

## Critical Thinking Starts with Logic...

The field of logic is concerned with arguments, in which two or more statements (called premises or propositions) are presented in order to assert a new claim (the conclusion). Logic is the means by which reliable conclusions are drawn and verified from the stated premises.

Logic makes use of two types of reasoning: inductive and deductive. Inductive reasoning starts with specific facts and tries to create general conclusions, while deductive reasoning starts with general concepts and works toward specific conclusions.

### Inductive Reasoning

Inductive reasoning is based upon arguments which do not contain categorical support for a conclusion. Rather, they confer only probability on the conclusion, which means that it is possible for premises to be true and the conclusion false.

**Example:** The premise that "Most people like ice cream" is true, as is the premise that "Mary is a person". The conclusion that follows, "Mary likes ice cream" is logically correct, but may not be true. The reason for this is that while we have stated that most people like ice cream, Mary may not be one of them.

Because inductive reasoning is based upon probabilities, conclusions are considered to be *cogent*, rather than true. This is because the probability exists that the two accepted premises may not truly lead to the acceptable conclusion.

When developing or listening to an argument, words such as "Most" or "Some" are a tipoff that inductive reasoning is being applied. There are 2 significant ways in which the conclusion can be wrong:

1. It may fall outside of the probability range of the premises, as in the example above.
2. The premise itself may be inaccurate -- Words such as "many" and "some" could be nothing more than editorializing or wishful thinking by the presenter.

If possible, try to turn "Most" into a specific amount, e.g., "80%." Doing so will provide a more accurate framework in which to assess the argument, while not being able to do so is cause for skepticism.

### Deductive Reasoning

Unlike induction, deductive arguments provide absolute support for a conclusion. Deductive reasoning makes the strong assertion that the conclusion *must* follow the premises out of strict necessity. Denying the conclusion means that at least one of the premises is self-contradictory and thus not true.

**Example:** From the statements "All creatures need water to live" and "I am a creature" follows the conclusion that "I need water to live" Note that the critical difference between this line of reasoning and the previous inductive example is the word "All" rather than the word "Most".

Because deductive conclusions must be true if the premises are true, a logically correct deductive argument is termed *valid*. (Note also that deductive reasoning takes arguments from very general to very specific outcomes.)

**The key to the credibility of a deductive conclusion lies in the premises.** Since the conclusion must follow from the premises, the only way for a deductive argument to be considered invalid is if one of the premises is proven false. **Make sure that the word "All" truly applies to the premise in which it is used. Otherwise, the argument will fall apart.**

## The Syllogism

One of the most basic and powerful types of logic is the *syllogism*, which is a simple form of deductive reasoning. Syllogisms consist of a minor premise, a major premise, and a conclusion, and are of the form *If A=B; and B=C; then A=C.*

Form	Proposition	Example
A=B	Minor Premise/ Specific Instance	Murphy is a dog.
B=C	Major Premise/ Generalization	All dogs can bark.
A=C	Conclusion	Murphy can bark.

## Syllogistic Fallacies...

There are at least three ways in which syllogisms and their conclusions can produce faulty conclusions:

### The Undistributed Middle

This fallacy occurs when the middle term is *undistributed*, meaning that it doesn't take into account all of the members of the group being described. An undistributed term makes generalizations invalid, since it doesn't allow for all conditions to be considered. The Undistributed Middle is probably the most common type of reasoning fallacy.

Example:

<b>The Fallacy of the Undistributed Middle</b>		
<b>Form</b>	<b>Proposition</b>	<b>Example</b>
<b>A=B</b>	Major Premise/ Generalization	Oak trees are fast growing plants.
<b>B=C</b>	Minor Premise/ Specific Instance	Some fast-growing plants don't need much water.
<b>A=C</b>	Conclusion	Oak trees don't need much water.

In this example, the conclusion cannot be supported by the facts, thanks to the word "Some" in the second premise. It is possible for the oak tree to be a plant species that is fast growing **and** requires a great deal of water. In fact, it may be that oak trees grow quickly **because** they consume large amounts of water!

This example is very similar to the one used above in the Inductive Reasoning section above. Again, words like "some," "many" and "most" are clues that the logic must be carefully scrutinized.

### The Illicit Major

An *Illicit Major* fallacy occurs when the predicate (last part) of the conclusion is broader than the premises allow:

**Example:** "Dolphins are mammals, not fish. Dolphins swim in the ocean. Therefore, fish don't swim in the ocean." In this case, the premise that "dolphins are mammals, not fish" is undistributed, but ends up (illicitly) as part of the conclusion. The part of the conclusion that's wrong is the predicate "don't swim in the ocean."

### The Illicit Minor

An *Illicit Minor* fallacy occurs when the subject (first part) of the conclusion is broader than the premises allow:

**Example:** "Dolphins are mammals. All dolphins swim. Therefore, all mammals swim." Here, the premise of swimming is undistributed, but ends up in the conclusion. The part that's wrong is the subject "All mammals."

## Other Fallacies...

There are many, many other types of reasoning fallacies. Here are some of the most common:

### **The Irrelevant Conclusion** (*ignoratio elenchi*)

This type of fallacy occurs when an argument is directed at proving an irrelevant or wrong conclusion.

**Example:** A legislator is trying to argue about the merits of her welfare reform bill. Instead of talking about the specific points in the bill, she bases her presentation on the premise that "every American is entitled to a decent standard of living." While the last point may be true, it does not logically make the case that the bill in question will lead to the desired outcome.

There are many variations of the Irrelevant Conclusion, including personal attacks and emotional appeals.

### **Arguing from Ignorance** (*ad ignorantium*)

A fallacy of this type is based on the supposition that failing to disprove an argument means that the premise must be true. Believing in ghosts because it has not been proven that they do not exist is a prime example, as are other forms of superstition.

### **After This, Because of That** (*post hoc, ergo propter hoc*)

This fallacy is also a cause of much superstition, as two independent occurrences become linked in an erroneous cause-and-effect relationship.

**Example:** A black cat runs in front of you on the way to work. After you arrive at the office, you spill coffee on your boss and believe that the black cat brought you bad luck.

This may sound silly, but *post hoc, ergo propter hoc* fallacies are not uncommon in scientific experiments in which the data point to statistical correlations that may not really exist:

**Example:** A survey indicates that the bird population in a certain area is declining, and is statistically correlated with increases in the human population. There may be a correlation, but without looking at other factors including predator/prey populations and rainfall, a valid case cannot be made that the decline in the bird population is due to increases in the human one.

### **The Personal Attack** (*ad hominem*)

The Ad Hominem fallacy creates an irrelevant conclusion by attacking the person rather than the argument.

**Example:** "Thomas Edison couldn't have possibly invented the light bulb because he failed at so many of his other inventive endeavors."

Ad hominem fallacies are very common in political fights, where candidates attack each other's character, rather than their platform or accomplishments. Sometimes, these types of arguments make sense -- If a candidate has a long record of renegeing on promises, it is reasonable to argue that future promises may not be kept. However, it is not valid to argue that a candidate's broken promises in the past indicate that his or her position on welfare reform is untenable.

## Composition and Division

Fallacies of *composition* involve applying standards from a small set to a much larger one:

**Example:** "If a few ladybugs help control insect pests, a huge number of them will be even more beneficial." This may turn out to be anything but the truth!

Fallacies of *division* result when we assume that the value of the whole will be distributed to the parts:

**Example:** "The Rolling Stones were one of the most successful rock and roll groups of the Century. Therefore, each of the members will be highly successful when the band splits up." Not necessarily!

These two fallacies can be summarized as follows: If a little is good (bad), a lot is better (worse); or if a lot is good (bad), a little will also be good (bad). **Watch out for fallacies of composition and division when reviewing arguments related to issues of risk, economics, and epidemiology.**

**Example:** Arguing that "if a very large dose of a certain drug or chemical is harmful, a small one will be harmful, too" may be a fallacy of division. Conversely, arguing that "if a small amount of a drug or chemical is safe, a large amount will also be safe" may be a fallacy of composition.

## Begging the Question (*petitio principii*)

Otherwise known as a circular argument, the conclusion also appears as an assumption and creates a faulty line of logic, as follows:

**Ann:** "To approve your application, we need a reference."

**Sam:** "Why not talk to my friend Bill?"

**Ann:** "OK, but how do I know that Bill is trustworthy?"

**Sam:** "I'd be happy to vouch for him."

## The Slippery Slope

This fallacy occurs when, without sufficient evidence, an idea is criticized because it will inescapably lead to a cataclysmic result. It is assumed that once a proposal is set in motion, results slide down an unrecoverable slippery slope.

**Example:** "Television is a powerful medium that allows people to view horrible acts of violence. Viewing horrible acts of violence will make people more violent themselves. The next thing you know, the murder rate will skyrocket and we'll all be forced to barricade our homes."

### The Complex, or Loaded, Question

This fallacy is based upon a question in which the answerer who responds directly will automatically become committed to its presuppositions, which are usually very unfavorable. The classic situation is:

*Yes or no professor, have you stopped beating your wife?*

Not matter if he answers 'yes' or 'no', the professor will be considered to have beaten his wife at some point in time.

This trick is used often, as in "When did your firm first learn that it was polluting the environment?" or "Have you told the members of the group that you have been illegally using hard-earned donations from thousands of contributors to pay for your personal expenses?"

### Rhetoric...

If logic tells us **what** to say, rhetoric tells us **how**. Such linguistic terms as the metaphor, simile, and euphemism; as well as hyperbole, irony, and personification; are all rhetorical tools.

Rhetoric can be used to increase the power of logic. Going back to the concept of the syllogism, there is a short form known as an *enthymeme*.

**Example:** "You can't create a successful program without a lot of money, and we certainly have a long way to go before we can call ourselves successful." The audience is left to figure out that there isn't a lot of money available.

This approach draws the audience into the presentation by making them actively involved. This cooperative understanding helps provide the speaker with a greater level of credibility, which is a very valuable commodity, especially if the next part of the presentation involves fund raising.

But rhetoric can also be used to confuse or offset logic, either through word play or emotional appeal.

### Wordplay

Wordplay can be hard to decipher, especially when it's used in advertising (which it frequently is).

**Example:** An aspirin manufacturer claims that "*when it comes to pain relief, there's nothing better than our Blaxo.*" At first glance, most people will think this means that Blaxo is the best product on the market. A closer look tells a different story: By stating that there is nothing better, what is really being said is that *Blaxo and its competitors perform similarly.*

## Emotional Appeals

There are four common appeals which can legitimately be called logical fallacies as well as rhetoric. They are listed here rather than in the logic section because of their emotional nature, as well as the fact that, in some cases, they actually may be valid arguments.

- **Appeals to Popular Sentiment** (*ad populum*)  
An ad populum argument tries to appeal to mass enthusiasms or passions. A political advertisement in which the candidate is shown kissing babies, while the flag flies proudly in the background and the national anthem blares, is a good example. The appeal usually lacks any substantive facts or arguments and plays to the heart, not the head.
- **Appeals to Authority** (*ad verecundiam*)  
Appeals to authority involve the use of experts as a way to build credibility for an argument. When the particular person or group is an expert in the field at hand, this type of appeal can be a valid way to enhance the appeal of an argument.

However, there are three occasions in which appeals to authority should be viewed with suspicion:

1. If the authority mentioned is not an expert in the field being cited. ("...talking to us today about monetary policy is that well known biologist...")
  2. When the authority or field is vague (e.g., "According to the experts...").
  3. When the "expert" is not an authority at all. (This is a popular scheme used by both business and special interest groups. Famous actors with no true expertise are used as a way to enhance appeal and hopefully credibility.)
- **Appeals to Pity** (*ad misericordium*)  
This type of appeal uses feelings of sympathy or empathy to overcome facts. The classic (and possibly funniest) example comes from a Yiddish story, in which a young man who has killed his parents begs the Court for mercy because he is an orphan!
  - **Appeals to Force** (*ad baculum*)  
The concept of "you either believe what I say or I'll break your leg" may sound funny or absurd, but it is used all the time by totalitarian regimes, terrorists and criminals.

## Summary...

**Logic and rhetoric together form the basis of reasoning**, making them essential to the process of critical thinking. A thorough understanding of both will significantly increase the chances of making good decisions and decrease the chances of being fooled by faulty arguments or clever use of words.

Here are concepts to consider when being asked to agree or disagree with a particular statement or point of view:

## Reasoning Crib Sheet

1. **Break arguments down into easy-to-understand steps of the A=B, B=C variety.** If arguments seem too complex to be broken down, treat them with caution.
2. **Be careful about drawing firm conclusions when the premises include words like "some", "many" or "most."** These words signal the use of inductive reasoning, which means that conclusions are based upon probabilities, and are not certain.
3. **Be sure that premises using the word "All" are true and not merely hyperbole.** Also, clarify statements that lead you to assume the word "All", such as "Trees need lots of light." It's possible that some trees can grow well in the dark, making airtight conclusions impossible.
4. **Avoid other overly conceptual generalizations,** such as "science has discovered that..." or "from history, we have learned that..." No one person can speak for all of science, history, medicine, etc.
5. **Appeals based upon emotion, not facts, are cause for skepticism.** The lack of hard data or evidence indicates that the presenter is on shaky ground.
6. **Make sure that authorities are speaking within their areas of expertise.** An economist is not an expert on ecology any more than an ecologist is an expert on the economy.
7. **Make sure that authorities truly are authorities.** Like the rest of us, actors, musicians, politicians and sports figures cannot usually be counted upon to truly understand fields outside of their own. Unless talking about their particular expertise, their opinions are worth no more or less than yours.
8. **Be wary of claims stating that if a little of something is good, then a lot will be great; or if a lot of something is bad, a little of it also will be bad.** There are very few linear relationships in the real world. Complex interactions are characterized by thresholds of change and not by ongoing, straight-line projections.
9. **Trust your instincts.** If the presented case doesn't seem to make sense, or defies common sense, get more information or ask to have the argument restated.
10. **Ask for help.** Very few people can effectively think through complex issues by themselves. Don't be afraid to get additional help or advice!



## References...

1. [Clear Thinking](#), Hy Ruchlis (Prometheus Books, 1990).
2. [The Elements of Logic](#), Stephen F. Barker (McGraw-Hill, 1989).
3. [Informal Logic](#), Douglas N. Walton (Cambridge University Press, 1989).
4. [The Logic of Failure](#), Dietrich Dorner (Perseus Press, 1997).
5. [The Power of Logical Thinking](#), Marilyn vos Savant (St. Martin's Press, 1997).
6. [The Realm of Rhetoric](#), Chaim Perelman (University of Notre Dame Press, 1980).