CRITICAL THINKING: AN OVERVIEW

By

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Based On: Critical Thinking: An Introduction by Alec Fisher
CRITICAL THINKING: AN OVERVIEW

Also Based On: Critical Thinking: What It is And Why It Counts by Peter Facione; Teaching Pigs To Sing: An Experiment In Bringing Critical Thinking To The Masses by Harriet Hall; A Working Definition of Critical Thinking by Michael Scriven & Richard Paul; A Field Guide to Critical Thinking by James Lett; Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction, The California Academic Press, Millbrae, CA, 1990); and Anonymous Others
CRITICAL THINKING: DEFINITIONS

- Active, persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and further conclusions to which it tends
  - (John Dewey, 1909, on "Reflective Thinking")

- Is an active process: not just passive listening
  - Question, seek information, think things through

- Is a persistent, careful process
  - Reflective (not unreflective) thinking; don’t jump to conclusions or make snap decisions

- Supportive grounds and implications for one’s beliefs are very important
  - Skillful reasoning is key to critical thinking
CRITICAL THINKING: DEFINITIONS

- From Edward Glaser, the “Watson-Glaser Critical Thinking Appraisal”:
  - An attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one’s experience
  - Knowledge of the methods of logical inquiry and reasoning and some skill in applying those methods
  - Critical thinking calls for a persistent effort to examine any belief or supposed form of knowledge in the light of the evidence that supports it and the further conclusions to which it tends
CRITICAL THINKING: DEFINITIONS

- Critical thinking is that mode of thinking – about any subject content or problem – in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them (Richard Paul - 1993)
  - The only way to develop one’s critical thinking ability is through thinking about one’s thinking (i.e., *meta-cognition*)

- Critical thinking is skilled and active interpretation and evaluation of observations and communications, information and argumentation (Michael Scriven, 1997)
  - Critical thinking is a learned academic competency like reading and writing, and should be taught in elementary and high school
CRITICAL THINKING: DEFINITIONS

- Critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do (a widely-used definition by Robert Ennis, 1989)
  - The affect on decision-making is explicit in this definition
  - This definition is short, easily remembered, and to the point
CRITICAL THINKING: DEFINITIONS

- Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action (Scriven & Paul)

  - Based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness

  - Entails the examination of those structures or elements of thought implicit in all reasoning: purpose, problem, or question-at-issue; assumptions, concepts, empirical grounding; reasoning leading to conclusions, implications and consequences; objections from alternative viewpoints; and frame of reference

  - Incorporated in the thinking mode of various disciplines, such as scientific, mathematical, and philosophical thinking
CRITICAL THINKING: DEFINITIONS

- Critical thinking is purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (from APA Delphi Report of expert consensus)
  - Essential as a tool of inquiry
  - The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit
Critical Thinking: Components

- Critical thinking has two components
  - A set of skills to process and generate information and beliefs
  - The ability to use those skills to make decisions and guide behavior

- Critical thinking, in an individual, may be discontinuous and interspersed with irrational thinking, blind spots, and self-delusion
  - The development of critical thinking skills and dispositions requires continuous commitment and practice throughout life
CRITICAL THINKING: SKILLS

A list of critical thinking skills (Edward Glaser, 1941):

- Recognize problems
- Find practical means of solving those problems
- Gather and marshal pertinent information
- Recognize unstated assumptions and values
- Comprehend and use language with accuracy, clarity, and discrimination
- Interpret data
- Appraise evidence and evaluate statements
- Recognize the existence of logical relationships between propositions
- Draw warranted conclusions and generalizations
- Test those generalizations and conclusions
- Reconstruct one’s patterns of belief on the basis of wider experience
- Render accurate judgments about specific things and qualities of everyday life
CRITICAL THINKING: SKILLS

- Another list of critical thinking (i.e., cognitive) skills (from *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction*, The California Academic Press, Millbrae, CA, 1990)
  - Interpretation
  - Analysis
  - Evaluation
  - Inference
  - Explanation
  - Self-regulation
CRITICAL THINKING: SKILLS

- Interpretation
  - To comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria
  - Includes the sub-skills of categorization, decoding significance, and clarifying meaning
  - Examples: recognizing a problem and describing it without bias; reading a person’s intentions in facial expressions; distinguishing a main idea from subordinate ideas in a text; constructing a tentative categorization or way of organizing something you are studying; paraphrasing someone’s ideas in your own words; clarifying what a sign, chart or graph means; identifying an author’s purpose, theme, or point of view
CRITICAL THINKING: SKILLS

Analysis

➢ To identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions

➢ Sub-skills include examining ideas, detecting arguments, and analyzing arguments

➢ Examples: identifying the similarities and differences between two approaches to the solution of a given problem; picking out the main claim made in a newspaper editorial and tracing back the various reasons the editor offers in support of that claim; identifying unstated assumptions; constructing a way to represent a main conclusion and the various reasons given to support or criticize it; sketching the relationship of sentences or paragraphs to each other and to the main purpose of the passage
CRITICAL THINKING: SKILLS

Evaluation

- To assess the credibility of statements or other representations which are accounts or descriptions of a person’s perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representation.

Examples: judging an author’s credibility of an author or speaker; comparing the strengths and weaknesses of alternative interpretation; determining the credibility of a source of information; judging if two statements contradict each other; judging if the evidence at hand supports the conclusion being drawn; recognizing the factors which make a person a credible witness regarding a given event or a credible authority with regard to a given topic; judging if an argument’s conclusion follows either with certainty or with a high level of confidence from its premises; judging the logical strength of arguments based on hypothetical situations; judging if a given argument is relevant or applicable or has implications for the situation at hand.
**CRITICAL THINKING: SKILLS**

- **Inference**
  - To identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to educe the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation.
  - Sub-skills include querying evidence, conjecturing alternatives, and drawing conclusions.
  - Examples: seeing the implications of a position someone is advocating; drawing out or constructing meaning from the elements in a reading; identifying and securing the information needed to formulate a synthesis from multiple sources; when faced with a problem, developing a set of options for addressing it; conducting a controlled experiment scientifically and applying the proper statistical methods to attempt to confirm or disconfirm an empirical hypothesis.
CRITICAL THINKING: SKILLS

Explanation

- To be able to state the results of one’s reasoning; to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one’s results were based; and to present one’s reasoning in the form of cogent arguments

- Sub-skills include stating results, justifying procedures, and presenting arguments

- Examples: to construct a chart which organizes one’s findings; to write down for future reference your current thinking on some important and complex matter; to site the standards and contextual factors used to judge the quality of an interpretation of a text; to state research results and describe the methods and criteria used to achieve those results; to appeal to established criteria as a way of showing the reasonableness of a given judgment; to design a graphic display which accurately represents the subordinate and super-ordinate relationship among concepts or ideas; to site the evidence that led you to accept or reject an author’s position on an issue
CRITICAL THINKING: SKILLS

- Self-regulation
  - To self-consciously monitor one’s cognitive activities, the elements used in those activities, and the results deduced, particularly by applying skills in analysis, and evaluation to one’s own inferential judgments with a view toward questioning, confirming, validation, or correcting either one’s reasoning or one’s results
  - Sub-skills include self-examination and self-correction
  - Examples: to examine your views on a controversial issue with sensitivity to the possible influences on your personal biases or self-interest; to monitor how well you seem to be understanding or comprehending something, to separate your personal opinions and assumptions from those of the author of a passage or text; to double check yourself by recalculating the figures; to vary your reading speed and method according to the type of material and one’s purpose for reading; to reconsider your interpretation or judgment in view of further analysis of the facts of the case; to revise your answers in view of the errors you discovered in your work; to change your conclusion in view of the realization that you had misjudged the importance of certain factors when coming to your earlier decision
REASONING

- Reasoning (i.e., to use the faculty of reason to arrive at a conclusion, where reason is a rational or sufficient explanation) should justify a conclusion

- Distinguish the reasons from the conclusions (where the conclusions may appear at the beginning or end of an argument (statement))
  - Typical reason indicators: because, since, for, the reasons are, firstly, etc.
  - Typical conclusion indicators: so, therefore, thus, consequently, conclude, justifies, proves, infer, it follows that, etc.

- Determine whether the reasoning contains implicit or explicit assumptions

- Determine the truth of assertions (i.e., whether they are based on fact or opinion)
EVIDENTIAL REASONING

- Six rules of evidential reasoning (Lett): to be followed when evaluating any claim – the first three rules are logically necessary, while the last three are pragmatically necessary (because people lie or rationalize or make mistakes)
  - Falsifiability
  - Logic
  - Comprehensiveness
  - Honesty
  - Replicability
  - Sufficiency
EVIDENTIAL REASONING

- Falsifiability
  - It must be possible to conceive of evidence that would prove the claim false
    - Every true claim is falsifiable
    - A single instance of evidence (fact) to the contrary can falsify a claim
    - Evidence must matter – or the claim is invulnerable to evidence and thus the claim is meaningless
    - Scientific claims are falsifiable – pseudo science and religion make nonfalsifiable claims
    - Example: All humans are mortal is a falsifiable claim; all humans have a soul is not a falsifiable claim
EVIDENTIAL REASONING

- **Logic**
  - Any argument offered as evidence in support of any claim must be sound (the rule of logic governs the validity of inference).
  - An argument is said to be "valid" if its conclusion follows unavoidably from its premises; it is "sound" if it is valid and if all the premises are true.
  - An invalid argument can be recognized by the simple method of counterexample: If you can conceive of a single imaginable instance whereby the conclusion would not necessarily follow from the premises even if the premises were true, then the argument is invalid.
    - **Example:** All dogs have fleas; Xavier has fleas; therefore Xavier is a dog – invalid argument because Xavier could be a cat.
    - **Example:** All dogs have fleas; Xavier is a dog; therefore Xavier has fleas – unsound argument, even though it is valid, because the first premise is false: all dogs do not have fleas.
EVIDENTIAL REASONING

- Comprehensiveness
  - The evidence offered in support of any claim must be exhaustive – that is all of the available evidence must be considered
    - It is never reasonable to consider only the evidence that supports a theory and to discard the evidence that contradicts it
    - This rule is frequently broken by proponents of pseudo science and those who make paranormal claims (i.e., highlight evidence that validates their claim but ignore evidence that contradicts it)
EVIDENTIAL REASONING

- **Honesty**
  - The evidence offered in support of any claim must be evaluated without self-deception
  - The rule of honesty is a corollary to the rule of comprehensiveness
    - When you have examined all of the evidence, it is essential that you be honest with yourself about the results of that examination; if the weight of the evidence contradicts the claim, then you are required to abandon belief in that claim (the obverse would hold as well)
  - Denial, avoidance, rationalization, and all the other familiar mechanisms of self-deception would constitute violations of the rule of honesty
EVIDENTIAL REASONING

- Replicability
  - If the evidence for any claim is based upon an experimental result, or if the evidence offered in support of any claim could logically be explained as coincidental, then it is necessary for the evidence to be repeated in subsequent experiments or trials.
    - Rule of replicability provides a safeguard against the possibility of error, fraud, or coincidence.
    - A single experimental result is never adequate; any experiment, no matter how carefully designed and executed, is always subject to the possibility of implicit bias or undetected error.
    - The rule of replicability, which requires independent observers to follow the same procedures and to achieve the same results, is an effective way of correcting bias or error, even if the bias or error remains permanently unrecognized (if the experimental results are the product of deliberate fraud, the rule of replicability will ensure that the experiment will eventually be performed by honest researchers).
    - If the phenomenon in question could conceivably be the product of coincidence, then the phenomenon must be replicated before the hypothesis of coincidence can be rejected.
Sufficiency

The evidence offered in support of any claim must be adequate to establish the truth of that claim, with these stipulations: the burden of proof for any claim rests on the claimant; extraordinary claims demand extraordinary evidence; and evidence based solely upon authority and/or testimony is often inadequate.

- The burden of proof always rests with the claimant because the absence of disconfirming evidence is not the same as the presence of confirming evidence.

- Extraordinary claims demand extraordinary evidence for the obvious reason of balance - if I claim that it rained for ten minutes on my way to work last Tuesday, you would be justified in accepting that claim as true on the basis of my report; but if I claim that I was abducted by extraterrestrial aliens, you would be justified in demanding more substantial evidence.
REASONING

- **Language in reasoning examples**
  - **Expressing a claim:**
    - my intuition, faith, opinion, view, belief, thesis is …
    - I am certain that, I can’t prove it but I believe that, the facts are, the fact appear to be, I observed that …
  - **Making assumptions:**
    - I am assuming that, implies, presupposes that …
  - **General terms for giving reasons for a conclusion**
    - Because, the reasons are, experts believe, my experience is, by analogy, if..then, implies …
  - **A causal explanation**
    - Explains why, that is why, the causes are …
REASONING

Language in reasoning examples

Making recommendations or a decision:
- I recommend, suggest, we should, the best option is, the best choice …

Clarifying or interpreting:
- To clarify, what I mean is, for example, by contrast, let us define …

Inferring:
- I infer, deduce, conclude, it implies, suggests, leads me to think …

Evaluating a claim:
- True, plausible, false, fair, biased, concise, simplistic, vague, objective, subjective, imprecise, ambiguous, acceptable, unacceptable, satisfactory,

Evaluating support for a view:
- Proves, justifies, supports, conflicts, consistent, refutes, fallacy, irrelevant, weak, strong
REASONING

- Expressing your arguments clearly
  - Choose a conclusion you would like to argue and present persuasive reasoning
    - Make your reasoning very clear (preferably presenting evidence or proof)
    - Develop a good argument against your conclusion and see if it can withstand the counter-argument (like a lawyer testing his case against the likely arguments of opposing counsel)
- To learn by example how to argue a case, examine the op-ed pages in major newspapers (e.g., New York Times, Washington Post, Wall Street Journal) or columnists in news magazines (e.g., Time, Newsweek, The Economist)
- Listen to talk radio (conservative or liberal) and evaluate quality of the arguments of the hosts and callers
REASONING PATTERNS: SIDE BY SIDE

- <Reason> so [conclusion]
  - Simple reasoning structure
  - Example: <High interest rates are causing a slump in the housing market>, so [interest rates must be reduced]

- <Reason 1> and <reason 2> so [conclusion]
  - More complex reasoning structure: two reasons side by side
  - Example: The slump in the housing market is caused by <high interest rates> and <a lack of consumer confidence>, so [a reduction in unemployment is needed in addition to lower interest rates before the housing market will improve]

- Side by side reasoning pattern can be extended to any number of sequential reasons leading to a conclusion
REASONING PATTERNS: CHAIN

- **<Reason> so [conclusion 1] therefore [conclusion 2]**
  - **Example:** Lack of vitamin E does not cause memory loss, so vitamin E cannot cure your memory loss, therefore stop taking Vitamin E for this problem
  - The reasoning chains can be as long as needed
REASONING PATTERNS: JOINT

- Each of several reasons give support to the conclusion, even without the other reasons
  - Example: Harvey smoked a pack of cigarettes daily, and his parents, who never smoked, died of lung cancer. Furthermore, Harvey worked in an asbestos factory. So it was inevitable that he would die of lung cancer.

- Sometimes one or more joint reasons may not support the conclusion, while the other reasons do
  - Example: Harvey smoked a pack of cigarettes daily, and his parents, who never smoked, died of lung cancer. Furthermore, Harvey worked in an ice cream factory. So it was inevitable that he would die of lung cancer.
REASONING PATTERNS: COMPLEX

- Often reasoning involves complex patterns consisting of combinations of side by side, chain, and joint patterns
- Disjunction
  - Either a meteor striking the Earth or extensive volcanoes caused the extinction of the dinosaurs
- Hypothetical
  - If there were universal health care, then the average life span would increase
Arguments versus explanations

- An argument attempts to persuade; an explanation clarifies why an event occurred (causality)
- Words like “because” or “that’s why” can signify either
- Test: if the author seems to assume that the consequence is true, then it is a causal explanation; if the author is trying to prove the consequence, then it is an argument
  - Causal explanation: I was sick because I drank too much beer
  - Argument: We should restrict beer drinking on campus because it damages the health of students
REASONING PATTERNS: COMPLEX

- Drawing more than one conclusion
  - Reasoning might lead to more than one conclusion
  - Example: The evidence is that a meteor strike likely caused the extinction of the dinosaurs, which then led to the rise of mammals, which then evolved to fill the vacant ecological niches left by the dinosaurs and led, eventually, to the existence of humans. Without this major natural disaster, we wouldn’t exist.
  - There are multiple conclusions in this argument, including indirect consequences of the original effect of the cause (which might have been a necessary but not sufficient condition for the evolution of primates)
REASONING ASSUMPTIONS

- People offering arguments or explanations often leave things unsaid which they believe to be true and relevant
  - These unsaid things are *assumed* in the discourse
  - Example: That fruit looks rotten; you shouldn’t eat it
    - Assumptions: because the fruit looks rotten, it is rotten; rotten fruit will get you sick; you do not want to be sick
    - These are *implicit* assumptions
- Explicit statements can also contain assumptions (e.g., where a fact is assumed, or the validity of a conclusion from a reason is assumed)
  - Example: You should take vitamin E to improve your memory [assumption: vitamin E improves memory]
  - Example: Government is incompetent, so it should not be responsible for universal health care [assumption: government is always incompetent]
REASONING CONTEXT

- People present arguments and explanations in some context
  - Context contains assumptions, presumptions, background beliefs, facts relevant to interpreting what is meant, rules of conduct, etc.
  - Example: The test was unfair because I studied very hard and made a major effort and did not get an A grade
    - Context: If the test were to reflect the preparation effort, then the student should get an A. But if the test grade were to reflect knowledge of the subject, then studying effort alone is irrelevant to the grade. Assumptions: the test is a suitable test of knowledge of the subject and all students were graded on the same basis and thus the test is fair
REASONING CONTEXT

- **Examples:**
  - Because he said global warming is a lie, Joe is a right-wing twit.
  - Because she said that we should have government-mandated universal health care, Sandra is a left-wing bleeding heart.
    - **Context:** political characterizations depend on the speaker’s position on, and his definition of, the political spectrum.

- **Example:**
  - The government should mandate that cars be small and low-powered because of the terrible traffic congestion.
    - **Context:** the conclusion may be valid or invalid depending on whether you own a car in Manhattan, New York, or Manhattan, Kansas.
UNDERSTANDING AND EVALUATING REASONING: THINKING MAP

- Thinking map: a list of key questions you should ask when weighing an argument (whether someone else’s or your own)
  - Allows you to avoid snap judgments as to the validity or reasonableness of an argument
  - Allows you to seek additional clarification and avoid unwarranted assumptions
- Divided into two parts:
  - Analysis: a guide for understanding an argument
  - Evaluation: a guide for deciding whether to be persuaded by the argument
UNDERSTANDING AND EVALUATING REASONING: THINKING MAP

- **Analysis:**
  - What are the main *conclusions*?
    - May be stated or unstated
    - May be recommendations, explanations, etc.
  - What are the *reasons* (data, evidence) and their structure?
  - What is assumed (implicit or taken for granted, perhaps in the context)?
  - Clarify the *meaning* (by the terms, claims, or arguments) which need it?
UNDERSTANDING AND EVALUATING REASONING: THINKING MAP

- Evaluation:
  - Are the reasons acceptable (including explicit reasons and unstated assumptions)?
    - May involve evaluating factual claims, definitions, and value judgments, and judging the credibility of a source
  - Does the reasoning support its conclusions?
    - Is the support strong or weak?
  - Are there other relevant considerations or arguments which strengthen or weaken the case?
  - What is your overall evaluation, given the performed analysis and evaluation sequence?
Clarity, as opposed to vagueness, is generally desired in discourse.

But vague (or fuzzy) language can be useful and reasonable to use (e.g., words like “tall” or “short,” “hot” or “cold,” “big” or “small,” etc.):

- Vague terms can have meaning
- A vague term means more when context is known
- It would be tedious or difficult to quantify or precisely define all language (“the sky is blue” vs. “the wavelength of the sky light is 0.41738 microns”)

The amount of clarity or clarification required in a communication depends on the circumstances (e.g., the situation, the communication, the communicator, and the audience).

Technical issues (e.g., science, law, military, management, etc.) generally require greater clarity than general conversation:

- Sadly, politics does not get the clarity it deserves
CLARIFICATION

- A vague term can be clarified with definitions, examples, similes, or metaphors.
- Some important vague terms are never clarified.
  - “Reasonable doubt,” a legal term upon which a defendant’s life may depend, remains vague and its meaning may be debated again and again by every jury deliberating every criminal case (e.g., I served on a jury convened for a case of attempted murder, and the jury spent the better part of two days just arguing the meaning of “reasonable doubt”).
  - Can you think of several others?
- The need for clarification depends on the background, knowledge, beliefs, and values of the audience.
  - The speaker usually assumes characteristics about the audience to decide what terms need clarification.
CLARIFICATION

- **Sources of clarification**
  - Dictionary definition: for normal usage
    - Example: “Intelligence is the ability to learn or understand or to deal with new or trying situations”
  - Definition or explanation from authority in the field: for specialized usage
    - Example: “Intelligence is that which is measured by the Stanford-Binet test”
  - Definition by speaker or writer (stipulating a meaning): for usage specifically intended by speaker or writer
    - May differ from normal usage or usage by others
    - O.K. as long as speaker/writer and audience agree on definition
    - Example: “Intelligence is the ability to make an appropriate choice”
CLARIFICATION

- Ways to clarify terms and ideas
  - Providing a synonymous expression or paraphrase
    - Alternative ways of expressing the same expression or thought
    - Example: he is a dullard; his elevator stops three floors short of the top floor
  - Providing necessary and sufficient (if and only if) conditions
    - Rarely used to clarify, but used often in science and mathematics
    - Example: an American is a bachelor if and only if the American is a male of marriageable age who is unmarried
  - Giving clear examples and non-examples
    - Example of a non-example: “I knew Jack Kennedy. Jack Kennedy was a friend of mine. Senator, you're no Jack Kennedy.” [Lloyd Bentson]
CLARIFICATION

- Ways to clarify terms and ideas
  - Drawing contrasts (including *per genus et differentiam*)
    - Example: He is tall even when compared with a typical NBA player
  - Explaining the history of an expression
    - Example: Cybernetics is a neologism coined by Norbert Wiener from the Greek *kubernetes* or *steersman*
EVALUATION OF REASONING

- The structure of reasoning, as previously discussed, says nothing about its credibility
  - To be a critical thinker, one must evaluate the speaker’s/author’s claims, argument, and reasoning
    - People tend to accept arguments with which they agree uncritically and question arguments with which they disagree
    - With critical thinking, all arguments should be scrutinized and evaluated
    - Once an argument is evaluated and accepted, there is not need to subsequently question and evaluate it - unless the previous acceptance was based on shaky evidence or there is new information

- In evaluating an argument or reasoning, ask:
  - Are the reasons acceptable (e.g., true or probably true)?
  - Does the reasoning support its conclusion?
  - Are there other relevant considerations or arguments to be considered (that were not mentioned)?
  - What is your overall evaluation of the credibility of the argument and reasoning?
EVALUATION OF REASONING

- Kinds of claims to be evaluated
  - Facts, evidence, data
    - Examples: The Washington Monument is 555 feet high; Iraq had weapons of mass destruction; Philo T. Farnsworth invented television
  - Value judgments
    - Examples: College students would be safer if they were allowed to carry guns to class; armadillo stew is delicious; I would rather have a tooth extracted than listen to her sing
  - Definitions, criteria, or principles
    - Examples: a camel is a horse designed by a committee; a penny saved is a penny earned; never trust a naked bus driver
  - Causal explanation
    - Examples: the dinosaurs became extinct because of a meteor strike; illegal immigrants come to the U.S. because Mexico does not provide them with sufficient job opportunities
  - Recommended course of action
    - Examples: execute murderers; build more roads to reduce traffic congestion; work at home to reduce traffic congestion
EVALUATION OF REASONING

- The question of acceptability is often about credibility

  - But value judgments or definitions may accepted or rejected without credibility being an issue

    - **Examples:** You may discern a flaw in a generally accepted (even dictionary) definition, or may determine it is becoming obsolete, and reject it; you may reject a value judgment because there is no solid evidence for the judgment, or opposing values seem equally reasonable (e.g., chopped liver is delicious; chopped liver is disgusting)

- **How certain is the claim?**

  - **Opinion, hunch, belief, guess, generally accepted, well-known, certainty, probability, some experts state, etc.**

  - **Examples:** I am so certain that I am willing to bet my house that the Brooklyn Dodgers won the 1955 World Series; I am guessing that the New York Giants won the 1963 World Series; there is a very high probability that smoking causes lung cancer
EVALUATION OF REASONING

- The question of acceptability is often about credibility (continued)
  - Does the context of the claim influence its acceptability?
    - Claim based on extensive study vs. untutored belief; direct observation vs. second-hand report
    - Examples: I am not a mechanic, but because your car is making that noise, it must be a transmission problem; my aunt’s friend’s cousin once had a snake crawl out of her toilet
  - Does the claim require expertise or research to decide?
    - Examples: The risk for any given person for suicide, particularly for middle-aged older white males, is dramatically higher than the risk of being mugged or being in a terrorist attack; it is possible to reduce the speed of light to slower than a person can walk
EVALUATION OF REASONING

- The question of acceptability is often about credibility (continued)
  - Is the claim widely known or believed?
    - Examples: Because the Universe originated with the Big Bang, we can detect 3-degree Kelvin blackbody radiation as a result of its cooling; border collies are one of the smartest breeds of dogs
  - How well does the claim fit our other beliefs?
    - Example: Because the U.S. does not value education as much as European cultures, public school teachers are paid comparatively poorly and accorded less respect
  - Is the claim from a credible source?
    - Examples: My cousin Bennie from Hoboken saw Bigfoot in Central Park; Albert Einstein said that matter could not be accelerated to a speed faster than the speed of light
EVALUATION OF SOURCES

- In judging the credibility of an argument, while it is important to evaluate the validity of the reasoning leading to the argument’s conclusion, it is also important to evaluate the source of the argument.
  - Especially where the facts or basis of the argument cannot be determined because limitations of the reader’s/listener’s knowledge or time constraints.
  - Examples: the discovery of 3-degree Kelvin blackbody radiation is evidence of the Big Bang; Galloping Grocer will win the Preakness while Sun King will run out of the money; transposons can rapidly reorganize genes in response to environmental stress.

- Credible sources may be occasionally wrong, while non-credible sources may be occasionally right.

- Lacking independent evidence, one must judge the validity of the reasoning and the source to evaluate the credibility of an argument/conclusion.
EVALUATION OF SOURCES

- Much of our information and beliefs are based on what others tell us (in writing, verbally, or through the media)
- One should always evaluate the credibility of the source of information, whether personal or media, including:
  - Whether the source has a good reputation
    - Example: The New York Times vs. The UFO Gazette
  - Whether source has vested interest
    - Example: Exxon disparages wind energy
  - Whether there is corroboration of the source
    - Example: Your doctor agrees with your cousin that 99,000 people per year die from infections caught in U.S. hospitals
  - Whether the source has relevant expertise
    - Example: Your dentist denies Darwinian evolution
  - Whether the source can provide credible reasons for the claim
    - Example: Your aunt insists she saw an image of Aristotle in a piece of burnt toast but can’t explain how she knows what Aristotle actually looked like
EVALUATION OF SOURCES

- Relevant expertise of the source (experience, knowledge, formal qualifications)
  - Experts can (and have) been wrong about many things, but they deserve the benefit of the doubt when compared with the claims of a non-expert in the subject
  - Examples: Your accountant friend claims a shard is ancient Greek pottery, but an archeologist disagrees; your uncle the farmer tells you smoking does not cause cancer; a lawyer disagrees with your mother about your ability to sue successfully for flood damage

- The ability of the source to observe accurately (eyesight, hearing, proximity to the event, absence of distractions, appropriate instruments, etc.)
  - Example: Research reveals that giving feedback to eyewitnesses of crimes after they have identified the suspect from a lineup or photos distorts a witness's memories of both the original event and the identification decision, even when the feedback is delayed by as much as 48 hours
EVALUATION OF SOURCES

- Reputation of source
  - Whether source has been honest or correct about previous statements
    - Example: O.J. Simpson (who is, undoubtedly, still searching for the real killer) says he was invited to enter the Las Vegas hotel room to get his own memorabilia, which he did peacefully without threats or guns, and the accusations of armed robbery are false
  - Reputation does not always guarantee reliability, but allows giving the source initial credence or the benefit of the doubt
    - Example: I know it is hard to believe, but even professors can be wrong
EVALUATION OF SOURCES

- Vested interest or bias of source
  - Vested interests do not always lead to bias, but indicate caution in accepting claims
    - Example: Physicians accepting funding from pharmaceutical companies may truly care whether a drug is helpful or harmful to people and conduct legitimate experiments – but maybe not
    - Example: Politicians accepting large donations from corporation, wealthy supporters, and lobbyists claim they cannot be bought and their principles are sacrosanct – even if one assumes most are telling the truth, it is likely that at least some are not
    - Example: Defense contractors may want to provide technology and systems to defend the country, but they also want to make money
    - Example: Lawyers may want to defend their clients (and plumbers, electricians, etc., may want to fix a homeowner’s problems), but they also want to make money
  - Vested interest and bias are often entangled with a desire to be truthful (except, of course, for professors, who can always be believed)
EVALUATION OF SOURCES

- Circumstances and context can affect the credibility of a claim
  - The source of the claim may be reputable or disreputable for a claim
    - Example: A coal baron versus a meteorologist in an argument over global warming
  - The time and place of the claim may contribute to, or detract from, its credibility
    - Example: A discussion in a bar versus in an economics forum over the merits of pension plans

- Justification by the source in support of the claim can affect credibility
  - Example: I saw a UFO land in my backyard [not credible claim].
  - Example: I saw a UFO land in my backyard and found a piece of material that the National Institute of Standards and Technology analyzed and determined that it was unlike any known material and had astounding anti-gravity properties; I can give you a contact at NIST to verify this [credible claim].
EVALUATION OF SOURCES

- Personal witness or experience is more credible than second or third-hand report
  - Example: I saw a snake emerge from my toilet is more credible than my third cousin’s brother-in-law saw a snake emerge from his toilet
  - Nevertheless, people can be deluded or fooled or psychotic, so personal witness does not necessarily mean that a claim is valid

- Primary sources are more credible than secondary or tertiary sources
  - Example: An account of the Watergate scandal in a diary written by a participant is more credible (although not necessarily more valid) than a newspaper article or history book

- Direct evidence is more credible than circumstantial evidence
  - Example: Crop circles and patterns indicate we are visited by UFOs (circumstantial)
  - Example: I saw a farmer create crop circles and patterns with a few simple tools (direct)
EVALUATION OF SOURCES

- The nature of the claim influences its credibility (i.e., whether the claim is plausible or implausible based on other things we know)
  - Example: Your mother-in-law insists she is often visited by monsters who come to her bed when she is trying to sleep, and that she becomes paralyzed and unable to escape; but you know that some people enter a hypnopompic state, which is the transition state of semi-consciousness between sleeping and waking, and that this state leads to visual and auditory hallucination, including delusions of monsters sitting on one’s chest in an attempt to asphyxiate

- A basic observation is more credible than an inferred judgment
  - Examples: My neighbor has an expensive car [observation]; my neighbor has an expensive car so he must be a cheating on his taxes [inferred judgment]
EVALUATION OF INFERENCES

- People make inferences from statements or arguments based on their other knowledge or experiences
  - *Inference* is the link between a proposition or statement considered to be true to another whose truth is believed to follow from that of the former
  - Some inferences are made with confidence, others with trepidation
    - Example: If someone says “I have a dog,” you may not know the breed, age, sex, etc. of the dog, but you can immediately and confidentially infer certain characteristics about the dog (e.g., it has fur, a head, and four legs; it eats, sleeps, and poops; etc.) – Note that the statement (“I have a dog”) is taken to be true and the linked statement (“the dog has four legs”) is inferred to be true (although the dog might, in fact, have three legs)
    - Example: If some one says “I have a pet,” you may infer, but without much confidence, that the pet is a dog or cat (i.e., it may be a hamster, a bird, a fish, an iguana, a monkey, a horse, a turtle, a snake, a capybara, etc.)
EVALUATION OF INFERENCES

- Initial test for good inferences
  - There must be a reasonable link between the true proposition (reason) and the inferred consequence
    - Example: *Post hoc, ergo propter hoc* (after this, therefore because of this) is a common fallacy: the rooster crows just before the sun rises, so I infer that the rooster must cause the sun to rise; a black cat crossed my path and later I lost a ten dollar bill, so I infer the black cat caused my misfortune
    - Example: There may be multiple causational variables, not just one: medical costs rise much faster than inflation so I infer it is because of the increased cost of malpractice insurance: but there are many variables contributing to increased medical costs and, in fact, malpractice insurance is a relatively minor component
  - The reason from which the inference is drawn must be true
EVALUATION OF INFERENCES

- For an argument to succeed in justifying its conclusion
  - Its reasons must be true or otherwise acceptable
  - The inferences which are drawn from the reasons must be good ones
- Different standards for evaluating inferences and arguments
  - Different kinds of reasons may be judged differently (e.g., for truth, credibility, acceptability, as values, definitions, etc.)
  - Likewise, different kinds of inferences may be judged differently
EVALUATION OF INFERENCES

- **Highest standard: deductively valid inferences**
  - If the reason is true, the conclusion must be true
    - Deductively valid example: the animal is a mammal, so it has hair
    - Deductively invalid example: he was arrested, so he must be guilty

- **Logically consistent propositions are deductively valid**
  - Example: If A is greater than B, and B is greater than C, then A is greater than C
  - However, humans are not necessarily logically consistent: if she prefers apples to oranges and oranges to pears, then she prefers apples to pears – in fact, she may prefer pears to apples (also, substitute political candidates for fruit)
EVALUATION OF INFERENCES

- Proved beyond a reasonable doubt
  - This is the high standard for criminal cases (civil cases have a lesser standard – *preponderance of evidence*)
  - The proposition being presented by the government must be proven to the extent that there is no “reasonable doubt” in the mind of a reasonable person that the defendant is guilty
    - There can still be a doubt, but only to the extent that it would *not* affect a “reasonable person's” belief that the defendant is guilty
  - The precise meaning of words such as “reasonable” and “doubt” are usually defined within jurisprudence of the applicable country
    - In the United States, it is usually reversible error to instruct a jury that they should find guilt on a certain percentage of certainty (such as 90% certain)

- Usually, reasonable doubt is defined as “any doubt which would make a reasonable person hesitate in the most important of his or her affairs”
EVALUATION OF INFERENCEs

- **Proved beyond a reasonable doubt**
  - Example: Einstein’s Theory of General Relativity; Theory of Plate Tectonics; Darwin’s Theory of Evolution
  - Example of guilty beyond a reasonable doubt: The DNA of the accused was found on the dead victim; a security camera photographed him strangling the victim; he had the victim’s wallet and watch; five witnesses heard him threaten the victim; he was twice previously convicted of violent crime
  - Example where guilt beyond reasonable doubt is not established: the accused was selected from a line-up by a witness who saw the crime from across the street in the dark; there is no physical evidence

- **More likely than not on the balance of evidence**
  - A probabilistic inference (e.g., more likely than not, curcumin, the main ingredient of turmeric in curry, will prevent breast cancer and Alzheimer’s)
  - Example: O.J. Simpson found guilty in the civil trial (albeit, many think his guilt was established beyond a reasonable doubt in the criminal trial)
IMPLICIT ASSUMPTIONS

- Sometimes implicit assumptions in a statement or argument are obvious and sometimes not so obvious
  - Obvious implicit assumptions: “The children are in the room so don’t smoke”
    - Secondary smoke is harmful; smoking in front of children might later induce them to smoke; smoking might cause a fire and harm the children
  - Not obvious implicit assumptions: “He’s a politician”
    - Politicians lie, cheat, and steal
- In general, attribute to statements or arguments those assumptions which
  - Seem likely in the context
  - Which make sense of what is said
  - Which seem necessary to make the reasoning as strong as possible (if true)
IMPLICIT ASSUMPTIONS

- Rationale for making implicit assumptions
  - Interpret reasoning as constructively as possible in order to discover the truth about issues rather than score points off people (e.g., play obtuse about an implicit assumption to make the speaker/writer seem stupid)

- Assuming that if reasons are true, then conclusion is true
  - This type of assumption does not strengthen the argument if there is no evidence that the reasons are true
    - Example: If the moon were made of cheese, then the lunar astronauts would have plenty to eat

- In examining a statement or argument, one must often be creative as well as critical (critico-creative) in trying to discern the implicit assumptions
  - Arguments about complex issues often have a number of difficult-to-recognize implicit assumptions
IMPLICIT ASSUMPTIONS

Judging implicit assumptions skillfully: a checklist

- Does the reasoning include important assumptions?
- Does the reasoning support its conclusions without implicit assumptions?
- Are there other considerations (implicit assumptions) which strengthen or support the case?
- What is the strength of the overall argument?
  - Are the reasons acceptable and the inferences deductively valid?
  - Is the case proved beyond a reasonable doubt?
  - Is the case shown to be more likely than not on the balance of probabilities?
  - Is the argument reasonable?
Much reasoning is concerned with causal explanations

Examples: What caused: death or disease; stock market ups and downs; natural disasters; wars and crime; business success or failure

However, keep in mind the fallacy of: *Post hoc, ergo propter hoc*

After this, therefore because of this: a logical error, pre-supposing a causal link

Classic example: The cock crows before the sun rises; therefore the cock crowing causes the sun to rise

As viewers of the TV show *CSI* know, the cause of a death may be complex and difficult to determine

A man, while falling from the top of the Empire State Building, is shot and killed while passing by the 32nd floor – is the shooter guilty of homicide?
CAUSAL EXPLANATIONS

- It is very difficult to discern causality in complex systems
  - Jumping to conclusions and arriving at incorrect conclusions (unscientifically) about causality (such as by pandering politicians) are a major source of problems
    - Solutions to problems become new problems
- Systematic analysis is often needed to determine causality
  - Jumping to conclusions
    - Insufficient consideration of alternative explanations: e.g., consider only one possible cause and accept it without considering other possibilities
    - Failure to consider all relevant evidence

I love you Murray, but let’s not jump to conclusions!
CAUSAL EXPLANATIONS

- Checklist for skilful causal explanation
  - What are the possibilities in this case?
  - What evidence could you find that would count for or against the likelihood of these possibilities (if you could find it)?
  - What evidence do you have already, or can you gather, that is relevant to determining what causes what?
  - Which possibility is rendered most likely by the evidence (i.e., what explanation fits best with everything else we know and believe)?
CAUSAL EXPLANATIONS

For explanatory reasoning to be successful, it must:

- Consider reasonable alternatives
- Find evidence which either rules out other possible explanations or supports the favored explanation
- Fit well with everything else we know (e.g., gravity causes things to fall to the ground)

For a sophisticated example of the attempt to discern the underlying causes of a variety of social phenomena, see “Freakonomics: A Rogue Economist Explores the Hidden Side of Everything,” by Steven D. Levitt and Stephen J. Dubner
INFORMAL FALLACIES

- A fallacy is a defect in an argument
- A formal fallacy is a defect in the form or structure of an argument
- Since deductive arguments depend on formal properties and inductive arguments don't, formal fallacies apply only to deductive arguments
- Informal fallacies are defects found in the content of the argument, which could be inductive or deductive
- There are many ways arguments can be defective
  - Some defects are common enough to warrant a name
  - And many common defects are similar enough to warrant classification
INFORMAL FALLACIES

- Fallacies of Relevance
  - The premises may be psychologically, but not logically, relevant to the conclusion
  - Logically relevant premises contribute to our ability to see that the conclusion is true (in this sense we have reason to believe that the conclusion is true)
  - Psychologically relevant premises may give us some reason to believe the conclusion is true but not because they help us see that the conclusion is true
    - Example: The neighbor’s children are noisy and rambunctious; they must be the ones who vandalized my mailbox
INFORMAL FALLACIES

- Appeal to Force
  - This fallacy occurs whenever the arguer presents a threat under the pretense of defending a conclusion
    - Premises that threaten are not relevant to the truth of the conclusion
  - Threat must occur in the context of an argument
  - Threats may involve physical or psychological harm
  - Threats may be direct or veiled
  - Example: If you don’t support the war, you must be a traitor (and traitors can be ostracized or killed)
INFORMAL FALLACIES

 Appeal to Pity

 Arguer attempts to get an audience to accept a conclusion by evoking pity or sympathy

 Pity could be directed at the arguer or some third party

 Some arguments from compassion are not fallacious; but they must supply some evidence that the pity or compassion is justified and that the recommended response is reasonable

 Example: He deserves to be president – he was an orphan and grew up in a log cabin and raised his brothers and sisters and overcame addiction and earned his fortune with hard work
INFORMAL FALLACIES

- Appeal to the People
  - The arguer exploits common desires to be loved, accepted, admired, etc. to get the audience to accept the conclusion
  - Direct approach: used when arguer excites the emotions of a crowd to win acceptance for a conclusion; mob mentality
    - Example: You should contribute to this candidate or you will lose your job because of illegal aliens
  - Indirect approach: used when the arguer targets an individual and exploits the individual's desire to be accepted or respected; the bandwagon argument; appeal to snobbery; appeal to vanity
    - Example: You should contribute to this candidate – all of your neighbors contributed
INFORMAL FALLACIES

- Argument against the Person
  - Two arguers: One presents an argument and the other responds by redirecting attention away from the argument and towards the arguer
    - The question of whether the premises support the conclusion are ignored; but the merits of an argument are independent of the character of the arguer
  - Abusive version: respondent verbally abuses the arguer and ignores the argument
  - Circumstantial version: respondent calls attention to special circumstances of the arguer and ignores the argument
  - Tu quoque: respondent attempts to make the arguer look hypocritical
  - Sometimes the character of a witness or informant are relevant to the credibility of testimony and it is fair to consider the character of the arguer before we accept the premises of an argument
    - The fallacy (against the person) occurs only when the person attacked is an arguer and when our attention is drawn from the character of the argument and to the character of the arguer
INFORMAL FALLACIES

- Accident
  - Accident occurs when a general rule is applied to a case it was not meant to cover
  - You should be able to see what the general rule is and why the specific case mentioned does not apply
  - Example: Never go into the water right after eating; my wife is drowning but I just ate so I cannot go into the water to save her
INFORMAL FALLACIES

- **Straw Man**
  - This fallacy is committed when the respondent distorts an argument, demolished the distortion, and then concludes that the original argument was demolished
    - The distortion (the "straw man") is usually easier to attack
    - The respondent pretends to have attacked to original argument
    - Sometimes the distortion is an exaggeration of the original argument
  - **Example:** You are proposing universal health care which is socialized medicine which is like communism which we all know doesn’t work
INFORMAL FALLACIES

- **Missing the Point**
  - A specific kind of fallacy of relevance
    - The premises of one argument support a particular conclusion but another vaguely related conclusion is drawn instead
  - Typically the arguer misunderstands the logical implications of the premises
    - You should be able to identify the correct conclusion
  - Example: Abstract art is inexplicable to me and I do not like it; therefore it is degenerate and an indication of the decline of civilization
INFORMAL FALLACIES

- **Red Herring**
  - The arguer shifts attention from the original subject to a related subject
    - Typically the arguer never returns to the original subject
  - The red herring differs from the straw man in that the latter involves a distorted argument and the former involves a change of subject; the latter also requires two arguers, the former doesn't
  - The red herring and straw man differ from missing the point in that the former involve generating new sets of premises; for the latter the conclusion is irrelevant to the premises but not so for the former
  - **Example:** Terrorists are a threat and some are in the U.S. illegally, so if we build a fence across the Mexican border we will stop terrorism in the U.S.
The scientific method is the best way (yet discovered) for winnowing the truth from lies and delusion

Simple version:

- Observe some aspect of the universe
- Invent an hypothesis that is consistent with what you have observed
- Use the hypothesis to explain phenomena and make predictions
- Test those predictions by experiments or further observations
- With much validation the hypothesis becomes a theory – modify the theory in light of new results
- Repeat as often as necessary

Kepler
SCIENTIFIC METHOD

- It is impossible for every scientist to do every experiment independently to confirm every theory
  - Because life is short, scientists have to trust other scientists, so a scientist who claims to have done an experiment and obtained certain results will usually be believed, and most people will not bother to repeat the experiment
  - But experiments may get repeated as part of other experiments and the initial experiments will get replicated a number of times
- Paradigm shifts (described by Kuhn) are revolutionary new theories, based on new facts, which punctuate the generally slow accumulation of scientific knowledge in support of existing theories
SCIENTIFIC METHOD

- An hypothesis is a tentative theory that has not yet been tested
  - Typically, a scientist devises an hypothesis and then sees if it can be validated by testing it against available data
  - An hypothesis that has been extensively tested and verified by many facts becomes a theory
- In scientific use, a theory is a substantial explanatory framework encompassing a wide variety of phenomena and facts and able to predict new phenomena and facts
  - In popular use (e.g., creationists), “theory” is often considered synonymous with “conjecture” or “hypothesis”
  - In science, there is no such thing as “only” a theory
SCIENTIFIC METHOD

- Science cannot “prove” anything in an absolute sense
  - One factual exception is sufficient to disprove a claim
- The objectivity and rationality of science has been responsible for the exponential increase in technology and social well-being in the very recent past
  - Before science, technology progressed little over millennia
  - Before science, human life was that of Hobbes’s *First Man*: poor, nasty, brutish, and short
  - With science, human life is converging toward Hegel’s *Last Man*: healthy, well-fed, technologically pampered
SCIENTIFIC METHOD

- Occam's Razor
  - Principle proposed by William of Ockham in the fifteenth century ("Occam" is a Latinized variant of Ockham)
  - Law of Parsimony: “Pluralitas non est ponenda sine neccesitate”: “entities should not be multiplied unnecessarily” (i.e., if you have two theories which both explain the observed facts then you should use the simplest until more evidence becomes available)
  - The reason behind the Razor is that for any given set of facts there are an infinite number of theories that could explain them
  - The Razor doesn't say anything about the truth or otherwise of a hypothesis, but rather which one to test first; the simpler the hypothesis, the easier it is to shoot down
  - A related rule (for conspiracy paranoids) is Hanlon's Razor: "Never attribute to malice that which can be adequately explained by stupidity“
SCIENTIFIC METHOD

- **Experimenter effect**
  - Unconscious bias introduced into an experiment by the experimenter, occurring in one of two ways:
    - Scientists doing experiments often have to look for small effects or differences between the things being experimented on: may be perceived even if non-existent
    - Experiments require many samples to be treated in exactly the same way in order to get consistent results: small variations can lead to altered results
  - Note that neither of these sources of bias requires deliberate fraud
Fraud in science

- Quantity of fraud is unanswerable, since undetected fraud is by definition unmeasurable
- But any important result will be replicated many times by many different scientists
  - The existence of known and documented fraud is a good illustration of the self-correcting nature of science; it does not matter if a proportion of scientists are fraudsters because any important work they do will not be taken seriously without independent verification
- Fraud may be more prevalent in certain kinds of research, such as medical research, where companies frequently suppress or distort data in order to support their own products (e.g., tobacco companies produced reports "proving" that smoking is harmless, and drug companies faked and suppressed data related to safety or effectiveness)
PSEUDOSCIENCE

- The 21st century is still not (strictly) an age of science
- Most people still believe in pseudoscientific and non-scientific traditions: religions, myths, magical thinking, superstitions, mysticisms, cults, New Age beliefs, and nonsense of all sorts pervade all societies, including (and perhaps especially) the U.S.

- Non-scientific (i.e., non-evidence based) beliefs include: dowsing, the Bermuda triangle, poltergeists, biorhythms, creationism, levitation, psychokinesis, astrology, ghosts, psychic detectives, UFOs, remote viewing, Kirlian auras, emotions in plants, life after death, monsters, graphology, crypto-zoology, clairvoyance, mediums, pyramid power, faith healing, Big Foot, psychic prospecting, haunted houses, perpetual motion machines, antigravity locations, and astrological birth control
PSEUDOSCIENCE

- Pseudo: means fake
- Pseudoscience
  - Displays a remarkable and characteristic indifference to fact – pseudoscientists simply make up bogus “facts where needed, instead of going to the trouble of consulting reference works of investigating directly – these fictitious facts are often central to the pseudoscientists argument and conclusions (and pseudoscientists never revise)
  - “Research” is almost invariably exegesis, i.e., the pseudoscientist clips newspaper reports, collects hearsay, reads other pseudoscience books, or pours over ancient religious or mythological works and never or rarely ever makes an independent investigation to check sources, which are taken at face value or interpreted as “symbolic,” so that anything can be interpreted from them
PSEUDOSCIENCE

- Pseudoscience
  - Begins with a hypothesis (usually emotionally appealing and spectacularly implausible) and then only seeks evidence which appears to support it, ignoring conflicting evidence
  - Rationalizes strongly held beliefs rather than investigates reality or tests various possibilities
  - Specializes in jumping to “congenial conclusions,” grinding ideological axes, and appealing to pre-conceived ideas and widespread misunderstandings
  - Shows a total indifference to criteria of valid evidence – emphasizes unverifiable eyewitness testimony, stories and tall tales, hearsay, rumor, and dubious anecdotes, not meaningful, controlled, and repeatable scientific experiments
  - Ignores citing genuine scientific literature and never presents any valid evidence for claims
DECISION MAKING

All the important decision-makers in the company are in this room.

No little people are allowed because we'll be making important strategy decisions.

First, let's make decisions about project Opal.

Does anyone know what the project is or what we need to decide?

My executive intuition tells me we should cut the budget by 10%.

I think Opal is one of your projects. It's named after your daughter.

Wait...a new intuition is coming in now...it says to increase the budget.

Why are those meetings secret?

You don't want to know.

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DECISION MAKING

- Common flaws in decision-making
  - Insufficient thought or analysis
  - Act on first impulse
  - Ignore possible alternatives
  - Ignore potential consequences
  - Insufficient information
  - No prioritization
  - Too hasty (rush to judgment)
  - Too emotional
  - Follow orders blindly
  - Accept recommendations blindly
DECISION MAKING

- Process for making good decisions
  - Be clear why decision is necessary
    - Identify and analyze problem
    - Define and analyze objectives
  - Consider alternative courses of action
    - Reasonable number of alternatives for situation
    - Think "out of the box"
  - Consider consequences of the various alternatives
    - Good and bad
    - Probabilities
    - Risk = PC (where P = probability of an event and C = consequence of an event, should it happen)
DECISION MAKING

- Process for making good decisions
  - Consider how likely or unlikely and how valuable or undesirable the possible consequences are
    - Estimated (not exact) probabilities are usually sufficient
    - Perform a risk analysis (for example, comparing outcomes (events) with low probabilities but major consequences with events having high probabilities but with minor consequences)
  - Consider morality or ethics
    - Are there decisions with such morally or ethically repugnant outcomes that they are to be completely avoided?
DECISION MAKING

- Process for making good decisions
  - Determine which alternative decision is best in light of the risk (probability of the outcome and consequences given the outcome)
    - Not making a decision is itself a decision
    - There are generally outcomes and consequences for doing nothing

- Decision making process summary
  - Determine why decision is necessary
  - Determine what is recommended and why it is recommended
  - Determine options and alternatives, whether conventional or unconventional
  - Determine decision outcomes (events) and probabilities and consequences or importance of the outcomes
  - Compare the alternative decisions in light of the risks
  - Make contingency plans to carry out the decision
DECISION MAKING

- Process for making good decisions
  - One might make the right decision (i.e., the best decision given the information available) but not the correct decision (i.e., the best decision given a God’s-eye view of all the information (or the “ground-truth”) of a situation)
  - Example: I leave my current employer to take a new job with better salary, more opportunity, more interesting projects, and a much closer commute, but I am assigned to a boss (whom I did not meet during the interviews) who turns out to be the spawn of Beelzebub
  - I can make the best decision possible, given the information available, which can turn out to be a bad decision – but I still made the right decision

The New Boss