond the apparent, the superficial. See unit IX. A., "Subjective Reality vs. Objective Reality". Speculation abounds, but with little or no attempt to test. Plenty of "evidence" is offered, but how good is it and what contrary evidence is being missed or swept under the rug. The mystery must be maintained! But in science, we attempt to learn what is behind the mystery. We don't settle for the anecdotal and subjective; we don't redefine words to suit our purpose *du jour*. We seek the objective, verifiable reality behind any claimed subjective reality. After writing these words, I came upon the following apt quotation by John Ruskin (1819-1900):

"The work of science is to substitute facts for appearances and demonstrations for impressions."

2. Over time, the pseudoscientific claim (or theory or belief) is held to by ignoring or distorting any contrary evidence. This very much "stabs" at the "Heart of Science".
 - a. Let's call upon my plumber metaphor, again. Suppose, instead of being scientific in his approach, he tells you over the phone that he knows what your plumbing problem is and how to fix it. OK. Then he shows up, and goes right into "fixing" it. You point out that there was something you forgot to point out on the phone. He doesn't care. He "knows" what the problem is. He "fixes" the problem. He leaves. There goes another \$100. You try it out (faucet, toilet, whatever) and--guess what? It still leaks. You did the test, he didn't. You call him back and inform him. He refuses to take you seriously; after all, you just don't understand what he knows, or whatever, in any case, he's too busy and has to go on with "fixing" other peoples' problems. He just isn't capable of processing objectively information that appears to go against his understanding. (See Unit X.D. "Mental Blocks")
 - b. Members of the Institute for Creation Research (ICR) willfully and publicly break the "Moral of Procrustes' Bed" to stab the heart of science by claiming to one and all to be scientific, while

A critical thought on evidence...

"It is not the *quantity* of evidence that makes an idea correct, but the *quality* of the evidence."

Psychologist Richard Kamman, 1980

at the same time swearing to an oath stating their belief in their "theory", never mind where the evidence actually points—just distort the evidence. This is not science—it is classic pseudoscience! Henry Morris, leading creation "scientist", gives credit for the success of the Creation Research Society to its specific doctrinal commitment and constitutional prohibition against compromise.²⁷

Again, from Shapiro²⁸, *"In essence, (ICR) attracted scientists willing to forsake the practice of their profession in certain areas, and accept instead explanations based upon the word of authority alone."*

Again, from Shapiro²⁹, *"In essence, (ICR) attracted scientists willing to forsake the practice of their profession in certain areas, and accept instead explanations based upon the word of authority alone."*

"Science commits suicide when it adopts a creed."

Thomas Huxley (1825-1895)

How Claudius Ptolemy exemplifies the science/pseudoscience distinction between astronomy and astrology

Astrology affords us a perfect insight into this. There's no better example of how pseudo-science is stagnant, and science progresses, than the contrast between astrology and astronomy. Central to the practice of modern astrology is the work of one man, Claudius Ptolemy, 1850 years ago in the 2nd century C.E. He wrote several books formalizing the practice of astrology. Ptolemy also did a lot of astronomy, and he also wrote several books compiling the state of astronomy at that period in time.

Today, astrology is mostly practiced in just the manner that Ptolemy laid it out. But in astronomy, virtually every astronomer utterly ignores Ptolemy. He has next to nothing to say to the modern astronomer. His work is of interest historically, for sure, but his understanding of the world, the details of his observations, are by today's standards very inaccurate and his ideas basically old stuff now proven to be wrong. Gee, might he have been equally as wrong in astrology? Science has gone on, but astrology is still there, encouraging people to look at the same make-believe patterns in the sky, the constellations, and pretend that one can draw meaning from patterns that someone just made up from their imagination.

c. from science and science fiction writer Isaac Asimov³⁰

"We, the rationalists, would seem to be wedded to uncertainty. We know that the conclusions we come to, based, as they must be, on rational evidence, can never be more than tentative. The coming of new evidence, or of the recognition of a hidden fallacy in the old evidence, may quite suddenly overthrow a long-held conclusion. Out it must go, however attached to it one may be.

"That is because we have one certainty, and that rests not with any conclusion, however fundamental it must seem, but in the process whereby such conclusions are reached and, when necessary, changed. It is the scientific process that is certain, the rational view that is sure.

"The fringers (believers in pseudoscience and superstition), however, cling to conclusions with bone-crushing strength. They have no evidence worthy of the name to support those conclusions, and no rational system for forming or changing them. The closest thing they have to a process of reaching conclusions is the acceptance of statements they consider authoritative. Therefore, having come to a belief, particularly a security-building belief, they have no other recourse but to retain it, come what may."

3. (from Bunge³¹) *"The main difference between science and pseudoscience is not so much that the former is true and the latter false, but that pseudoscience does not abide by those principles (of science), as a consequence of which it seldom delivers truth and it never corrects itself."*

"Reason recognizes no authority above itself."

Philosopher Allan Bloom, Closing of the American Mind

- D. Some astronomically related examples & brief personal remarks:
1. **ancient astronauts**—neat idea, but, uh, "Where's the beef?"
 2. **astrology**—there are cosmic influences, but none of those claimed by astrology; besides, tests show it doesn't really work anyway. The key to understanding its popularity lies in human psychology.
 3. **"scientific" creationism**—a wilful misuse of the mind; an oxymoron (alleging a scientific study of a supernatural notion), the misreading of the Bible, particularly one of its oldest books, *Genesis*, as a science text, and never mind the real-world facts learned over the past 2500 years. The trick is to just distort the facts or just don't mention them to their credulous, scientifically illiterate audience who can't/won't see the distortion and whose religious beliefs resonate with this Bible-based "science", (another oxymoron—science is not based upon any book. It's based on reality, its object of study). So, is this science or religion or what? Oh—it's a classic pseudoscience, this one with a resonance with religion. Again from LaFerrière³²:

"The most fundamental problem in the creationist approach is not with the fine points of evolutionary theory that they have chosen as the battleground, but with the dogmatism of their adherence to their beliefs. The theory of special creation is, in the view of the creationists, infallible, since there is no new fact or idea that could possibly be discovered that could refute the theory...Morris (1984) gives credit for the success of the Creation Research Society to its specific doctrinal commitment and constitutional prohibition against compromise."

Reflect on the above. It should be clear to you that what is being described is not at all science. And yet its proponents call it "creation science" and are striving to have this pseudoscience taught as science in our public schools. Their success has been limited, but their struggle continues as they give grief to teachers for teaching evolution, arguably the greatest insight ever.

4. **UFOs**—My favorite. Wish it were true—I mean we need help! But this subject is a prime example of the application of the maxim "Extraordinary claims require extraordinary support." It's got the claims, but not the support. Remember, it's not the *quantity* of the evidence; it's the *quality* of the evidence that counts. Carl Sagan put the UFO phenomenon succinctly in its place when he pointed out, "There are reports of things, but never the things themselves."

And besides, the skeptical side of the scientific attitude gets aroused when I find myself wishing something were true.

VII. The Popularity of Pseudoscience

- A. from **How Superstition Won and Science Lost**, 1987, by John Bumham
1. popular science reporting over the past century has transformed from *"interesting science reporting which fits into a general world view and extend's one's vision"* to *"gee whiz science which excites irrelevant emotion and reinforces one's mysticisms."*
 2. the central role of skepticism has been left out in writing about science
 3. scientists by and large do not enthusiastically embrace the education of the public in science.
 4. the result—*"(by the 1980s) in functional terms, science probably did not exist any longer on the popular level. Superstition did."*
- B. Weakness of television's science coverage is deplorable. When TV Guide once asked Carl Sagan what he thought of TV's science coverage, he responded, *"It's absolutely dismal. A national scandal."* Television's science coverage is probably strongest in medical science, and yet note the following critique by science writer Gary Schwitzer.³³

"Most television medical reporting today doesn't help as much as it confuses, because it provides no context, follows no trends, and fosters unrealistic expectations on the part of the viewing audience.

"Instead of a 'gee whiz' story on laser angioplasty, for instance, television news could present a more balanced report, including the view of some physicians that this new technology has not proven itself in comparison with other approaches...But, for the most part, television news fails to put such questions in context."

- C. And similarly, the publishing industry was criticized for its collective lack of responsible skepticism: by John F. Baker, Editor-in-chief of *Publisher's Weekly*³⁴:

"And so, yes, a publisher should think long and hard before he prints as truth something that may be only entertaining conjecture, before he passes along superstitious nonsense as serious scientific theory...."

*"We're not calling for impossible virtue in a world notably short of it—simply suggesting that publishers should see themselves as important and influential citizens who should behave accordingly in the books they choose to publish. It is not so many years ago that a group of academic editors at Macmillan rose up as one against that house's publication of a highly questionable book called **Worlds in Collision**. They could not in good conscience condone it. Can one imagine a similar action in any (publishing) house today, when books much more foolish and reprehensible are far more common? One can't; and that's a sad thought."*

- D. Examples of pseudoscience permeating our society—and who sees the problem? (Details briefly presented in class)
1. astrology article in EBONY—fluff
 2. cover story on astrology in LIFE magazine—again, fluff
 3. astrology drivel started in TV GUIDE around 1990
 4. Jan '91 *Cosmopolitan*: 71 pages of "Bedside Astrologer"!
 5. *Critic's Choice* videos ad for "science" tapes
 6. poor Proctor & Gambol
 7. Pima College *Aztec Press* started "serious" astrology column in 1996
 8. chain letters sampling
- E. Survey results
1. Astrology belief amongst adolescents aged 13-17 was 40% in 1978, 58% in 1988 (Gallup)
 2. Astrology belief amongst adults has held pretty steady for decades at 25%, 1997 (Gallup)
 3. also in 1988, Gallup results showed a 29% teenage belief in witchcraft, 50% belief in ESP, and 74% in angels
 4. a 1986 University of Texas survey of college students showed 30% believing in the lost continent of Atlantis (as popularly described)

5. 1998 Gallup Poll on UFOs and extraterrestrial life—45% believe in UFOs as visitors from space
 - a. 71% believe US government knows more about UFOs than it has disclosed.
 6. Adult belief in ghosts is 30%; in the devil is 56%, in angels is 72% (1997, Gallup)
- F. Willful rejection by individuals of medical science because of pseudoscientific level of understanding
1. dying actor's wife refused medical treatment for cancer, preferring quack remedies (*People* article – yes, she soon died)
 2. man's dying mother in Phoenix and Psychic Surgery. Son objected to her avoiding medical treatment in favor of wasting (a lot of) money on a Psychic Surgeon who took advantage of her religious beliefs. Son called in police who raided and charged the man with medical fraud. Mother so angry with son for doing this, she refused to speak with him for months. Then she died. (*Unsolved Mysteries*)
 3. Woman, suffering from Lupus Erythematosus, went to faith healer who prescribed a snake meat remedy which killed her (*Eating Well* magazine).
 4. Woman, fearful that her throat problems were cancerous, committed suicide and killed her two children "to be with her in heaven" rather than be uncared for in this life. Autopsy showed she had no cancer in the first place. (newspaper story)
 5. On CNN, hospital took drastic step of removing child from mother for needed chemotherapy to fight cancer. Mom had refused treatment, preferring instead to treat child with herbs (1996)
 6. short essay, questionably titled "The Truth", in an ad for a local Tucson chiropractor: "*And yet you ask, 'Can chiropractic cure appendicitis or the flu?' Have you more faith in a knife or a spoonful of medicine than in the power that animates the living world?'*"

Factoid: 1984 GALLUP SURVEY— _____% view tabloids as accurate. (Percentage given in class.) Think about that for a moment...Do those people vote?...

VIII. **Dangers of Pseudoscience** — The above points exemplify what is generalized below. Note how the themes of personal growth and self-responsibility run through the three points):

A. **The First Danger:** Becoming another sucker to be taken...

As individuals, when we do not avail ourselves of the best scientific information or best rational perspective (fail to apply critical thinking) on some issue of personal importance, we are vulnerable to propaganda and set ourselves up to be taken, bilked by others - of our money, our health, our dignity, and even our lives.

1. Americans are plunging into an "ignorance spiral" in which ever simpler propaganda devices work on an increasingly less informed populace. (social psychologists Pratkanis and Aronson³⁵) **Some examples**--bulk mailings, cults, car salesman, TV evangelists, health quacks, and, last but not least, political campaigns--show how we must sort out conflicting truth claims and may allow ourselves to be taken.
2. The lack of the scientific attitude--openness balanced by a healthy skepticism (Unit V., Sec. F.)--contributes to this problem
 - a. Example: A warning³⁶ for net "surfers" about the advertising dangers on the Internet and World Wide Web: "*It's often difficult to separate the junk from the jewels when online...many quacks truly believe in what they're selling...Online services don't aggressively police the content of their forums...Moreover, scam artists are discovering the World Wide Web..., which has no central authority at all. The lesson? ...A healthy skepticism is probably your greatest online weapon.*" (emphasis added)
 - b. And a relevant perspective by U of A anthropologist David Kenig: ³⁷ "*It's dangerous for an individual to be limited in their knowledge. This leaves the average person at the mercy of his society.*"
3. Magician James ("The Amazing") Randi, who has had a long career debunking charlatans, expressed his outrage over their devastation.³⁸ He was further enraged by a myopic *Washington*

Star editorial which claimed that scientists only waste their time if they choose to deal with pseudoscience:

from the *Washington Star*: "Nothing is funnier than the misapplication of a rigorous discipline to tasks disproportionately trivial. It is overkill. It is classic gnat-killing by sledgehammer. It is the machine-gunning of butterflies...the line between sense and nonsense is not, we think, so stark as these earnest vigilantes of science make it out to be, nor the dangers of mass popular delusion so menacing....What has happened to their funny bones?"

Randi's response: "That writer never saw the distraught faces of parents whose children were caught up in some stupid cult that promises miracles. He never faced a man whose life savings had gone down the drain because a curse had to be lifted. He never held the hand of a woman at a dark séance who expected her loved one to come back to her as promised by a swindler who fed on her belief in nonsense. 'Nothing is funnier...?' Tell that to the academics who lost their credibility by accepting the nonsense about telepathy that came out of the Stanford Research Institute. 'The machine-gunning of butterflies'? Explain that to those who spent their time and money trying to float in the air because a guru said they could. Are the 'dangers of mass popular delusion' not 'so menacing'? Mister, go dig up one of the 950 corpses of those who died in Guyana and shout in its face that Reverend Jim Jones was not dangerous. 'What has happened to their funny bones?' That deserves an answer. Our collective sense of humor has been dulled by the grief, frustration, and anger that comes of preaching in the wilderness. The Star, apparently, would like that wilderness to continue to be empty of rational forces. I hope they enjoyed their big laugh."

4. Cults: Religious and political cults are based upon the strict limiting of their members' thinking. Their societal influence has grown in recent decades. Consider the following insights:

"The most important work to be done in this area (parapsychology) is to expose the fallacies. This is not a game. A lot of people are putting around misleading ideas, and others are being conned financially and intellectually."

Dr. Nicholas Humphrey, British psychologist and producer of a television documentary, "Is there anybody there?"

"Cults, virtually without exception, are virulently anti-intellectual, and they emphasize blind acceptance of their teachings as a cardinal virtue. Doubt and questioning--in other words, critical thought--are considered sinful and dangerous, and in many cults members are told that their doubts come directly from the devil. A Moonie slogan expresses this cult position quite succinctly: "Stamp Out Doubt."

"This is done through thought-stopping techniques, especially the use of hypnotic (repetitious) praying and chanting..."—Chaz Bufé³⁹

"For those of us who have been in cults, these events (mass suicide of Heaven's Gate cult and militia cultist Timothy McVeigh's bombing of the federal building in Oklahoma city) hold a particular significance. No matter their differing beliefs, all cults share with Heaven's Gate one important factor: a rabid contempt for skepticism. To doubt is to have weak faith. To question out loud is to admit defeat."

"Cults will continue to be a problem until skepticism becomes a family value and critical thinking skills are treasured as much as a positive mental attitude."—Charles McAlpin⁴⁰

Moral of the First Danger: "Question authority!"

- B. **The Second Danger:** Pseudoscience hinders personal growth from the Child to the Rational Adult.

Remember...

"Science is a way of trying not to fool yourself."

physicist Richard Feynman

1. Discourages critical thinking. Remember that pseudoscience claims are based upon appearances. It's simpler. Trying to get to the reality or truth of things is hard work, requiring critical thinking, the same suite of habits of mind necessary for personal growth. But pseudoscientific notions are more straightforward and foster acceptance of simple, magical, authority-based ideas. By not encouraging us to do the hard work of questioning and learning, we seek our answers from authority sources of various sorts. An over-dependency on authority figures will foster a mindset in which we comfortably place the responsibility for our lives on something or someone else outside of ourselves. The independent-minded critical thinker is Captain of his/her own ship, as it were. The relevant phrase from psychology you may have learned is "external locus of control". The self-actualized individual has an "internal locus of control."
 - a. This ties in with the cults aspect of the First Danger of pseudoscience. Seekers of outside authority to validate lives, behavior and thought are especially vulnerable to propaganda as referred to in the book Combating Cult Mind Control (referred to just above). Mind control is the defining characteristic of cults. "*mind control is used to change a person's belief system without informed consent and make him dependent on outside authority figures*"
 - b. external locus of control thinking is exemplified by the line, usually said for humorous purpose, "*The devil made me do it!*" Astrology provides an excellent example of this by its reference to planet positions relative to some constellation to explain your feelings or your situation--You yelled at your friend because Mars is in Libra and you're a Pisces--or this actual statement by an astrology-believing friend of mine who described a recent period of trial and uncertainty: "*I don't have any Earth signs in my chart and being Aquarian with Libra rising - I was sort of flitting around above the earth plane.*"⁴¹ There may well be metaphorical value in this sort of statement, but any real insight into physical, objective, reality is just not there.
2. Fosters anti-intellectual attitudes. People accepting of pseudoscientific claims do so at the loss of our best scientific understanding. They develop their own unscientific understanding of life and reality. "Works for them." The lack of intellectual curiosity for the truth and the lack of critical thinking skills results in a satisfactory situation, philosophically, for them. The person who accepts pseudoscience notions then resists information that refutes their current understanding. (See the "mental block"--See Unit X. D. for reasons discussed above and the reason below. This anti-intellectual attitude will shut off individuals from established understanding that could help them deal more directly and effectively with the real problems of life that confront them.
3. Inordinately fosters the Child within us. The primary emotional impetus towards accepting claims and beliefs based on pseudoscience is to satisfy some emotional need or respond to our fears and insecurities. These beliefs/claims comfort the individual by fostering a personal "wall of illusion" to protect the fearful, insecure, helpless "Child" to be found within us all from the negative, hurtful, and impersonal aspects of existence. The challenge is, not to denigrate or dissociate ourselves from that Child (and its related positive emotions) within us, but to grow to balance it with a rational, self-responsible "Adult". For more on the terms Parent, Child, Adult and Transactional Analysis, see references.^{42 43})

And so:

A scientific claim is not to be accepted because some authority figure (like me) tells you to, or because there is some emotional, spiritual, or religious payoff for you. Your personal reaction to such a claim is irrelevant to the claim's degree of objective truth. No, you are to accept this claim because the claim makes sense. You understand the logic, reason, and evidence on which it rests. Moreover, you understand the process by which the claim has come to be validated, in other words, you understand science.

- C. **The Third Danger: Societal ramifications.** If such acceptance of pseudoscience as described in preceding sections is sufficiently widespread, whole societies will similarly suffer. Are you aware of societal or global problems that some do not want to deal with? Let's run through this once more. In pseudoscientific thinking there is a satisfaction of some emotional need, and a mental laziness in which the individual settles for accepting the apparent, the immediately perceived, the superficial. The underlying reality is not dealt with. Attempts to get beyond that level of understanding, can even be met with resistance by people who have settled for that level of understanding. Write large, how effectively do you think a society soaked in

Magic is science—nothing else. Young people can be easily deceived when they think they are seeing something supernatural. I want them to know that things aren't always what they seem. I want to help them find real meaning in their lives.

Tucson magician Adrian Van Vactor, Tucson Citizen, 5/19/95

pseudoscience can deal with its problems? What would happen to the notion of progress. (Progress involves actually doing something about problems; proposing ideas; the notion of change, which many fear and will resist.)

1. Stanford mathematician John Allen Paulos expressed the societal danger from the mathematical ignorance–pseudoscience connection (Unit IX., Section D.)⁴⁴:

"In a society where genetic engineering, laser technology, and microchip circuits are daily adding to our understanding of the world, it's especially sad that a significant portion of our adult population still believes in Tarot cards, channeling mediums, and crystal power.

"Even more ominous is the gap between scientists' assessments of various risks and the popular perceptions of those risks, a gap that threatens eventually to lead either to unfounded and crippling anxieties or to impossible and economically paralyzing demands for risk-free guarantees. Politicians are seldom a help in this regard since they deal with public opinion and are therefore loath to clarify the likely hazards and trade-offs associated with almost any policy."

2. There are legal ramifications as well.
 - a. When criminals attempt to defend themselves by appeal to pseudoscientific rationalizations
 - (1) in Tucson, a murderer of two women based his defense on his assertion that he was told to do it by space aliens
 - (2) any defense that appeals to astrological or health quackery excuses for some antisocial behavior
 - b. When pseudoscientists and their organizations sue science-based organizations for making public, scientifically based, responses to the claims of the pseudoscientists
 - (1) "Psychic" Uri Geller and his suits against Magician James Randi and The Committee for the Scientific Investigations of Claims of the Paranormal
 - c. When pseudoscientific proponents attempt to use legal means to *replace* science with their pseudoscience
 - (1) The widespread attempts during the 20th century in America by "scientific" creationists to use the legal system to get their pseudoscience taught as science. Legitimate scientifically derived ideas do not need the power of the courts to be taught in science classes.
 - (2) The creationists lost in courts, not so much because of the scientific baselessness of their ideas, but because the courts recognized their true basis in religious beliefs, and therefore, not promotable in public-funded schools as science. Some sectarian schools are another matter, however...
3. Preferring ideas that feel good, we organize to resist their scientific testing. Psychologist Carol Tavris, co-author of the article and textbook cited in the Critical Thinking (Unit V.), reflected on the costs of pseudoscience in this regard⁴⁵:

"So we have our work cut out for us in trying to educate the public to resist the lures of antiscientism. We need to reassure the public that good science, good information, is not their enemy:

information is always liberating if we use it right...Pseudoscience concocts worthless, costly, or fraudulent therapies and treatments, such as Facilitated Communication; good science is telling us what treatments work—and which do not. Pseudoscience costs us millions of dollars in worthless social programs, such as “DARE” (which has no effect at all on children’s subsequent drug use or in preventing abuse)...good science helps us create, test, and assess programs that work.

“If we fail to consider the many diverse reasons that people cling to unsubstantiated beliefs, are reluctant to change their minds when faced with disconfirming evidence, or prefer to “go along with the crowd” rather than think for themselves, we will not advance our goal—improving the quality of science, the quality of thinking, and the quality of our lives.”

Summing up: the following by David S. Saxon, Honorary Chairman of the Massachusetts Institute of Technology, and President, Emeritus, of the University of California⁴⁶

“It is beyond argument that our most generously educated citizens, our college graduates, are grossly undereducated when it comes to science and technology, even ‘ignorant’--to use Leon Lederman’s characterization. But there is no consensus at all when it comes to what to do about it...”

With regard to what our goals should be, perhaps we can all accept something along the following lines: Our goal is to assure that our citizens know enough about science

- *so that they can tell the difference between science and pseudoscience.*
- *so that they can distinguish the possible from the impossible, the probable from the improbable.*
- *so they can understand both the powers and the limits of science and technology.*
- *so they are not at the mercy of experts--or worse, of charlatans posing as experts.*
- *so they can be participants, not victims, in our increasingly and irreversible technological society.”*

IX. **Non-psychological** Reasons for the Acceptance of Pseudoscience and Paranormal Claims (for critiques of some particular pseudosciences, see the Magazine Article List)

A. *“Post hoc, ergo propter hoc”* fallacy (a.k.a. “False Cause” fallacy)–

1. Literally translated means “after this, therefore because of this.” Suppose you observe two consecutive events, first event “A”, then event “B.” If you assume that “B” was caused by “A,” congratulations, you just thought fallaciously.
2. Just because event “B” follows event “A”, does not logically imply that B was necessarily caused by A. It could have been, BUT a demonstrated connection (cause-effect) between the two events must be understood (In other words, you’ve got to have an hypothesis, or better, a theory.), before one is logically allowed to claim a connection. In other words, you gotta actually KNOW what you’re talking about.
3. This form of fallacy is more common than you might think—it is the defining fundamental to superstitious beliefs. example from James Randi⁴⁷: Visiting a man’s house in Mexico, the man pointed out a talisman on his mantle whose purpose was to ward away bears from the house. He had had no bears in the house, so concluded the talisman works.” But what’s the cause-effect connection? A major example of this fallacy: astrology—Pluto is in Libra, and because I am a Leo, I may be tempted during this time to do an antisocial act. But what is the cause-effect connection between Pluto and my attitudes?

“It is common error to infer that things which are consecutive in order of time have necessarily the relation of cause and effect.”

Jacob Bigelow (1786-1879)

- B. Ignorance of philosophy and science—unfamiliarity with scholarship
1. A mind untrained in scholarship (Unit V.) is one willing to settle for simple, sometimes magical or supernatural, answers to complex issues ("black/white" thinking) or unusual experiences
 - a. *"For every complex problem, there is an answer that is simple, plausible--and wrong!"* (Social pundit H.L. Menken; also science fiction writer Ben Bova)
 2. Ignorance of science and philosophy allow the acceptance of beliefs and claims that run counter to logic and nature's laws. If an individual doesn't know the relevant logic and natural law, then how concerned will they be over the discordancy?
- C. Misinformation about supernatural claims and notions spread by
1. The entertainment and communications media
 - a. Unusual things (ideas or occurrences) naturally catch our attention. The media thrive on the unusual.
 2. proponents themselves
 3. parents
 - a. As soon as we can communicate, we are raised to believe in the supernatural and supernatural beings, calling them, astutely, "make-believe" (e.g. witches, elves, trolls, Santa Claus, Easter Bunny, fairies, devils, angels and on and on).
 - b. It can sometimes take considerable emotional as well as intellectual effort to grow out of this background, depending upon later upbringing and events, degree of acculturation (how effected by popular culture one is), and quality and duration of education.
- D. Innumeracy — Mathematical incapacity
1. The widespread failure to comprehend the probabilities of coincidence or to appropriately recognize patterns in data, leads to the personalizing of events ("Why has this happened to me?") and reading meaning out of random, meaningless occurrences.
 - a. We ask why bad things happen to me. But why not to me? We experience much in our life. Logically, our reactions to these experiences are either like, dislike, or indifference.
 - b. Personal attitudes are important, but bad experiences are going to happen, like it or not.
 2. again from John Allen Paulos⁴⁸:

"(Innumeracy leads to) an exaggerated appreciation for meaningless coincidence (and) a credulous acceptance of pseudosciences..."

"One contention of this book is that innumerate people characteristically have a strong tendency to personalize - to be misled by their own experiences, or by the media's focus on individuals and drama."

3. There are more coincidences in our lives than you may think. Most coincidences we experience go unnoticed because of their lack of personal import. Those are the ones we are indifferent to. Indeed, we probably won't even notice them. So, lacking in awareness of the commonality of coincidences, when we experience a coincidence that happens to have some personal, that is positive or negative, effect on us, then we take notice and exaggerate in our minds the fact of its occurrence, thinking that such a coincidence is just **too** unlikely to happen and we **leap** to conclude that there was some supernatural or fatalistic intervention. Such an effect happened to one Luis Alvarez. But this gentleman was one with a strong background in physics and mathematics. Read below about his personal coincidence and how differently he dealt with it.⁴⁹

Luis Alvarez had a paranormal personal experience while reading the newspaper one evening. A news story got him to thinking of a band leader back in his college days of whom he probably had not thought for 30 years. Just a few minutes later, his attention was directed to an obituary item on the very same man! Amazing or what!? This is a rather typical paranormal account, one that is impressive to the person having the experience, often affecting his or her belief system. But not in this case. Dr. Alvarez (now deceased) held a Ph.D. in Physics and more than that, was a winner of the Nobel Prize in Physics! He is known outside of science, not for the Nobel Prize, but for reviving the comet impact theory for the extinction of the dinosaurs.

Dr. Alvarez was indeed impressed, but his response was to make some rough estimates and calculate the

odds that such a pair of occurrences--remembering a person, then reading of his death--might actually occur. He calculated that, as one would expect, the odds are low for such a pair of events to occur for a given individual, 3×10^{-5} @ year. So, still amazing, right? But this is not the proper perspective. The proper perspective on this is to ask, what are the odds of this happening at all? In other words, we must take into account our sample size, which, as natural as it may seem, is not one (Luis Alvarez). It is the population of the country, or the globe, if you prefer. We must multiply the above probability for one individual by the number of individuals in, say, our country (where we are more likely to read about it in supermarket tabloids). There were at the time of his experience (1965) about 2.5×10^8 people living in the United States. Multiplying the two factors together leads to a probability of this pair of events occurring 6×10^3 times a year, or about 20 a day!

I have described Dr. Alvarez's experience in some detail, because it exemplifies a very important point. Our natural tendency is to focus on what happens to an individual (Watch/read the news.), without placing that individual's experience in a broader perspective that appropriately includes statistical factors, notably sample size or time. And a part of this understanding is the next point.

4. More on coincidence. Even a most unlikely event that may happen to a particular individual is, given enough time and/or sample size, actually likely to occur. Plutarch, so long ago, put this thought well: *"It is no great wonder if, in the long process of time, while fortune takes her course hither and thither, numerous coincidences should spontaneously occur."* More on this from **Innumeracy** to make clear the point⁵⁰:

"A tendency to drastically underestimate the frequency of coincidences is a prime characteristic of innumerates, who generally accord great significance to correspondences of all sorts while attributing too little significance to quite conclusive but less flashy statistical evidence. If they anticipate someone else's thought, or have a dream that seems to come true, or read that, say, President Kennedy's secretary was named Lincoln while President Lincoln's secretary was named Kennedy, this is considered proof of some wondrous but mysterious harmony that somehow holds in their personal universe. Few experiences are more dispiriting to me than meeting someone who seems intelligent and open to the world but who immediately inquires about my zodiac sign and then begins to note characteristics of my personality consistent with that sign (whatever sign I give them)." (emphasis added--try this simple trick yourself)

"The surprising likelihood of coincidence is illustrated by the following well-known result in probability. Since a year has 366 days (if you count February 29), there would have to be 367 people gathered together in order for us to be absolutely (emphasis added) certain that at least two people in the group have the same birthday. Why?

"Now, what if we were content to be just 50% certain of this? How many people would there have to be in a group in order for the probability to be half that at least two people in it have the same birthday? An initial guess might be 183, about half of 365. The surprising answer is that there need be only 23. Stated differently, fully half of the time that twenty-three randomly selected people are gathered together, two or more of them will share a birthday." (Instructor note: the proof of this is in Paulos's book, within this excerpt.)

"A couple of years ago, someone on the Johnny Carson show was trying to explain this. Johnny Carson didn't believe it, noted that there were about 120 people in the studio audience, and asked how many of them shared his birthday of, say, March 19. No one did, and the guest, who wasn't a mathematician, said something incomprehensible in his defense. What he should have said is that it takes twenty-three people to be 50% certain that there is some birthday in common, not any particular birthday such as March 19. It requires a large number of people, 253 to be exact, to be 50% certain that someone in the group has March 19 as his or her birthday.

"...The paradoxical conclusion is that it would be very unlikely for unlikely events not (emphasis added) to occur." (Instructor addition: So Carson, to properly test this statistical claim, should then have asked each person in the room their birthday and have any of the rest speak up if their birthday was coincident with that of the person asked. You can surely now see how, with about 120 people in the room, that the odds actually would be considerably greater than 50-50 that two people shared the same birthday.)

5. Reflection: Peoples' inability to appropriately estimate the expectation of coincidence (we tend to

underestimate), leads us to read meaning, usually implying some vague supernatural influence, into coincidental occurrences, especially when the occurrence holds some personal import for us. We lack the tools of probability and statistics needed to complete our understanding of the world. Why are probabilities and statistics not taught in our high schools? Their uses are daily... How often do we need something we learned in Algebra II?

X. Psychological Reasons for Acceptance of Pseudoscience and Paranormal Claims

- A. Confusion over "subjective reality vs. objective reality"—the personal experience, illusion, and honest misperception
1. Physical reality is one thing; our perception of it can be quite another. Perception is our conscious awareness of physical reality. It involves sensory stimuli processed by our brain.
 2. The perception process is influenced by the physical limitations of our sensory organs, our understandings, our *a priori* beliefs, our emotions, even what is "on our minds" while perceiving. You have heard that science, properly done, is objective. It does this partly by using instruments to perceive reality in an objective manner without the subjective aspects of human perception.
 3. Illusions of Connections--making unwarranted connections
 4. Illusions of Pattern and Form--We are pattern recognition machines.
 - a. constellations (imagined patterns in the random distribution of stars)
 - b. imagined faces seen in natural formations
 5. Psychic experiences are the inevitable consequence of the way we think, suggests British Parapsychologist Susan Blackmore⁵¹. They are comparable to visual illusions. The experience is real enough, but its origin lies in the internal perceptive process, not from bizarre breakings of natural law. Though our perceptive process usually serves us well, that process can, as with visual illusions, give us the wrong "answer." As with the mathematician Paulos, she also points out how people will downplay coincidence and treat chance events as connected and seek for explanations, where none are really required. Making unwarranted connections is described above in terms of logic by the "*post hoc*" fallacy described above
 6. "The rub" here is that as questionable and unreliable as personal experiences can be, they nevertheless are "real" to the individual who has them, making the witness resistant to scientific input and reasonable alternative explanations. Some personal anecdotes:
 - a. Had I not observed my UFO in Pittsburgh long enough for it to come close by, I might well have been skeptical of any investigator telling me all I saw was an advertising plane.
 - b. An uncomfortable argument resulted when a philosopher friend of mine attempted to inform his brother-in-law of the reasons why water dowsing is a typical, baseless pseudoscience, after his brother-in-law had had a positive personal experience with it. Rather than appreciate the valuable insight to his experience, the brother-in-law was quite offended!
 - c. Recall Kathie Lee Gifford's rejection of Carl Sagan's factually correct remarks, pointing out that regardless of established scientific fact, a person may reject that if they have had a "personal experience with God." Not made clear is why the two perspectives would ever differ. (See unit VI. C. 5., "Avoid emotional reasoning.")
- B. Memory selection effect--noticing and remembering the hits/winners and forgetting or ignoring the misses/losers. This effect is a major reason pseudoscientific and superstitious beliefs arise and spread. A psychic can make one good prediction and his fame spreads. His missed predictions, which could number 50 to 100 typically, are not noticed. Or a person reads her sun-sign horoscope in the paper one day and finds a suggestion she finds helpful and relevant. Her interest is piqued and she more assiduously reads her horoscope from then on, never mind that the previous several weeks of horoscopes didn't do much for her. From **Innumeracy**:

"There is a strong general tendency to filter out the bad and the failed and to focus on the good and the successful. Casinos encourage this tendency by making sure that every quarter that's won in a slot machine causes lights to blink and makes its own little tinkle in the metal tray. Seeing all the lights and

hearing all the tinkles, it's not hard to get the impression that everyone's winning. Losses or failures are silent. The same applies to well-publicized stock-market killings vs. relatively invisible stock-market ruinations, and to the faith healer who takes credit for any accidental improvement but will deny responsibility if, for example, he ministers to a blind man who then becomes lame. This filtering phenomenon is widespread..."

C. Cold Reading—The art of impressing a person just met, by telling him apparently insightful things about him, by alleged occult, paranormal means. This technique describes the practice of astrologers, psychics, tarot card readers, and the like.

1. The interplay between reader and client can be something quite different from what they actually think. That is, there are psychological factors involved in a reader-client transaction that neither may know about. Neither most likely have any particular formal education in psychology. In regard to psychic readings of a variety of kinds, some "rules"⁵²:
 - a. Get the client to cooperate. Tell them little things to do and get them to feel at ease.
 - b. Use commonplace information, for example mention a scar on their left knee. If not there exactly, it's probably somewhere.
 - c. Use flattery. We are receptive to 90% of positive statements told us and rejective of 90% of negative statements. (Percentages not intended to be precise.)
 - d. If you are reading palms, note when the client's hand gives a little pull away or push towards you, depending upon whether they like or agree with what you are saying. (Push means like/agree.)
 - e. Pretend to know more than you do. NEVER be surprised by what the client says.
 - f. Not stated by Hyman, but related to his point "c" above, is to simply tell the person what they want to hear

2. A further key insight into cold reading⁵³

"One danger of playing the role of reader is that you will persuade yourself that you really are divining true character. This happened to me. I started reading palms when I was in my teens as a way to supplement my income from doing magic and mental shows. When I started I did not believe in palmistry. But I knew that to 'sell' it I had to act as if I did. After a few years I became a firm believer in palmistry. One day the late Dr. Stanley Jaks, who was a professional mentalist and a man I respected, tactfully suggested that it would make an interesting experiment if I deliberately gave readings opposite to what the lines indicated. I tried this out with a few clients. To my surprise and horror my readings were just as successful as ever. (emphasis added) Ever since then I have been interested in the powerful forces that convince us, reader and client alike, that something is so when it really isn't."

3. Want to know more of those relevant psychological aspects of cold reading I alluded to above? See my write up on Cold Reading at the Library Reserve desk for "focussing", "stock spiels", and the "fallacy of personal validation". These are some of the psychological aspects that contribute to the common impression (illusion, I should say) that psychics, tarot card readers, astrologers and the like, are tapping into something paranormal/supernatural.

D. The Mental block. When processing information relevant to their beliefs, believers will tend to filter out contrary information and accept only the supportive. Skeptics will tend to respond reasonably to new information, whether supportive or refutive of their beliefs/understanding⁵⁴

1. Astrology—test of believers & skeptics demonstrates difference in processing information between skeptics and believers
2. Evolution—some don't want to know about, or even anyone else to know about it

"People believe what they prefer to be true."

Francis Bacon, ca. 1600 C.E.

- E. Satisfaction of emotional need. This grows in importance when we feel fear and/or insecurity. UNCERTAIN situations will exacerbate both feelings; at these times we are especially open to any offer of advice or assistance. This is when we are most vulnerable to accepting poorly based notions that may relate to pseudoscience and superstition. But at these times, we must protect the Child within us.
1. Isaac Asimov⁵⁵: *"Inspect every piece of pseudoscience and you will find a security blanket, a thumb to suck, a skirt to hold. What have we (rationalists) to offer in exchange? Uncertainty! Insecurity!...the more 'certain' a fringer is, the more angry he seems to get at any expression of an opposing view."*
 2. The more uncertainty, the stronger the desire to believe in anything that purports to help us get through.
 - a. example: Baseball players have little superstitious routines and beliefs that they think, or at least, hope, help them with their batting. But you may not have noticed the lack of such beliefs and practices in regard to the fielding aspect of the sport. Here's why. The probability of success in fielding is typically very high—0.9 or more. But batting? Batting averages (in other words, their probability of success) typically fall only in the 0.2 to 0.35 range, a far more uncertain situation.
 - b. example: An item as uninspiring as a rubber band may nevertheless, be the object of desperate need, as exemplified in a moving scene in the movie, "The Memphis Belle" in which one crew member in dire straits is courageously given another's "lucky" rubber band. The band was thought to be lucky, because a crewman had worn it each time they flew a mission over Nazi Germany—a frightening situation fraught with great danger.
- F. The Placebo Effect
1. a recent study reinforces previous work that demonstrated that people's health can improve as much as 70% of the time even when they receive dummy treatments! The key to this high of a success rate (higher than the previously thought 33%) is to not only have the patient believe in the treatment, but also the healer as well. Other factors include patients' suggestibility, their history of success or failure during other treatments, and the place a patient is treated.
 2. The placebo effect is surely a major factor to consider when pondering the merits of not only legitimate medical cure claims, but also claims involving faith healers and New Age healing methods. In fact, the key distinction between legitimate medical science treatment and alternative forms of healing is that medical science treatments have been scientifically tested for efficacy beyond the placebo effect and alternative (Read "unscientific.") treatments have not. These alternative forms are testable, however, and over time, some may yet be scientifically proven successful. Until their testing, however, medical science's attitude tends to be skeptical, not only because of a lack of such testing, but also because some popular alternative forms of healing have been tested and failed. Further their underlying assumptions may not be consistent with established medical science understanding.

XI. Testing of Psychic Claims

- A. How does one go about testing a collection of claims that willfully do not have an explanation (hypothesis or theory) to test, or have one, but testing of it is resisted? Well, we can critically examine the alleged effects in the physical world. This mixed bag of claims has historically been referred to as the occult, which means "hidden", did you know? And what's hidden? Any real sense or understanding as to cause and effect. The occult is one big "Post Hoc" fallacy! As soon a claim is investigated and explained (away), it is no longer "hidden" and the occult continues with its other claims and new ones. Even an explained claim can continue in the public's mind as unexplained, for reasons of wishful thinking and ignorance of the relevant studies and alternative naturalistic explanations. For example, "channelling" may seem "New Age" to some, but it's just a new word for an old superstitious practice involving "mediums" called spiritualism. Spiritualism fell out of popularity around the 1920s after so many spiritualist mediums had been exposed by skeptics as frauds. Decades later, with new uninformed generations as ready and willing to believe as previous ones, we have an old product repackaged with a

new label. As the great motivation for learning history says, if we don't learn from history, we are condemned to repeat it. Today, we can ensure that we don't fall for pseudoscience and superstition, because we have the wisdom and perspective of history, science, and psychology. But will we? Astronomer Carl Sagan, in one of his last books,⁵⁶ in which he described science as a candle in the darkness of ignorance, expressed his growing concern for our society's future:

"I worry that, especially as the Millennium edges nearer, pseudoscience and superstition will seem year by year more tempting, the siren song of unreason more sonorous and attractive. Where have we heard it before? Whenever our ethnic or national prejudices are aroused, in times of scarcity, during challenges to national self-esteem or nerve, when we agonize about our diminished cosmic place and purpose, or when fanaticism is bubbling up around us—the n, habits of thought familiar from ages past reach for the controls. The candle flame gutters. Its little pool of light trembles. Darkness gathers. The demons begin to stir."

- B. The Challenge of the Casino. Our selective memory ignores a telling fact regarding Casinos. This deals particularly with the popular belief in "PK" (mental effort moving matter). The success of casinos contradicts that notion. The probabilities of winning are predictable from statistical theory. The way gambling games are set up, the odds overall are in favor of the "house." (Is this news?) Yet minute by minute, countless people are summoning all their mind's power (and psychics agree in saying we all have psychic abilities to varying extent) to effect the outcome of these games in their favor. So why don't customers overwhelm Casinos with their alleged "psychic abilities?"

The success of casinos are a practical, continuing and decisive real-world demonstration that psychic powers, at least PK and telepathy (reading another person's mind, e.g. the Blackjack dealer's) do not exist. Yet belief in these alleged powers is widespread. Think about it.

- C. When one is unfamiliar with science, fails to appreciate fully its power, then one can think science's claims and judgements can be dismissed as just those of another belief system, and scientists as being closed minded. Lacking in appreciation of the meaning of the word "scholarship", many think all opinions are equal. Well, they are *only equal in a legal sense*. Ideas are certainly not inherently equal in terms of their validity (or human value, if relevant). Legally, one may hold and express the most fallacious or dangerous notions. We must learn to use and be willing to use our critical faculties to evaluate ideas and claims to Truth. This is in fact a related aspect to one of the goals of this course.
- D. There are hundreds (thousands?) of competently designed experimental tests and surveys regarding the psychology and perception of para normal/supernatural claims, but only extremely rarely do have they yielded curious results. The story is not yet over for them¹. I exclude innumerable flawed tests with alleged positive results obtained by questionable means by people of questionable qualifications and motivation. I will not present a survey of these studies considering our time available. However, you may obtain a brief familiarization with the current state of affairs in parapsychology, in which current testing is based upon the *ganzfeld* approach⁵⁷. I do show in lab classes some tests on video, produced by the skeptical magician James ("The Amazing") Randi (<http://randi.org/>), who provided a live television challenge⁵⁸ to people who believed they had paranormal abilities. He has also investigated some faith healers (finding all studied to be using chicanery—read The Faith Healers by J. Randi, Prometheus Press). His dramatic exposure of television evangelist/faith healer Peter Popoff caught national attention. A rich source of investigations into paranormal claims is *The Skeptical Inquirer*, available in our library. Visit Randi's fun and fascinating Web site, The James Randi Education Foundation at the URL given just above. I also offer many good references to such studies in the Magazine Article List handout, given you at the start of the course. Several excellent papers I especially

¹Since a previous edition (June 1996) of these notes, one, the so-called "Mars Effect", has been convincingly demonstrated to be due to a subtle data selection effect on the part of the statistician who came up with the claim.

wish to point out:

"The Elusive Open Mind: Ten Years of Negative Research in Parapsychology", Blackmore, *The Skeptical Inquirer*, Spring 1987, pp. 244-255.

"A Consumer Guide to Pseudoscience", Trefil, *Saturday Review: "Currents"*, April 29, 1978, pp. 16-21. (10 pts.)

"Occult Beliefs", Singer & Benassi, *American Scientist*, Volume 69, January-February 1981, pp. 49-55. (12 pts.)

"Fooling Some of the People All of the Time", Singer & Benassi, *The Skeptical Inquirer*, Winter 1980-81, pp. 17-24. (9 pts.)

List of Recommended Books

For future related reading, here are some of the highly readable, excellent, enlightening books that have stuck out in my mind. Come back to this list sometime for a challenge. Your view of the world may change and grow...

SCIENCE, PHILOSOPHY, RELIGION

- Cosmos** by Carl Sagan a sweeping tour and long-time best seller of both the universe and the scientific enterprise
- Origins** by Robert Shapiro an engaging, insightful look, accenting healthy scientific skepticism, at many ideas, scientific and otherwise, about the origin of life. Very well done!
- Finding Darwin's God** by Kenneth Miller Read this fascinating and enlightening presentation of evolution, scientific creationism, intelligent design, and God by a noted scientist who is also an avowed Christian. Excellent!
- Ancient Myths and Modern Life** by Gerald LaRue a theologian's look at the contemporary influence on western culture of ancient myths from the middle east

PSYCHOLOGICAL ASPECTS OF DEALING WITH REALITY AND PEOPLE RATIONALLY

- If You Meet the Buddha on the Road, Kill Him!** by Sheldon Kopp
- An End to Innocence: Facing Life Without Illusions** “ ” “ These two books by Kopp can be unsettling to some. This is “X-rated” stuff, psychologically speaking. Are you really ready to “get real?” That warning having been made, these two books by Kopp are two of the wisest books I've ever read. I suggest you read them in the order listed, and maybe more than once. They are rich with lessons of life.
- I'm OK, You're OK** by Thomas Harrisan Insightful classic, useful in understanding the psychology behind human communication. Offers coincidental insight of both the True Believer and the True Unbeliever, and why it is so difficult for the two to communicate.

CRITICAL ANALYSES WITH BREADTH AND INSIGHT OF PSEUDOSCIENCE

- Innumeracy** by John Allen Paulos for all those who have asked why they need to study math—actually very interesting!
- Flim Flam** by James Randi a magician's skills plus a healthy dose of skepticism means less bunk in the world
- Is God a Creationist?** The Religious Case Against Creationism edited by Roland Frye Intelligent essays by authors of differing religious persuasions.

And if you read only one of these books, here it is

THE DEMON-HAUNTED WORLD: Science as a Candle in the Dark by Carl Sagan

His last book published while he was alive—and greatest (1996). A must-read for anyone interested in knowing the world and human fallibility. Sagan is best known for his great publicizing of science, particular astronomy. But in his later years his concern grew over the growing influence of pseudo-scientific and ideological thinking. In this book he makes clear, that in spite of our scientific and technological achievement, the potential for a return to a “Dark Age” remains and grows. He insightfully explores UFO abductee reports to bring out startling and broad implications. A sweeping, absorbing, and most enlightening book. See me, if you think you might want to read this book this semester. I will give you guidelines to do a book report. Any credit you earn thereby will be awarded as Outside Event Credit.

Claims of which I am aware that have/had curious results:

- 1) Mars Effect in Astrology, since clarified
- 2) Schmidt's random number generator work
- 3) Ganzfeld experiments, done by the friend of Susan Blackmore who died, involving 1) white light, and 2) noise of static
- 4) water dowsing—almost, by Betz. But see SN article, August, '95: "Dowsing Expectations"
- 5) In 1999, article in SN, referenced in final paragraph, states that *ganzfeld* experiments are the way to go now in parapsychology

1. start of essay on the meaning of life, "To Be a Person" (*The Humanist* magazine, Jan/Feb 1985, p. 20)
2. column "Students feel, but apparently don't think", *AZ Daily Star*, May 3, 1988
3. *Newsweek*, October 26, 1992, p. 58.
4. **Dumbth**, Steve Allen, Prometheus Books, 1989, p. 14
5. **Cultural Literacy: What Every American Needs to Know**, E.D. Hirsch, Jr., Houghton Mifflin, p. xiii.
6. "Why we need to understand science", *Parade Magazine*, September 10, 1989, p. 6
7. "Web endangers scientific surveys, pollsters say," *Arizona Daily Star*, May 15, 1999.
8. at his reception of the 1990 *In Praise of Reason* Award by CSICOP (Committee for the Scientific Investigation of Claims of the Paranormal)
9. at his reception of the first Annenberg Foundation Award, 1993, for his efforts in astronomical education
10. *US News & World Report*, December 23, 1991
11. *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, U.S. Department of Education, Gov't. Printing Office, 1998, or the web site: <http://nces.ed.gov/TIMSS/>
12. Joseph E. Leferrière, "Certainty and Proof in Creationist Thought," *Skeptical Inquirer*, Winter 1989, Vol. 13, pp. 185-188
13. **Genius: The Life and Science of Richard Feynman**, James Gleick, Simon and Schuster, 1992
14. **In Defense of Secular Humanism**, Paul Kurtz, Chapter titled "The Scientific Attitude versus Antiscience and Pseudoscience," p. 244
15. *Ibid*
16. **ORIGINS**, Robert Shapiro, Bantam, 1986
17. column "Students feel, but apparently don't think", *AZ Daily Star*, May 3, 1988
18. "The Scientist's Skepticism" in *Skeptical Inquirer*, Summer 1992, pp. 377-380. See the Magazine Article List
19. Dr. Nicholas Humphrey, "Is There Anybody There?" documentary on paranormal claims, aired on PBS
20. **Ancient Myth and Modern Life**, Gerald LaRue, Centerline Press, Long Beach, CA, 1988

21. Kornberg, A., editorial in *Science*, August 14, 1992
22. "Thinking Critically and Creatively", by Carole Wade and Carol Tavris, *Skeptical Inquirer*, Summer 1990, pp. 372-377
23. September 18, 1992 Regis Philbin television talk show
24. The Skeptic's Dictionary Web site at <http://skepdic.com/>
25. "Time to Look and Listen", "My Turn" column, Magdoline Asfahani, *Newsweek*, December 2, 1996, p. 18
26. from the conclusion of **Ancient Myth and Modern Life**, Gerald LaRue, Centerline Press, Long Beach, CA, 1988
27. "Certainty and Proof in Creationist Thought", Leferriere, *The Skeptical Inquirer*, Winter 1989, pp. 185-187. See the Magazine Article List.
29. **ORIGINS**, Bantam, 1986
30. "The Perennial Fringe", Isaac Asimov, *The Skeptical Inquirer*, Spring 1986, pp. 212-217.
31. "The Scientist's Skepticism" in *Skeptical Inquirer*, Summer 1992, pp. 377-380. See the Magazine Article List
32. "Certainty and Proof in Creationist Thought", Leferriere, *The Skeptical Inquirer*, Winter 1989, pp. 185-187. See the Magazine Article List.
33. Gary Switzer, *The New sletter of the National Association of Science Writers*, Summer 1992
34. *Publisher's Weekly*, August 4, 1987
35. **Age of Propaganda: The Everyday Use and Abuse of Persuasion**, Anthony Pratkanis and Elliot Aronson, 1991, W. H. Freeman & Co.
36. *Family PC* magazine, September 1995
37. *Arizona Daily Wildcat*, Oct 10, 1991, p. 5
38. **FLIM-FLAM!**, James Randi, Prometheus Books, 1982, pp. 250, 251
39. *The Arizona Skeptic*, July/August 1992 review of the book Combatting Cult Mind Control by S. Hassan (a former high-ranking official in the Unification ("Moonies") Church), 1988, Park Street Press
40. "Letter to the Editor", *Skeptical Inquirer*, November/December 1997, Vol. 21, No. 6, p. 61
41. private communication from high school friend, Barbara W.

42. **I'm OK, You're OK**, Thomas A. Harris, M.D., Avon, 1969
43. **Games People Play**, Eric Berne, M.D., Ballantine, 1964
44. **Innumeracy**, John Allen Paulos, Ph.D., Hill and Wang, 1988, pp. 4, 5
45. Keynote Address, "The Science and Politics of Gender Research" at the "Gender Politics in Science" CSICOP (Committee for the Scientific Investigation of Claims of the Paranormal) conference at the University of Colorado, Boulder, Colorado, June 6,7, 1997
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47. **FLIM-FLAM!** James Randi, Prometheus Books, 1982
48. **Innumeracy**, John Allen Paulos, Ph.D., Hill and Wang, 1988, p. 5
49. Luis Alvarez, "Anecdote and Coincidence in Parapsychology", *Skeptical Inquirer*, Summer 1982, pp. 72-75.)
50. **Innumeracy**, John Allen Paulos, Ph.D., Hill and Wang, 1988, pp. 25-28
51. Susan Blackmore, Ph.D., "Psychic Experiences: Psychic Illusions", *Skeptical Inquirer*, Summer 1992, pp. 367-376.
52. Ray Hyman, Ph.D., palm-reading pointers given on Dr. Nicholas Humphrey's, "Is There Anybody There?" investigative documentary on paranormal claims, aired on PBS
53. Dr. Ray Hyman, psychologist and member, National Academy of Sciences, from "Cold Reading: How to Convince Strangers that You Know All About Them", *The Zetetic*, (now, *The Skeptical Inquirer*), Spring/Summer 1977)
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56. **The Demon-Haunted World**, Carl Sagan, Random House, 1995, pp. 26, 27.
57. "ESP Findings send controversial message," *Science News*, July 31, 1999, Vol. 156, p. 70.
58. "Exploring Psychic Powers", television special Summer 1989, hosted by Bill Bixby, produced by James Randi