



Critical Thinking

The process we use to reflect on, assess and judge the assumptions underlying our own and others ideas and efforts.

Determines how skillfully someone gathers, processes and applies information in order to identify the best way to reach a goal or navigate a complex situation.

Socratic Questioning is at the Heart of Critical Thinking

Structured Critical Reasoning

To Identify:

- **The conclusions**
 - **The Evidence**
 - **The Assumptions**
 - **The Strength and Weakness of each Assumption**
 - **Fallacies in logic**
-

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Structured Critical Reasoning

Step 1. Identify all the conclusions.

A conclusion is a statement or idea in a document or speech that the writer or speaker wants you to accept.

- Make a list of all the conclusions in the document/proposition/presentation.
 - When looking for the conclusion, ask yourself first “*What are the issues?*”
 - To rapidly identify the conclusion, look for *indicator words* such as
 - *therefore,*
 - *consequently,*
 - *which leads us to,*
 - *proves that,*
 - *the point is, etc.*
- in the written statement or presentation.

Structured Critical Reasoning

Step 2. *Look for the reasons and evidence the author uses to support each conclusion.*

There is an important distinction between *reason* and *evidence*.

- **Reasons** are internal evaluations that can be based on facts and data, but are not necessarily well substantiated.
- Many times reasons are based on feelings, personal experiences and observations, intuition or beliefs such as “I think this statement is true because....
- Reasons are often put forth as evidence and it is up to the analyzer to decide if they are valid.

Structured Critical Reasoning

Step 2. *Look for the reasons and evidence the author uses to support each conclusion.*

There is an important distinction between *reason* and *evidence*.

- **Evidence** is based on external evaluations, such as facts, data, laws, observations, case examples or research findings.
- For each conclusion make a list of all evidence that has been given that you think supports the conclusion.
- How strong is each piece of evidence?
- Does the evidence support the conclusion?
- What evidence would cause you to reject the conclusion?
- Is there a general lack of evidence or has significant information been omitted?

Structured Critical Reasoning

Step 3. *List all major assumptions*

*An assumption is a belief we use to support the evidence.
Make a list of the assumptions in each piece of evidence.
Look for hidden or unspoken assumptions.*

For example “ An employee reported to his supervisor that his work team was not functioning well. He spoke generally about friction between members of the team. The supervisor stated that she would look into it. She noted that just prior to the complaint a new member had been added to the team. Her *hidden assumption* was that because the complaint and the new member’s arrival coincided, there must be a connection. She transferred the new member to a different team, and was surprised when the workgroup continued to have friction and communication problems”.

Structured Critical Reasoning

Step 4. *Evaluate all the assumptions and evidence.*

Our job is to evaluate each assumption to determine whether it is strong or weak, whether it is relevant and whether it is valid?

During the evaluation look for contradictions and for fallacies in the assumptions.

Structured Critical Reasoning

Step 5. Identify Fallacies in Logic

The following table gives eleven common fallacies in logic to look for when evaluating the assumptions used in supporting the evidence and the conclusions

Fallacies in Logic

- Ambiguous or vague words or phrases.
 - Citing a questionable authority
 - Straw Person.
 - False Dilemma, i.e. Either-Or.
 - Red Herring.
 - Slippery Slope.
 - Appeal to Popularity.
 - The Perfect Solution.
 - False, Incomplete or Misleading Facts or Statements.
 - Causal Oversimplification.
 - Hasty Generalization.
-

Eleven Fallacies in Logic to Look For

1. **Ambiguous or vague words or phrases** Uses words, phrases or sentences that have multiple interpretations or really don't say anything.

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“The model is in close agreement with the data.” What does the word “close” mean? What is the measure of a “close agreement?” Within 10%? 50%?

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John agrees with me that consuming energy drinks is bad for you.

What makes John an expert on the perils of drinking energy drinks?

John *could* be an expert dietician studying the subject **or** have no basis for knowing anything about the effects of energy drinks on the body other than an uneducated opinion.

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3. **Straw Person**. Discredits an exaggerated version of an argument.

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Recent auto accidents in your neighborhood have led you to propose to city council to place speed bumps near each of the two intersections along Main Street to calm the traffic flow. Opponents complain that placing speed bumps all up and down the street is counter productive and an unnecessary burden on drivers.

The straw person argument here is the expansion of your proposal from “ a speed bump near each of the two intersections” to “speed bumps all up and down the street”. The attribution of this alternative argument deflects the focus from your true proposal.

Eleven Fallacies in Logic to Look For

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At a recent cocktail party, the conversation has turned to family pets, and your friend asks you “Are you a cat or a dog person?” Your choices here have clearly been limited to two, when in reality there are many others: you may have no interest in pets at all, you may be a bird person, or you may equally enjoy cats and dogs.

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5. **Red Herring**. Introduces an irrelevant topic to distract the conversation from the main topic.

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*You call your cell phone provider to complain about how poor your cell phone battery life is after the recent software update and the representative, instead of responding to your concern, praises the providers **new unlimited text messaging** plans that are due to be released in the next month.*

Eleven Fallacies in Logic to Look For

6. **Slippery Slope**. Assumes that if this fact is true then everything else follows.

For example a father talking *to his daughter on dating a boyfriend he doesn't like*: “*If you continue dating this guy who doesn't take his education seriously, you'll end up dropping out of school, you then won't be able to get a job, and get married too young.*”

Dating someone who doesn't take education seriously does not mean the daughter will drop out of school herself, marry early and be unemployable.

Eleven Fallacies in Logic to Look For

7. **Appeal to Popularity**. Justifies an assumption by stating that large groups have the same concern or that anything favored by a large number of people is desirable.

An opinion article in a campus newspaper states that in an all campus survey, 95% of students think that tuition should be lowered and therefore tuition should be lowered immediately.

The students are biased since they have to pay tuition and are not inclined to think of the budget problems that would be caused if the school lowered tuition for all students.

Eleven Fallacies in Logic to Look For

8. **The Perfect Solution**. Assumes that if a part of the problem is not satisfied or solved (even a small part) then the entire solution should be abandoned.

“Don’t waste your money on a home security system, master thieves will still be able to get into your house.”

However, many thieves may be deterred by a security system.

Eleven Fallacies in Logic to Look For

9. **False, Incomplete or Misleading Facts or Statements**. Presents data in such a way that it falsely leads someone to the wrong conclusion.

“Because 90% of college students polled had no debt, education costs are not a problem.”

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9. **False, Incomplete or Misleading Facts or Statements**. Presents data in such a way that it falsely leads someone to the wrong conclusion.

“Because 90% of college students polled had no debt, education costs are not a problem.”

It's possible that only 10 college students were polled, or that the poll was taken at a banquet for scholarship students.

Eleven Fallacies in Logic to Look For

10. **Causal Oversimplification**. Explaining an event by attributing it to a single factor, when many factors are involved or by overemphasizing the importance of a single factor.

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At a party you overhear a friend tell their spouse “I had high blood pressure at the doctor’s office today, I really need to reduce the stress in my job.” This friend is obviously attributing the high blood pressure reading to job-related stress, while there may be many additional contributing or more important factors (lack of exercise, poor diet, genetic predisposition, white coat syndrome, etc.)

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11. **Hasty Generalization**. Drawing a conclusion about a large group based on the experiences with a few members of the group.

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All engineers are introverts who would rather relate to computers than people

Clearly there are many engineers who are outgoing. It is very dangerous to make sweeping generalizations regarding a group based on limited experience.

Underground Power Lines

Perform an SCR on the article and determine the validity of the author's argument.

The issue of placing overhead power lines underground is raised after all major power outages. This issue when examined on a basis of the costs and benefits to customers and utilities of undergrounding power lines ends up that the costs outweigh the benefits.

Studies show that underground infrastructure tends to have slightly better reliability performance than overhead power lines. However, in a major storm, the entire utility is effected, not just the overhead lines, meaning underground lines would not prevent some outages.

The cost to bury aboveground power lines range from \$80,000 a mile in rural areas to \$2.1 million a mile in urban areas according to a 2009 study. This cost is simply unreasonable for the minimal added utility. Undergrounding power lines is simply not the answer to solve power outages.

Darlington County Press

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Solution

Conclusion:

1. Power lines should not be put underground

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Evidence:

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Evidence:

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Assumptions:

1. Undergrounding power lines is only worth it if it prevents all outages
2. The author correctly calculated the value of the added utility of undergrounding before calling the cost unreasonable

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Strengths and Weaknesses of Assumptions:

1. Questionable assumption – increasing the reliability of the system has some value
2. Questionable assumption – the author is unknown and the facts are not cited

Fallacies in Logic:

1. Fallacy 8 – Perfect Solution. Just because the undergrounding of lines not prevent all outages does not mean it does not still add value to the system.
2. Fallacy 2 – Citing Questionable Authority

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Tracking Phone Call Lengths

It is, once mused an actor of London's east-end origins, "good to talk". Since mobile phones tipped into the mainstream in the late Nineties, we've had voice contact with everyone from loved ones to the local pizza delivery place a pocket's distance away. But, according to the CTIA, the trade group representing the US wireless industry, the average length of our mobile phone calls has dropped drastically in the last six years. In 2006 the average call was 3.03 minutes long. By the end of 2011 they were down to 1.78 minutes.

Tracking Phone Call Lengths

Red: Conclusion(s) **Green: Evidence**

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Tracking Phone Call Lengths

- **Why have we stopped talking? (Or, at least, paying to talk.) The answer,** at least according to a lengthy report in The Wall Street Journal, is – like so many things – down to Apple and its 2007 release of the iPhone, **which allowed users to communicate via numerous non-call routes** including voice-over-internet protocol, email and, latterly (the fee-free) iMessage. The other smartphones that followed Apple only furthered this troublesome development for the phone networks (who will counter it with increased unlimited-call packages).
-

Tracking Phone Call Lengths

- It's not just smartphones, though. Since 2006, **Facebook has gained as many users** as there were on the entire web at its inception in 2004. Twitter has doubt eaten into the SMS market, too. Do we need to no ring cousin Dave to see how his newborn is doing, when we can see pictures of the baby on Facebook and get instant updates from the delivery room? Possibly not. But we won't stop chatting. This week sees the launch of Sean Parker and Shawn Fanning's peer-to-peer chat network Airtime, which hopes to do to the phone industry what their Napster did to music. Which could be great news, unless you own shares in 02 or AT&T.
-

CONCLUSION

Increases in Smartphone and social network usage have caused the decrease in cell phone voice communication.

EVIDENCE

According to the CTIA, the average length of our mobile phone calls has dropped from 3.03 minutes to 1.78 minutes in the last six years

Smartphones have risen in popularity from 2006 to 2011 and offer many additional ways to communicate other than talking

Facebook became continually more popular from 2006 to 2011 and provides information that would be otherwise received over the phone

ASSUMPTIONS

The CTIA is a reliable source for cell phone call information

The decreased average length of calls is due to a reduction in total talking time and is not offset by a greater number of shorter calls

Smartphone non-call communication features can reduce/replace talking on the phone

Utilization of social networks can reduce/replace talking on the phone

STRENGTHS AND WEAKNESSES

Questionable assumption. The CTIA is a trade group representing the US wireless industry and there is no information on their data and it could be biased.

Weak assumption: There is no information provided other than the average call time. Frequent service interruptions could cause calls to be dropped or lost, decreasing average call length with no effect from social media.

Good assumption: The author provides a lot of information about smartphones' features such as voice-over-internet protocol (VOIP), email and, latterly (the fee-free) iMessage, which users can use to communicate instead of calling.

Good assumption: Individuals can get information from others via Facebook such as pictures and status updates that would otherwise be received by calling

FALLACIES IN LOGIC

Fallacy 2 Citing Questionable Authority. There is no reason given to believe the CTIA has accurate data on the length of calls.

Fallacy 4 False dilemma: The author provides no evidence that the total talking time is reduced and not compensated for by more numerous shorter calls.

Reasonable assumption: no fallacy

Reasonable assumption: no fallacy

Conclusion

- Conclusion has mixed support
 - Good case that social networks and Smartphones offer features and capabilities that can replace talking time on phones
 - Does not offer support for the CTIA's data or any other possible causes in the reduction of call duration
-

A Public Health Hazard - Eggs

Carry out a Structured Critical Reasoning analysis of the following synopsis of some articles written about a recent study examining the health effects of eggs.



A Public Health Hazard - Eggs

A recent study performed by Canadian medical researchers on the health effects of eggs has caused quite a stir. They compared the cardiovascular risks associated with eggs to that of smoking. This led to a series of news reports with sensationalized titles like “Eggs Are Nearly as Bad for Your Arteries as Cigarettes” and “Are Eggs the New Cigarettes?”. The study involved approximately 1200 subjects about equally split between men and women who were being treated for cardiovascular diseases. The average age was 61 years old. On their first visit to the Canadian vascular prevention clinics the subjects were surveyed for some baseline characteristics including blood cholesterol, blood pressure, body mass index as well as their total carotid plaque area (mm^2). TPA, was measured ultrasonically. TPA, a protein involved in breaking down blood clots, had previously been proven to be a reliable indicator of cardiovascular risk. Personal habits were also tabulated with a lifestyle survey at the initial visit. Egg consumption and smoking behavior was estimated by the subjects. For egg consumption, if a subject said they consumed two eggs per week for the past 50 years, they were assigned a “score” of 100 egg-yolk years.

A Public Health Hazard - Eggs

Similarly, smoking was estimated by the number of packs per day times the number of years the individual was a smoker (30 years as a smoker of 0.5 packs per day = 15 pack-years). Alcohol consumption and exercise were not taken into account because the textual responses were too hard to quantify (“quit drinking six years ago” and “plays golf twice a week”). The study concluded that the effect of egg-consumption was approximately two-thirds of the deleterious effect produced by smoking on cardiovascular health because carotid plaque area increased for egg-yolk years at 2/3 of the rate it did for pack-years. Interestingly, the highest egg-yolk consumption group (average age 69.77, egg-yolk years >200) had the lowest total cholesterol and the lowest body mass index but the highest TPA of all the groups surveyed.

A Public Health Hazard - Eggs

Answer

Conclusions:

Eggs Are Nearly as Bad for Your Arteries
as Cigarettes

Evidence:

Carotid plaque increased at
approximately 2/3 of that caused by
smoking

Highest egg yolk
group has
highest TPA

Assumptions:

Estimation of
the amount of
eggs eaten per
week is
accurate and
remains
constant

It is valid to
compare the
effect of
smoking with
that of eggs

The study is
applicable to
everyone

Egg
consumption is
the dietary
cause of the
increased TPA

A Public Health Hazard - Eggs

Assumptions:

Estimation of the amount of eggs eaten per week is accurate and remains constant

It is valid to compare the effect of smoking with that of eggs

The study is applicable to everyone

Egg consumption is the dietary cause of the increased TPA

Strengths and Weaknesses:

Questionable assumption - self-reported food surveys, particularly with estimates spanning many years are not reliable

Questionable assumption - smoking inflames the arteries which respond by building up plaque. Eggs are an indirect cause of plaque. They first have to increase cholesterol to create plaque buildup, and the highest consumption group had the lowest total cholesterol.

Questionable assumption - the subjects in the survey were all in poor health going into the study and the average age was 61.

Questionable assumption - The subjects' diets were uncontrolled and could very likely be high in other saturated fats (bacon and eggs, coffee with cream, red meat, etc.)

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Fallacies in Logic:

Fallacy No. 1 Questionable Authority: Assuming that the subject actually can estimate the no. of eggs eaten per week over a period of years is not reasonable.

Fallacy No. 9 - Incomplete data or facts: This evidence is not supported by the fact that the highest egg consumption group had the lowest total cholesterol.

Fallacy No. 11 - Hasty Generalization: individuals who were the subjects of this study and there is no evidence it would apply to healthy does not mean this eggs could very well be an integral part of an overall healthy lifestyle

Fallacy No. 10 Causal Oversimplification: The eggs could be "guilty by association." Other factors in the uncontrolled diet could be responsible.

Fires in Orange County

In the following situation define the Mayor's perceived problem.

In Orange County, Calif., only 2% of firefighter emergency responses involve fires, the rest are car accidents, fender benders, bicycle accidents, and other small medical emergencies. This unnecessary deployment of firefighters wastes money by sending gas guzzling fire trucks and full fire crews to situations they are not needed. The Mayor responds to this data stating that because firefighters are out at the streets on non-fire emergencies, they don't receive the calls and therefore don't respond to many fires in the county. He adds that new fire stations and detection systems should be implemented throughout the region.

- a) Carry out a structured critical reasoning on this situation.
- b) What is the perceived problem.
- c) Ask one of each of the type of Socratic questions about the Mayor's Perceived Problem.
- d) Identify the mayor's real problem.

Fires in Orange County

Solution to Fires

Conclusion:

Add new fire stations

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Solution to Fires

Conclusion:

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Evidence:

Only 2% of the emergency calls involve calls because firefighters are out on non emergencies.

Fires in Orange County

Solution to Fires

Conclusion:

Add new fire stations

Evidence:

Only 2% of the emergency calls involve calls because firefighters are out on non emergencies.

Assumptions:

1. There are fires not being put out. Fighters would respond to more calls if they were in the station and not out on other calls.
2. Save money on gas by not traveling so far with more stations (i.e., greater density of station).

Fires in Orange County

Solution to Fires

Conclusion:

Add new fire stations

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Assumptions:

1. There are fires not being put out. Fighters would respond to more calls if they were in the station and not out on other calls.
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Strengths and Weaknesses of Assumptions:

1. Weak assumption that there are some fires not being responded to.
2. Good assumption in if more stations less distance from a given current station.

Fires in Orange County

Solution to Fires

Conclusion:

Add new fire stations

Evidence:

Only 2% of the emergency calls involve calls because firefighters are out on non emergencies.

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Fallacies in Logic:

1. Fallacy 3 – Incomplete information.
2. Fallacy 11 – Hasty generalization.

Critical Thinking

R.W. Paul's 9 Types of Socratic Questions

- 1) Questions for Clarification:**
- 2) Questions that Probe Assumptions:**
- 3) Questions that Probe Reasons and Evidence:**
- 4) Questions about Viewpoints and Perspectives:**
- 5) Questions that Probe Implications and Consequences:**
- 6) Questions about the Question:**
- 7) Questions that Probe Concepts:**
- 8) Questions that Probe Purpose:**
- 9) Questions that Probe Inferences and Interpretations:**

The Five Building Blocks of the Heuristic

