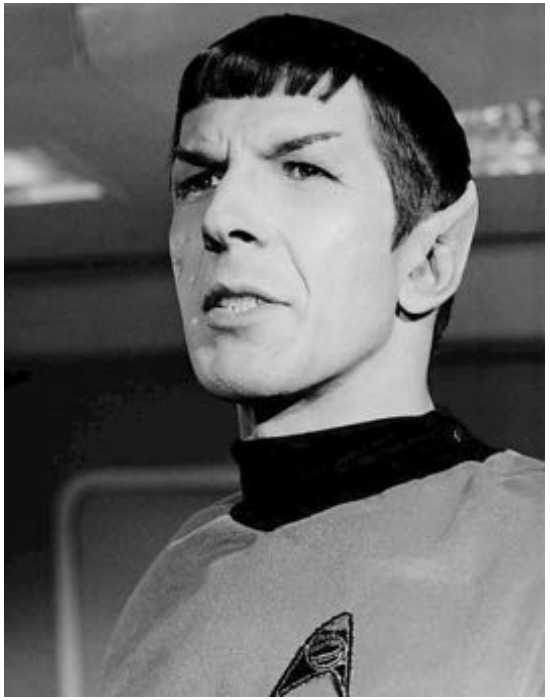
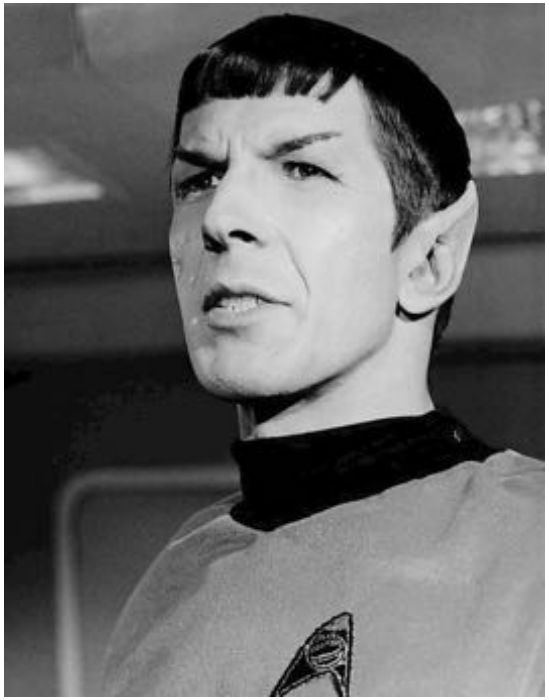
Reasoning

http://compcogscisydney.org/psyc2071/

Danielle Navarro



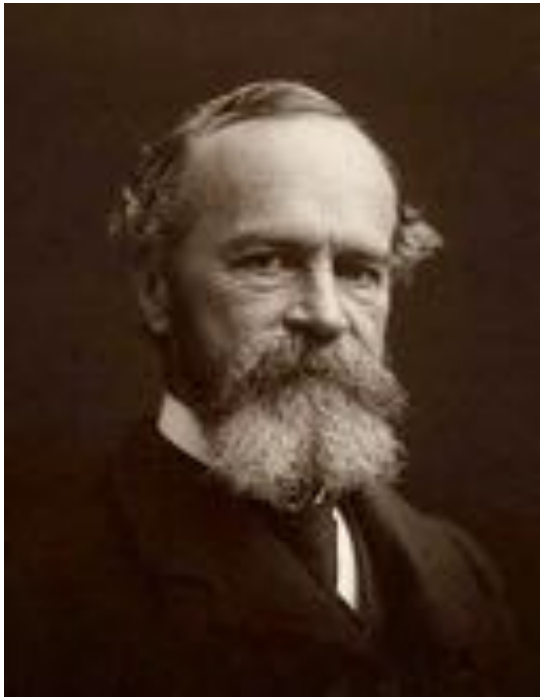
- Deductive reasoning
- Inductive reasoning
- Informal reasoning



"WE talk of man* being the rational animal; and the traditional intellectualist philosophy has always made a great point of treating the brutes as wholly irrational creatures.

Nevertheless, it is by no means easy to decide just what is meant by reason"

- William James (1890)



Reasoning, logic and truth

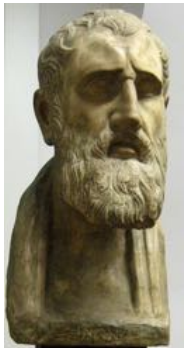
Aristotle

… and the peripatetics

Philo

… and the dialecticians

Zeno



… and the stoics

- How is the truth of a claim established?
- What should we believe?
- Are there rules we should follow?
- What are these rules?
- (And do we follow them?)

http://plato.stanford.edu/entries/logic-ancient/

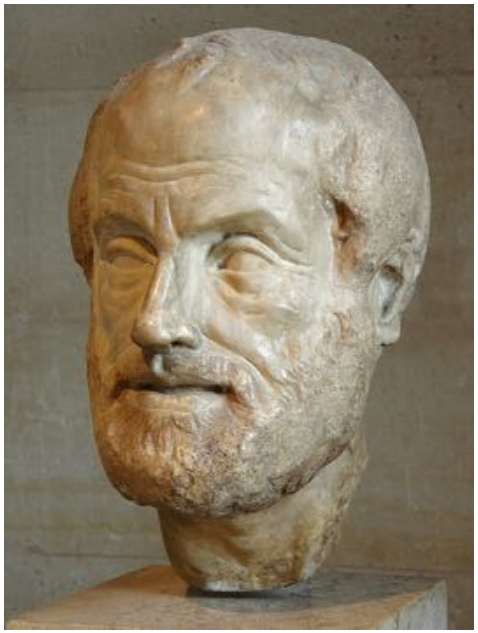
Kinds of reasoning

Deductive reasoning	→	Using facts to reach a "logically certain" conclusion

Kinds of reasoning

Deductive reasoning	→	Using facts to reach a "logically certain" conclusion
Inductive reasoning	→	Using facts to reach a "plausible" conclusion (allows room for doubt)

Part 1:
Deductive reasoning



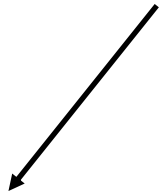
"Syllogisms" are a tool for formalising arguments

All men* are mortal
Socrates is a man

Therefore, Socrates is mortal

(*With very sincere apologies to everyone for the sexist framing here – this specific phrasing has a long history)

The major premise states a general rule



All men* are mortal

Socrates is a man

Therefore, Socrates is mortal

The major premise
states a general rule

The minor premise
states a specific fact

All men* are mortal

Socrates is a man

Therefore, Socrates is mortal

The major premise
states a general rule

The minor premise
states a specific fact

All men* are mortal
Socrates is a man

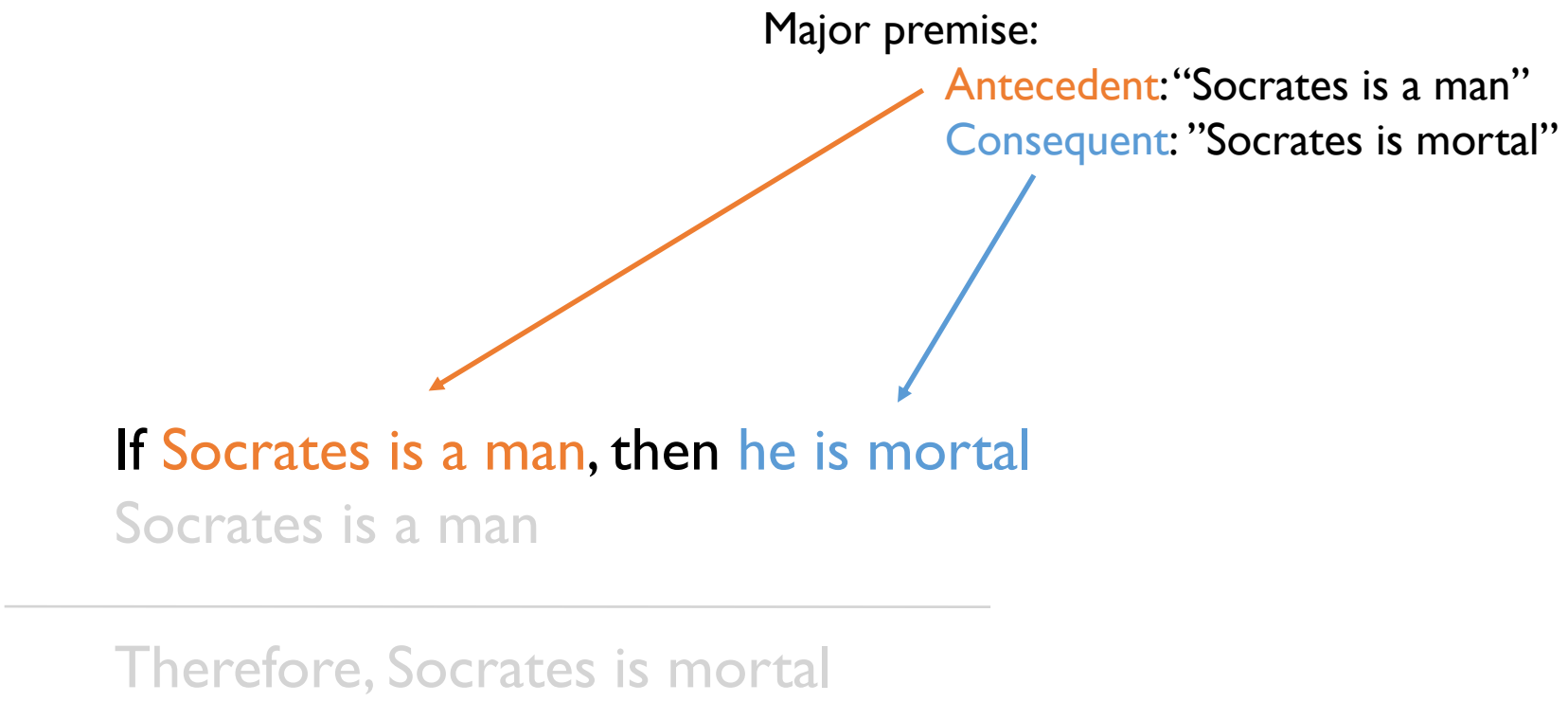
Therefore, Socrates is mortal

The conclusion is the statement
we are asked to accept

A slight variation on this argument

If Socrates is a man, then he is mortal
Socrates is a man

Therefore, Socrates is mortal


Major premise:
Antecedent: "Socrates is a man"
Consequent: "Socrates is mortal"
If Socrates is a man, then he is mortal
Socrates is a man
Therefore, Socrates is mortal

Major premise:

Antecedent: "Socrates is a man"

Consequent: "Socrates is mortal"

If Socrates is a man, then he is mortal

Socrates is a man

Therefore, Socrates is mortal

No changes to the minor premise or the conclusion

If Socrates is a man, then he is mortal

Socrates is a man

"Affirming" evidence refers to a fact (in the minor premise) that agrees with the major premise in some sense

If Socrates is a man, then he is mortal

Socrates is NOT a man

"Denying" evidence refers to a fact (in the minor premise) that disagrees with the major premise in some sense

- Valid arguments:
  - Conclusion is *necessarily* true if the premises are true
  - i.e., it is impossible for the premises to be true and the conclusion to be false (at the same time)

Valid argument by affirmation…

(positive evidence)

	Affirms	**Denies**
Antecedent	"Modus ponens" ✓	Denying the antecedent
Consequent	Affirming the consequent	"Modus tollens"

Modus ponens

("the way that affirms")

If Socrates is a man, then he is mortal

Socrates is a man

Therefore, Socrates is mortal

← Minor premise asserts that the antecedent of the major premise is TRUE

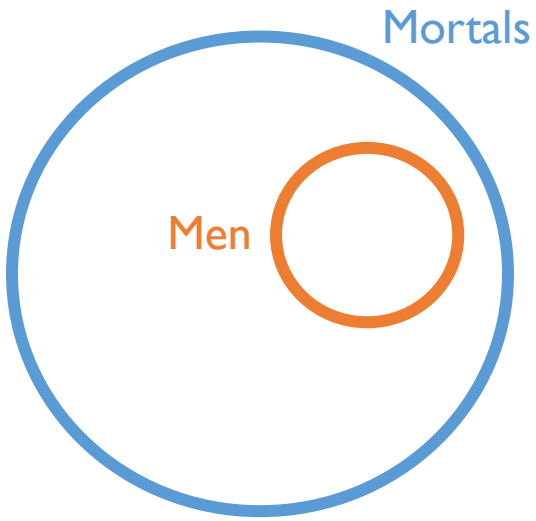
Modus ponens

("the way that affirms")

If Socrates is a man, then he is mortal

Socrates is a man

Therefore, Socrates is mortal



This Venn diagram describes the structure of the major premise (*sort of)

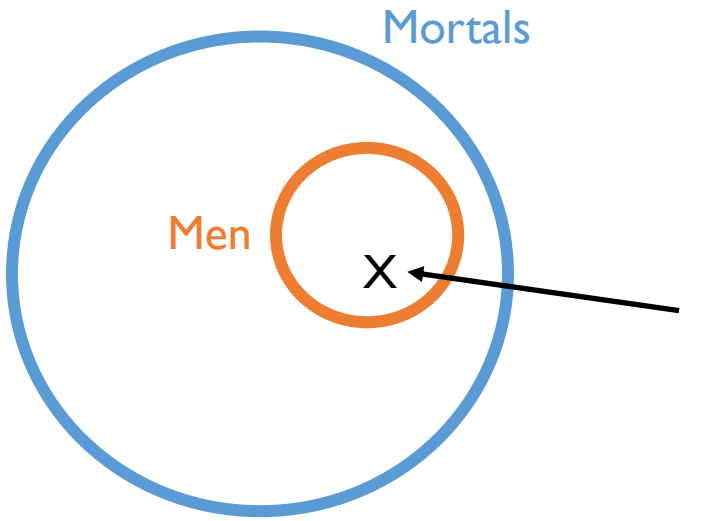
Modus ponens

("the way that affirms")

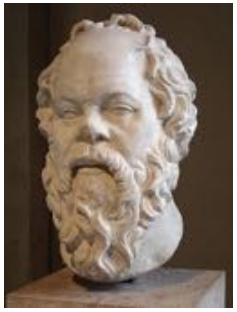
If Socrates is a man, then he is mortal

Socrates is a man

Therefore, Socrates is mortal



It's impossible to put the x inside the "man circle" and outside the "mortal circle"



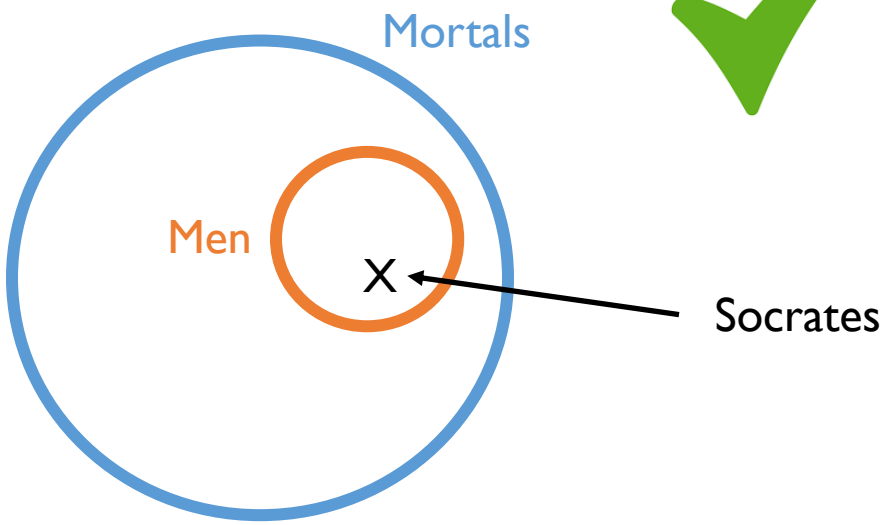
Modus ponens

("the way that affirms")

If Socrates is a man, then he is mortal

Socrates is a man

Therefore, Socrates is mortal



Valid argument by denial…

(negative evidence)

	Affirms	Denies
Antecedent	"Modus ponens"	Denying the antecedent
Consequent	Affirming the consequent	"Modus tollens" ✓

Modus tollens

("the way that denies")

If Socrates is a man, then he is mortal

Socrates is a NOT a mortal

Therefore, Socrates is NOT a man

← Minor premise asserts that the consequent of the major premise is FALSE

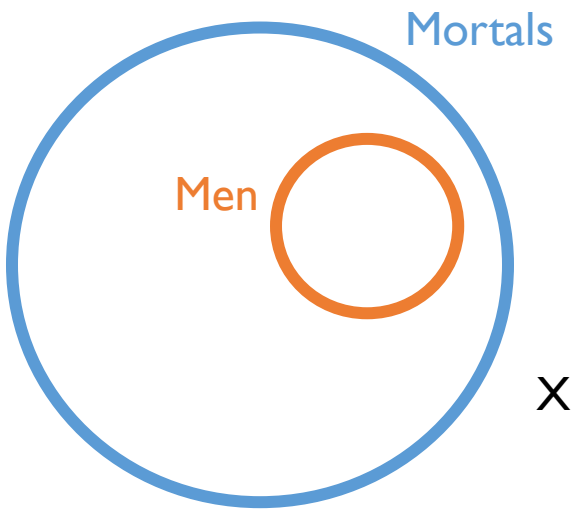
Modus tollens

("the way that denies")

If Socrates is a man, then he is mortal

Socrates is a NOT a mortal

Therefore, Socrates is NOT a man



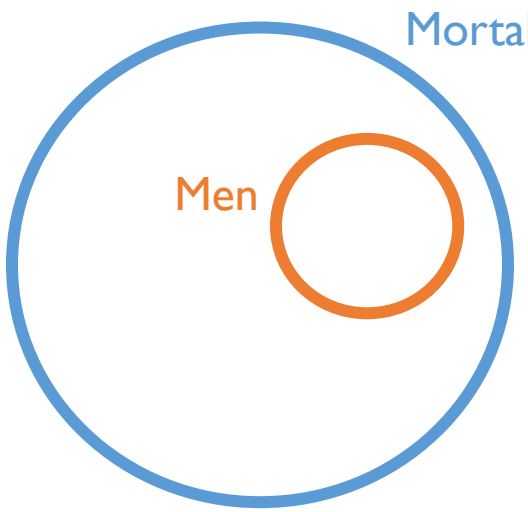
If Socrates is outside the mortal circle, then "he" can't be inside the man circle

Modus tollens

("the way that denies")

If Socrates is a man, then he is mortal
Socrates is a NOT a mortal

Therefore, Socrates is NOT a man



- Valid arguments:
  - Conclusion is *necessarily* true if the premises are true
  - i.e., it is impossible for the premises to be true and the conclusion to be false (at the same time)

- Invalid arguments:
  - Conclusion *might* be true, but it is not guaranteed by the premises
  - i.e., it is *possible* for the premises to be true but the conclusion can still be false

Invalid argument by affirmation…

	Affirms	Denies
Antecedent	"Modus ponens"	Denying the antecedent
Consequent	Affirming the consequent 	"Modus tollens"

Affirming the consequent

If Socrates is a man, then he is mortal
Socrates is mortal

Therefore, Socrates is a man?

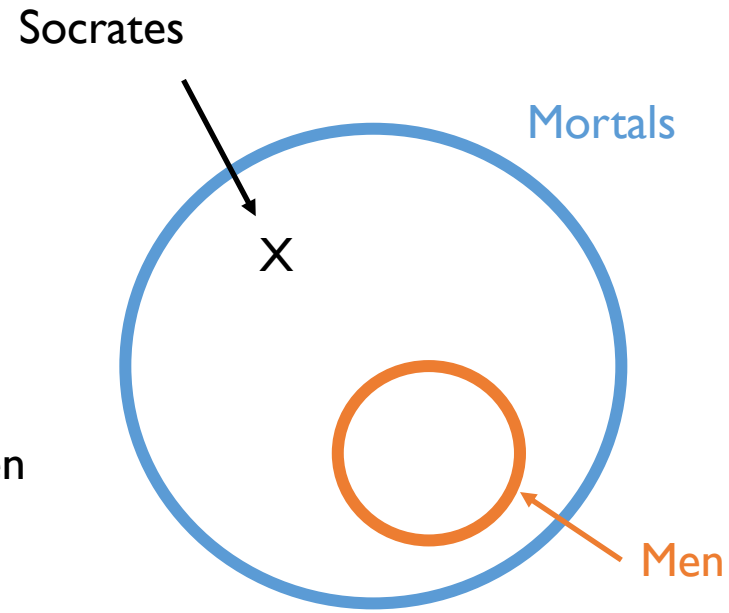
← Minor premise asserts that the consequent of the major premise is TRUE

Affirming the consequent

If Socrates is a man, then he is mortal
Socrates is mortal

Therefore, Socrates is a man?

This is invalid because there are other things that are mortal without being men



Invalid argument by denial…

	Affirms	Denies
Antecedent	"Modus ponens"	Denying the antecedent 
Consequent	Affirming the consequent	"Modus tollens"

Denial of the antecedent

If Socrates is a man, then he is mortal
Socrates is a NOT a man

Therefore, Socrates is NOT a mortal?

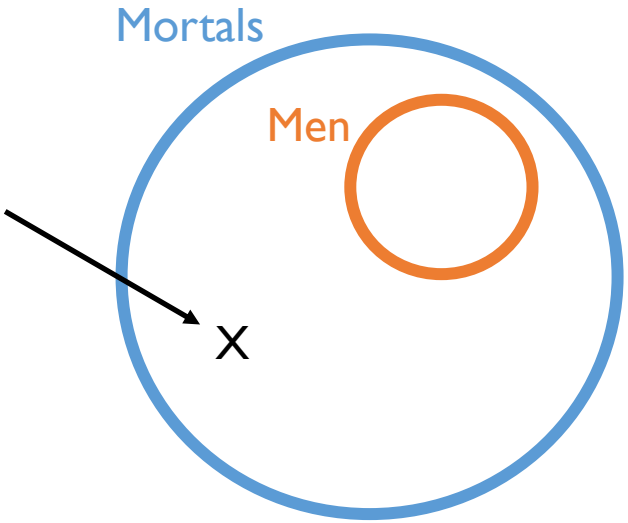
← Minor premise asserts that the antecedent of the major premise is FALSE

Denial of the antecedent

If Socrates is a man, then he is mortal
Socrates is a NOT a man

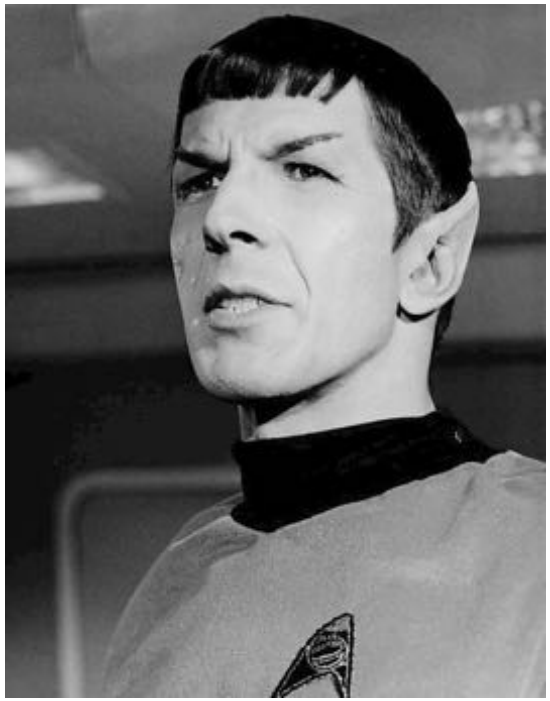
Therefore, Socrates is NOT a mortal?

As before... we have a mortal that is not a man

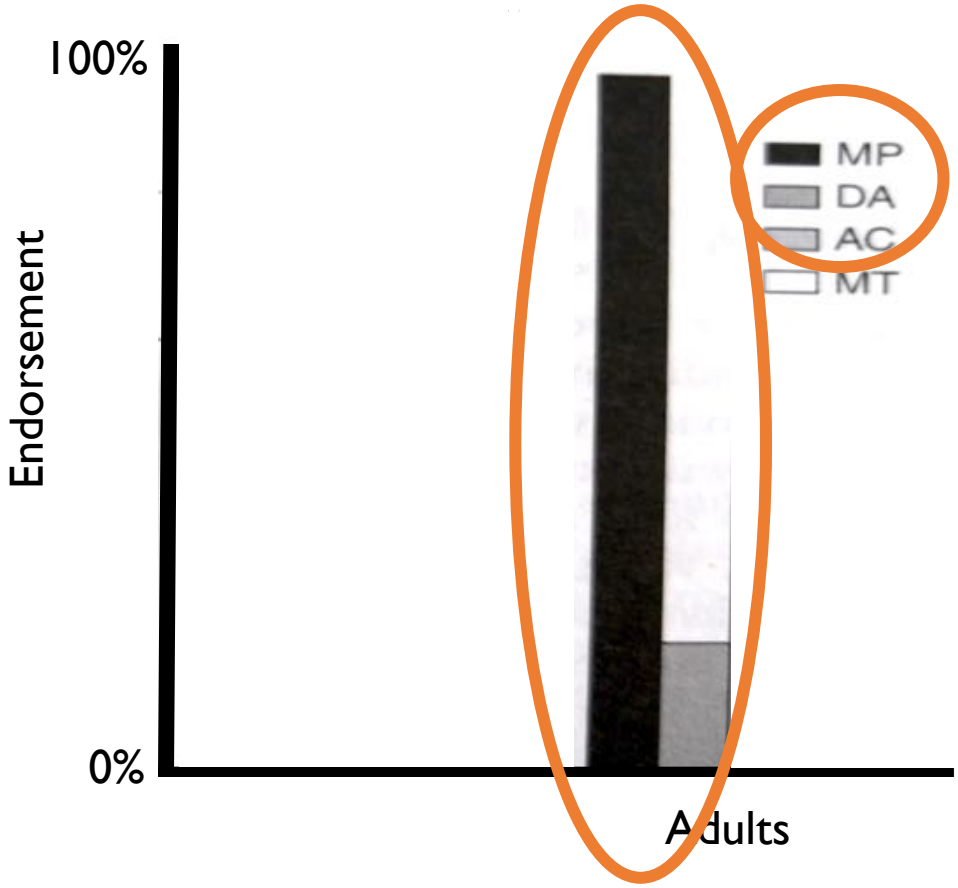


	Minor premise AFFIRMS…	Minor premise DENIES…
… the ANTECEDENT	**Modus Ponens (MP)** If P, then Q P Therefore, Q	**Denying the Antecedent (DA)** If P, then Q not P Therefore, not Q
… the CONSEQUENT	**Affirming the Consequent (AC)** If P, then Q Q Therefore, P	**Modus Tollens (MT)** If P, then Q not Q Therefore, not P

Do people follow these deductive rules?

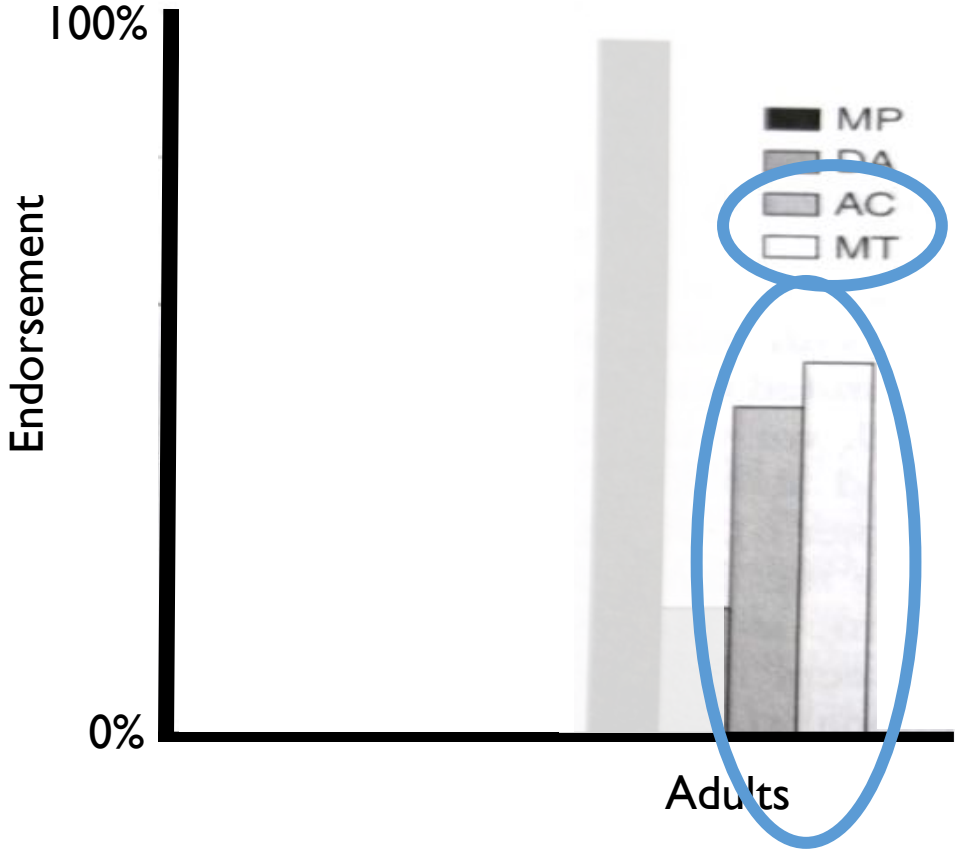


Barrouillet et al (2000)



Adults are good with arguments about the **ANTECEDENT**

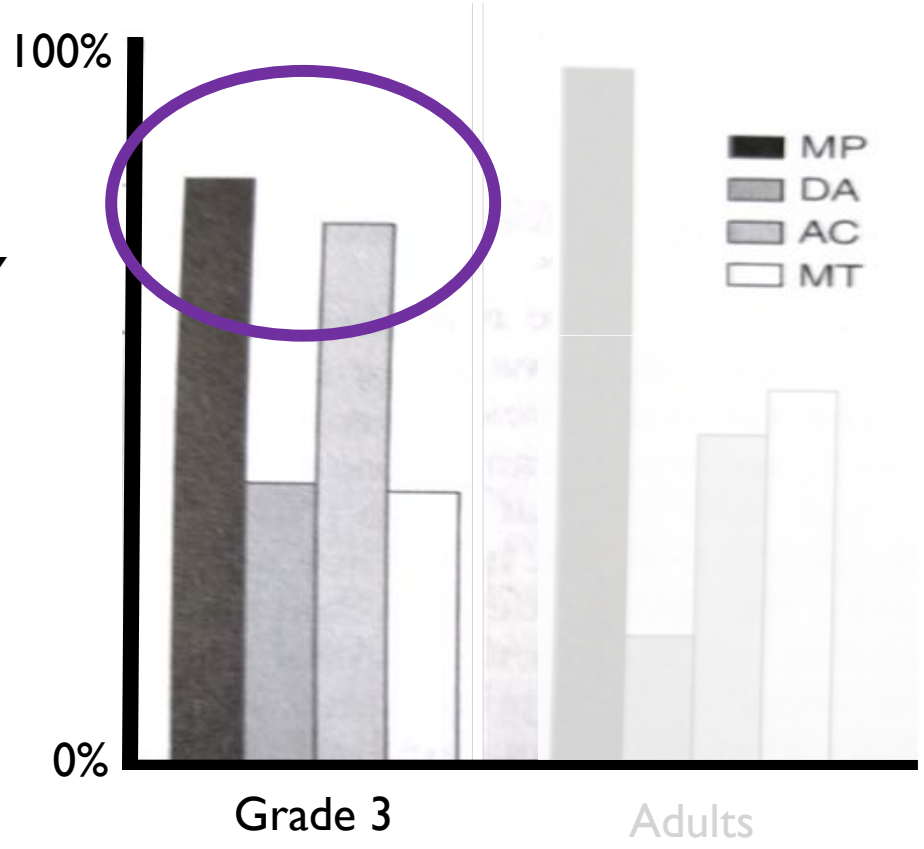
Barrouillet et al (2000)



We're not so sure what to do when the argument pertains to the **CONSEQUENT**

Barrouillet et al (2000)

Kids assume that **AFFIRMATORY** arguments are correct?

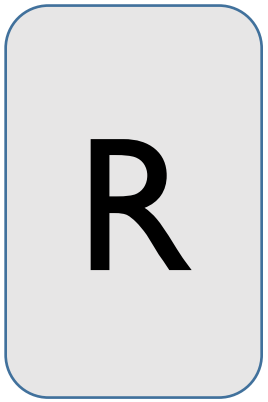


Wason's (1968) selection task

Rule: If there is an R on one side of the card, then there is a 2 on the other

Wason's (1968) selection task

Rule: If there is an R on one side of the card, then there is a 2 on the other



Does this need to be turned?

Wason's (1968) selection task

Rule: If there is an R on one side of the card, then there is a 2 on the other

Does this need to be turned?

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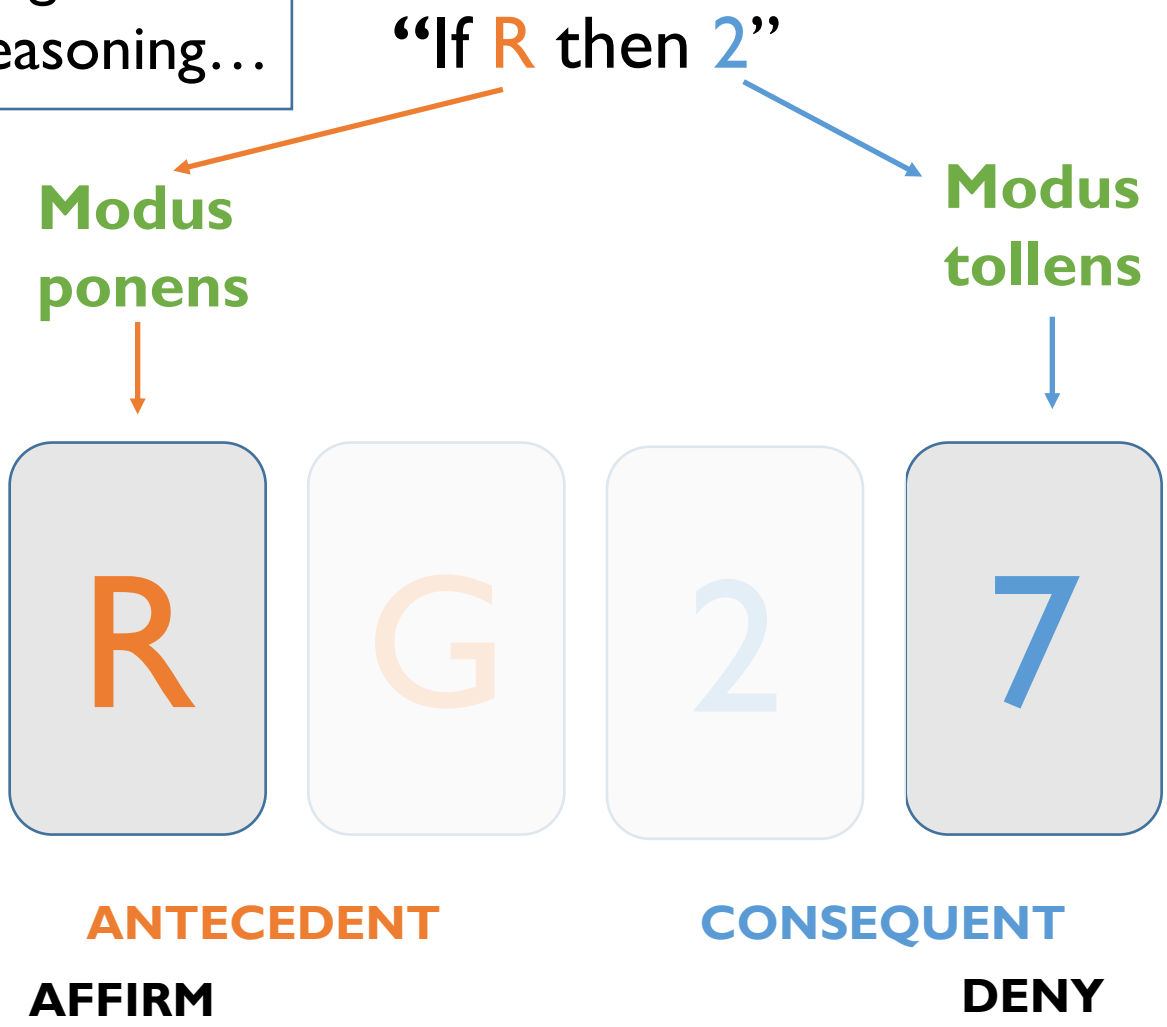
Wason's (1968) selection task

Rule: If there is an R on one side of the card, then there is a 2 on the other

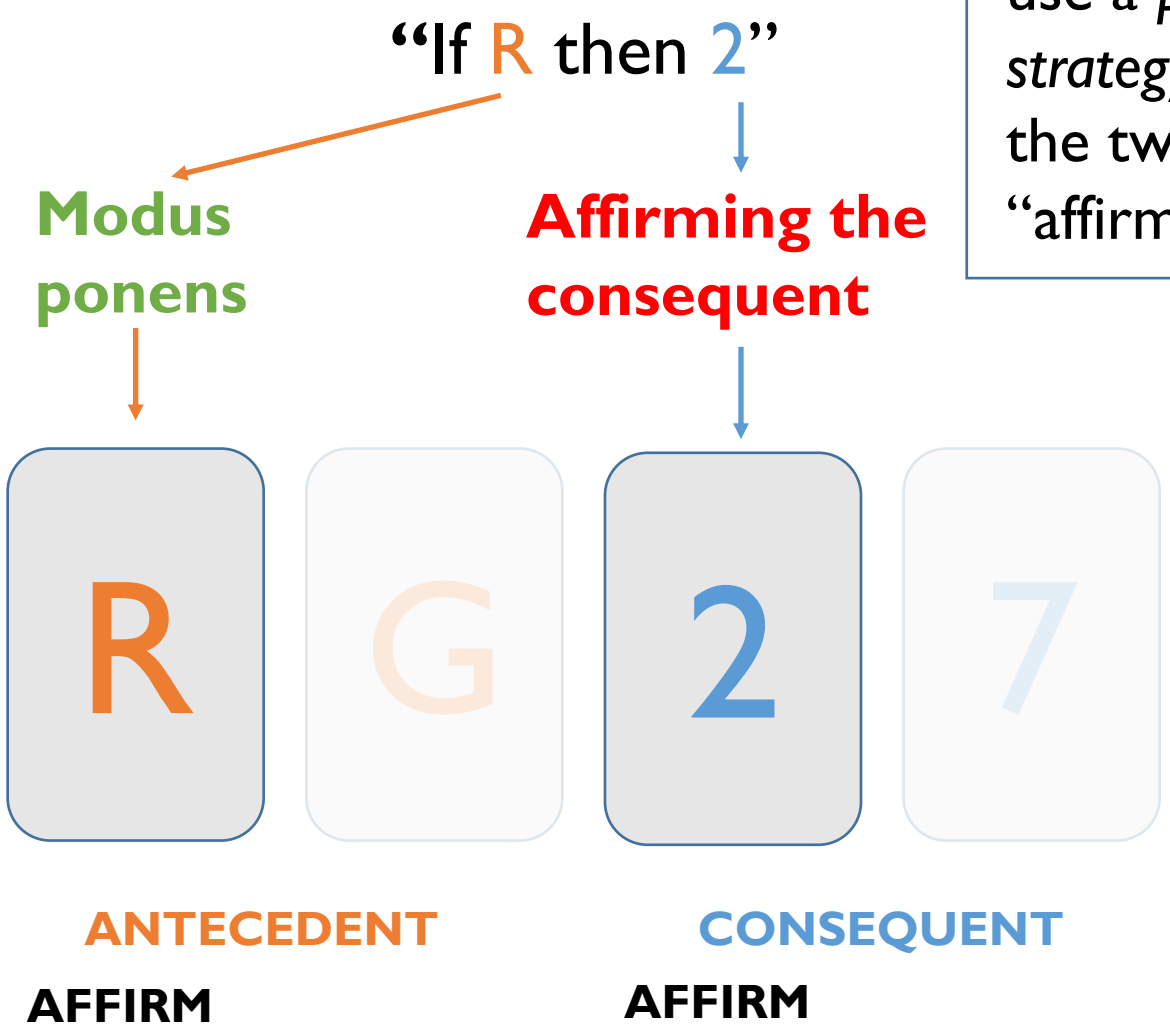
Does this need to be turned?

Rule: If there is an R on one side of the card, then there is a 2 on the other

If people solved the problem using deductive reasoning…

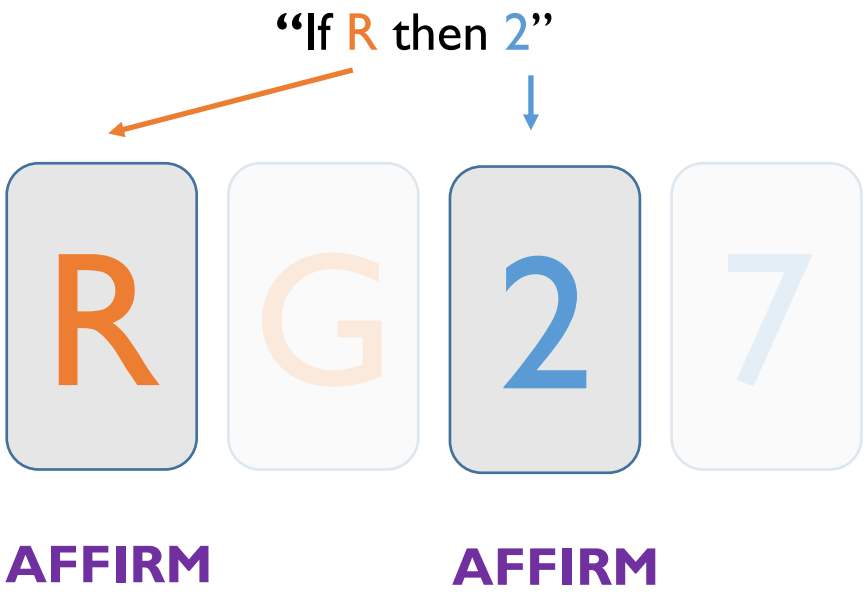


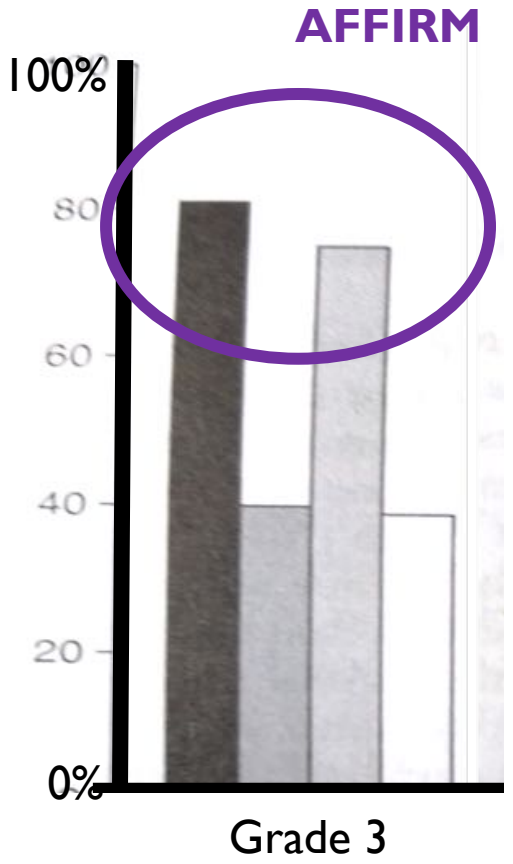
NOPE… people use a *positive test strategy**, selecting the two cards that "affirm" the rule



* More traditionally called "confirmation bias" but this terminology is misleading

Aside: note the similarity between adults and kids…





… humans ***like*** positive evidence

(there's a good reason for this, btw)

People are better at deontic versions of the selection task

Indicative rule

- *if this then that*
- "On Monday I wear black"

(Sperber & Girotto 2002)

People are better at deontic versions of the selection task

Indicative rule

- *if this then that*
- "On Monday I wear black"

Deontic rule

- *if this then you should that*
- "On Monday you MUST wear black"

(Sperber & Girotto 2002)

Whose ID needs to be checked?

Minor drinking
SOMETHING

Whose ID needs to be checked?

Minor drinking
SOMETHING

Adult drinking
SOMETHING

Whose ID needs to be checked?

Minor drinking SOMETHING

Adult drinking SOMETHING

SOMEONE drinking tea

Whose ID needs to be checked?

Minor drinking SOMETHING

Adult drinking SOMETHING

SOMEONE drinking tea

SOMEONE drinking beer

Whose ID needs to be checked?

Minor drinking SOMETHING

Adult drinking SOMETHING

SOMEONE drinking tea

SOMEONE drinking beer

Modus ponens

Modus tollens

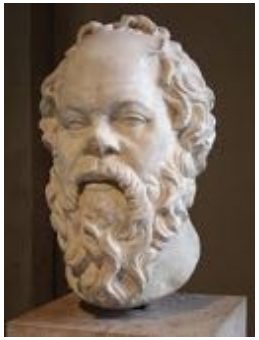
(Sperber & Girotto 2002)

Mini-summary

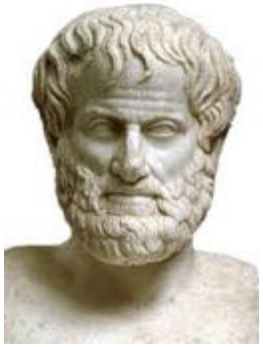
- Logical reasoning
  - Definitions of deductive and inductive reasioning
  - Syllogisms and how they work
  - Definitions of valid and invalid reasoning
  - Four argument types: MP, MT, DA and DC

- Empirical evidence
  - Developmental changes?
  - Wason selection task
  - Indicative vs deontic versions

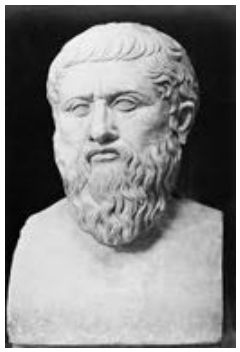
Part 2:
Inductive reasoning



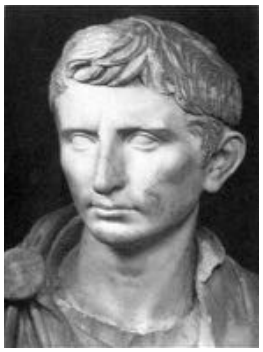
Socrates
was mortal



Aristotle
was mortal



Cicero
was mortal



Augustus
was mortal

→ All humans are mortal?

Inductive arguments rely on limited evidence to make a (general or specific) conclusion seem more ***plausible***

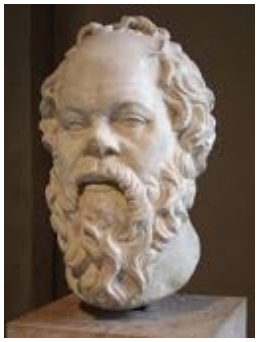
Socrates
was mortal

Aristotle
was mortal

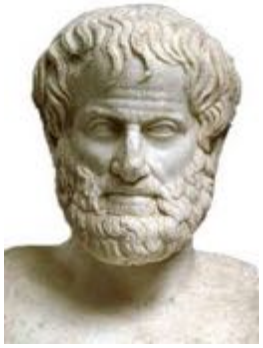
Cicero
was mortal

Augustus
was mortal

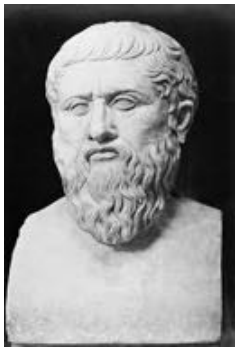
All humans
are mortal?



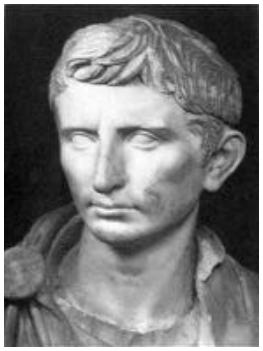
Socrates
was white



Aristotle
was white



Cicero
was white

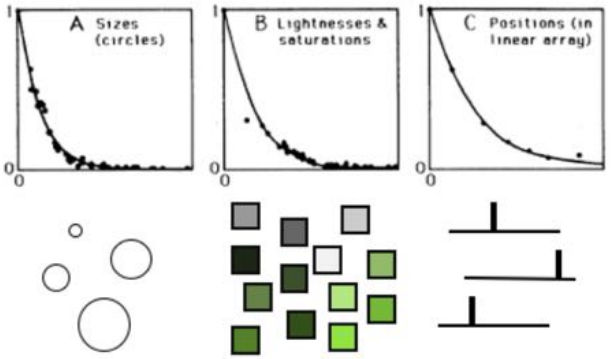


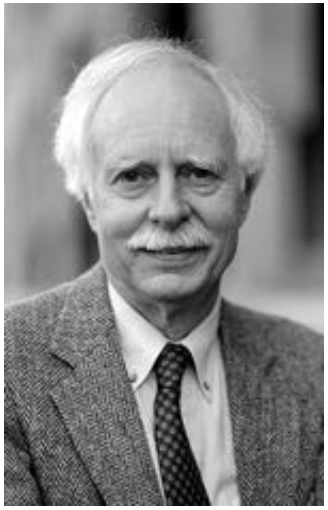
Augustus
was white

All humans
are white.
And male?
And statues?

It... um… doesn't always work

(FYI, we've seen inductive reasoning in the last lecture…)





"Generalising from one stimulus to another is an act of induction"

Inductive arguments

Dolphins express the TH4 gene

Seals express the TH4 gene

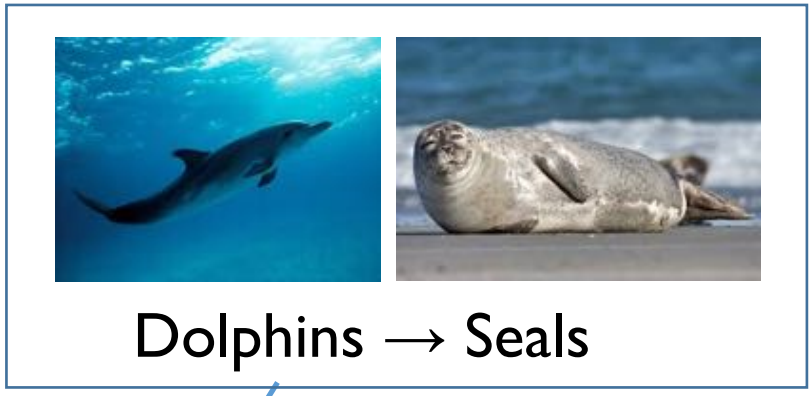
Dolphins → Seals

Argument strength = do the premises make the conclusion feel more believable?

Which feels stronger?

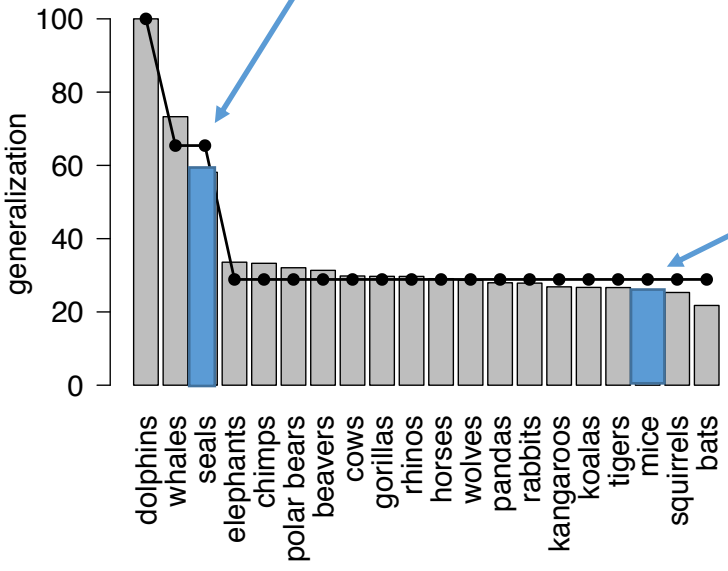

Dolphins → Seals


Dolphins → Mice



Dolphins → Seals

Dolphins → Mice



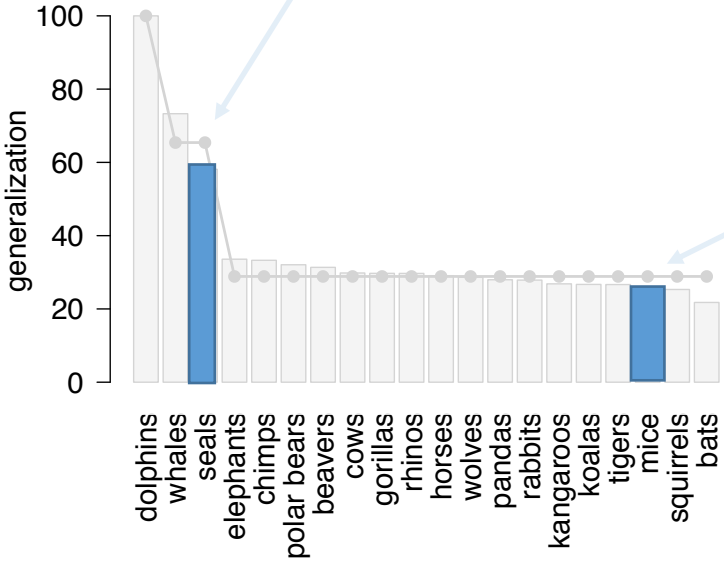
(Data from Tauber, Navarro, Perfors & Steyvers, in press)

Premise-conclusion similarity

(Osherson et al 1990)

Dolphins → Seals

Dolphins → Mice



People are more willing to endorse an inductive argument when the premise and conclusion items are similar

Which feels stronger?

Dolphins + **Seals** → Cows



Dolphins + **Mice** → Cows

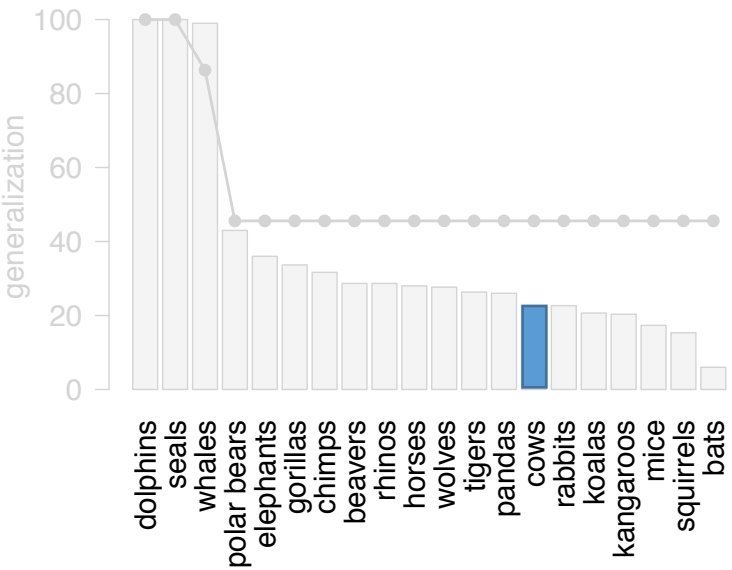


Premise diversity

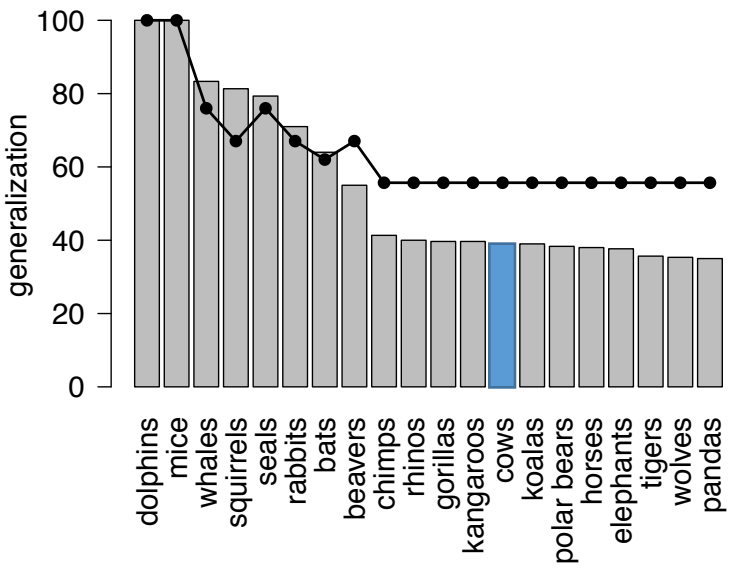
(Osherson et al 1990)

People are more willing to endorse an inductive argument when the premises are dissimilar

Dolphins + **Seals** → Cows



Dolphins + **Mice** → Cows



Which feels stronger?

Dolphins → Cows


Dolphins + **Mice**→ Cows

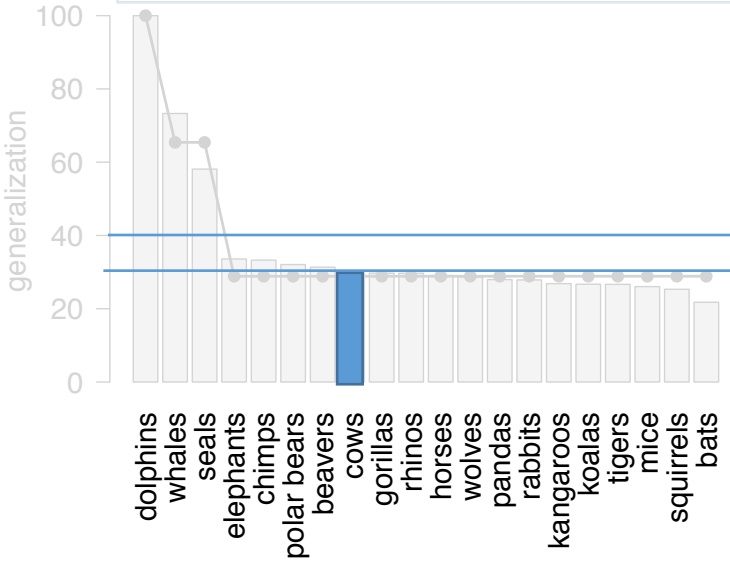


Premise monotonicity

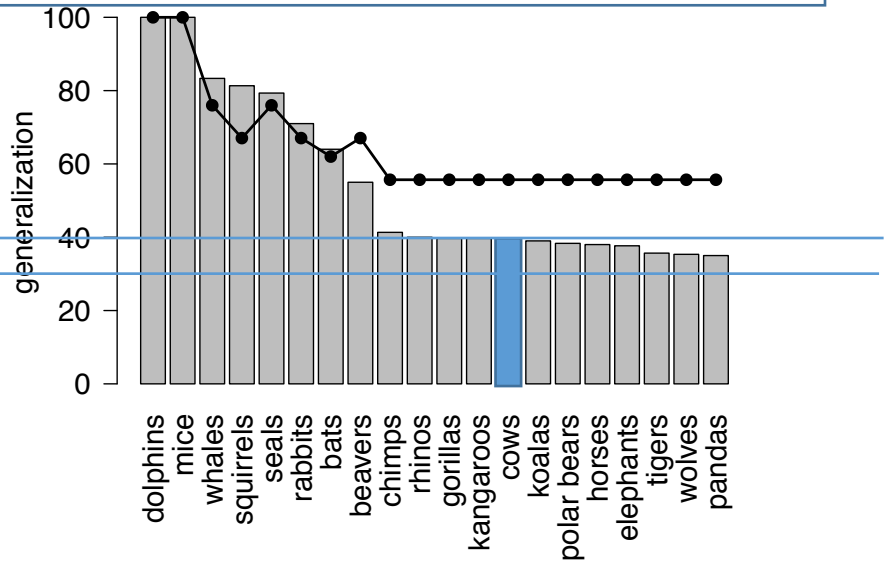
(Osherson et al 1990)

People are more willing to make inductive generalisations when they have more examples!

Dolphins → Cows



Dolphins + **Mice**→ Cows



Mini-summary

- Difference between induction and deduction
- Phenomena in inductive reasoning
  - Premise-conclusion similarity
  - Premise diversity
  - Premise monotonicity

Part 3:
Fallacies & informal reasoning

Propositional fallacies [edit]

A propositional fallacy is an error in logic that concerns compound propositions. For a compound proposition to be true, the truth values of its constituent parts must satisfy the relevant logical connectives that occur in it (most commonly: <and>, <or>, <not>, <only if>, <if and only if>). The following fallacies involve inferences whose correctness is not guaranteed by the behavior of those logical connectives, and hence, which are not logically guaranteed to yield true conclusions.

Types of propositional fallacies:

- Affirming a disjunct – concluding that one disjunct of a logical disjunction must be false because the other disjunct is true; *A or B; A, therefore not B*.[8]
- **Affirming the consequent** – the antecedent in an indicative conditional is claimed to be true because the consequent is true; *if A, then B; B, therefore A*.[8]
- **Denying the antecedent** - the consequent in an indicative conditional is claimed to be false because the antecedent is false; *if A, then B; not A, therefore not B*.[8]

Some "reasoning fallacies" occur because people fail to follow deductive logic… as we saw earlier in the lecture

Informal fallacies [edit]

- Appeal to the stone
- Argument from ignorance
- Argument from (personal) incredulity
- Argument from repetition
- Argument from silence
- Argument to moderation
- Argumentum ad hominem
- *Argumentum verbosium* -
- Begging the question
- Shifting the burden of proof
- Circular reasoning
- Circular cause and consequence
- Continuum fallacy

Other reasoning fallacies occur because there's something not-quite-right with their content

Informal fallacies [edit]

Main article: Informal fallacy

Informal fallacies – arguments that are fallacious for reasons other than structural (formal) flaws and usually require examination of the argument's content.[12]

- Appeal to the stone (*argumentum ad lapidem*) – dismissing a claim as absurd without demonstrating proof for its absurdity.[13]
- Argument from ignorance (appeal to ignorance, *argumentum ad ignorantiam*) – assuming that a claim is true because it has not been or cannot be proven false, or vice versa.[14]
- Argument from (personal) incredulity (divine fallacy, appeal to comm… must be false.[15][16]
- Argument from repetition (*argumentum ad nauseam*, *argumentum a…* nobody cares to discuss it anymore;[17][18] sometimes confused with …
- Argument from silence (*argumentum ex silentio*) – where the conclu… …ence of evidence.[19][20]
- Argument to moderation (false compromise, middle ground, fallacy … compromise between two positions is always correct.[21]
- Argumentum ad hominem – *the evasion of the actual topic by directing an attack at your opponent.*
  - ergo decedo – where a critic's perceived affiliation is seen as the underlying reason for the criticism and the critic is asked to stay away from the issue altogether.
- *Argumentum verbosium* - See Proof by verbosity, below.
- Begging the question (*petitio principii*) – providing what is essentially the conclusion of the argument as a premise.[22][23][24][25]
- Shifting the burden of proof (see – *onus probandi*) – I need not prove my claim, you must prove it is false.
- Circular reasoning (*circulus demonstrandi*) – when the reasoner begins with what he or she is trying to end up with; sometimes called *assuming the conclusion*.
- Circular cause and consequence – where the consequence of the phenomenon is claimed to be its root cause.
- Continuum fallacy (fallacy of the beard, line-drawing fallacy, sorites fallacy, fallacy of the heap, bald man fallacy) – improperly rejecting a claim for being imprecise.[26]

We'll focus on some of the empirical evidence about how these two work

Arguments from ignorance

"Claiming that X must be true just because you can't prove that X is false"

"Ghosts exist… because there is no proof that they do not"

(Hahn & Oaksford 2007)

This is also an argument from ignorance

"Ghosts exist… because there is no proof that they do not"

"There's no Hatfield stop in Sydney … because it's not on the Metro map"

(Hahn & Oaksford 2007)

Structure of the ghosts argument

If ghosts don't exist, there should be proof of their impossibility

There is no proof of the impossibility of ghosts

Therefore, ghosts exist

Structure of the trains argument

If Hatfield exists, it should be listed on the Metro map

It is not listed on the Metro map

Therefore, Hatfield does not exist

These are both deductively valid

If A then B
Not B

Therefore, not A

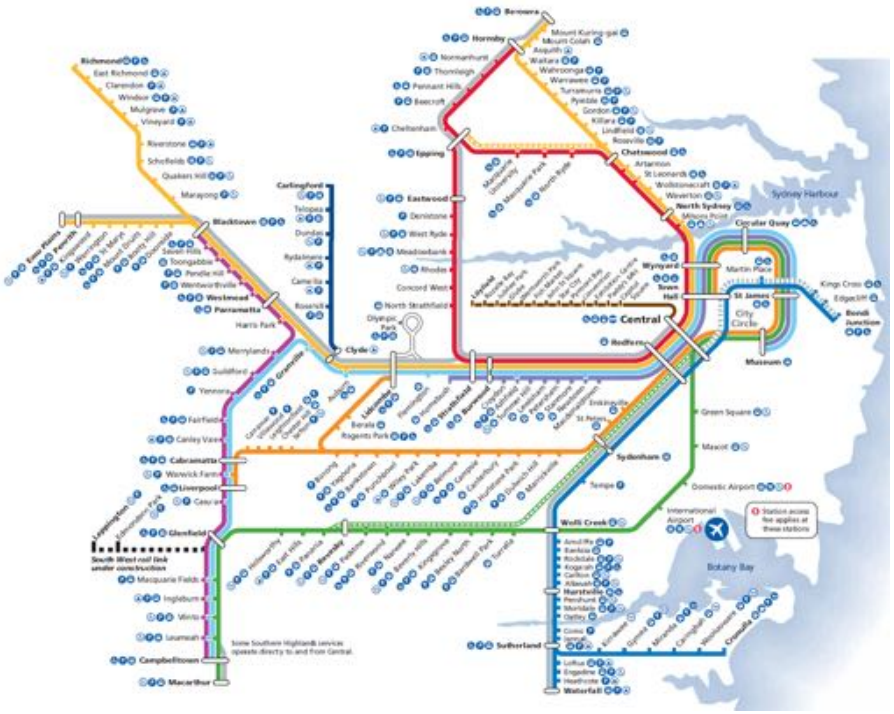
→ Modus tollens

A = ghosts exist
B = proof that ghosts are impossible

A = the Hatfield stop exists
B = Hatfield is listed on the Metro map

Epistemic closure ("closed world")

The Sydney metro map is *epistemically closed*: it is presumed to be a complete representation of the train network



No Hatfield on the map is *very* strong evidence that there is no Hatfield in world

Epistemic closure ("closed world")

The scientific literature on ghosts is NOT epistemically closed: there are true facts not in scientific journals!

The fact that no-one has *proved* ghosts impossible is not very strong evidence *for* the existence of ghosts

Another example

Jon Snow can't remember a day when it was 50 degrees in Sydney… therefore the temperature in Sydney has never reached 50 in living memory

"Um… you're a fictional character and basically an idiot"

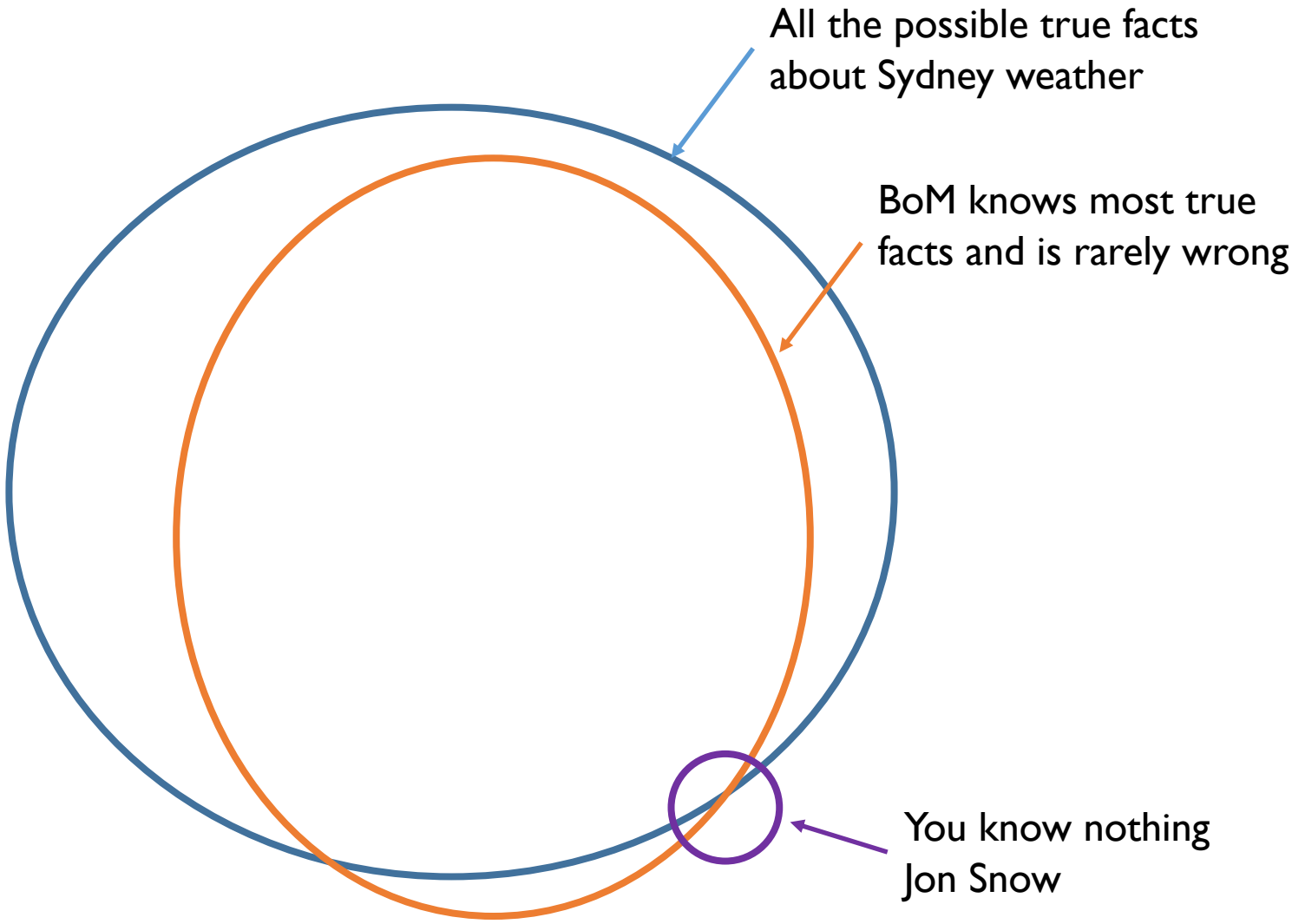
Another example

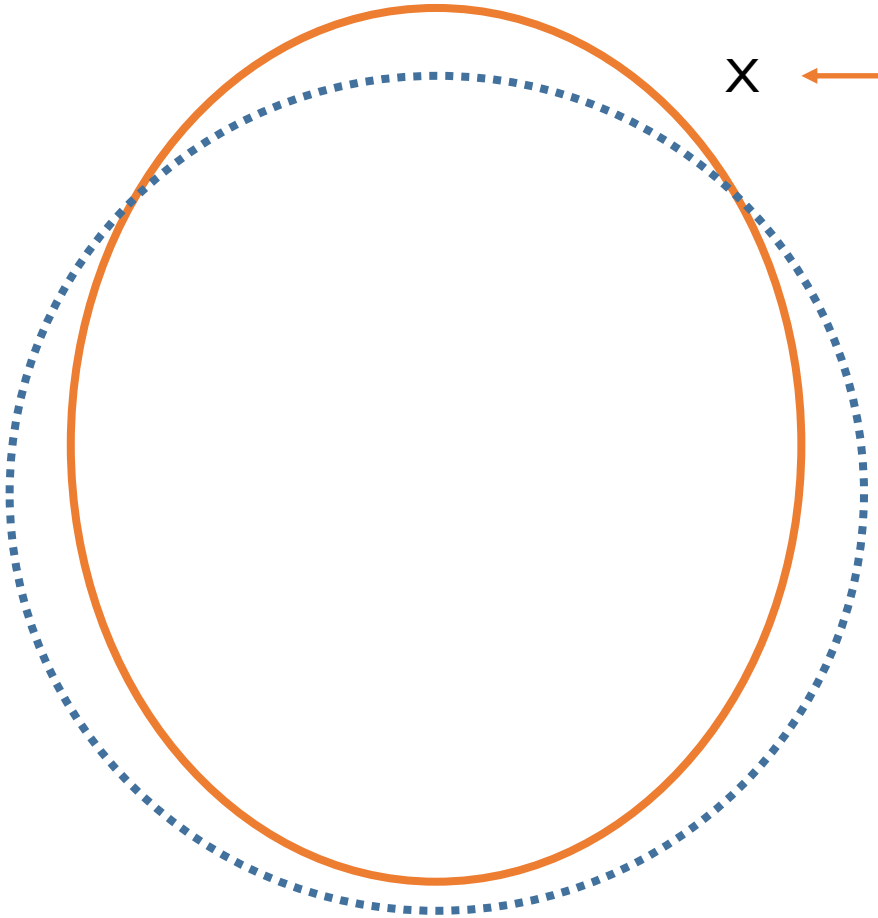
Jon Snow can't remember a day when it was 50 degrees in Sydney… therefore the temperature in Sydney has never reached 50 in living memory

"Um… you're a fictional character and basically an idiot"

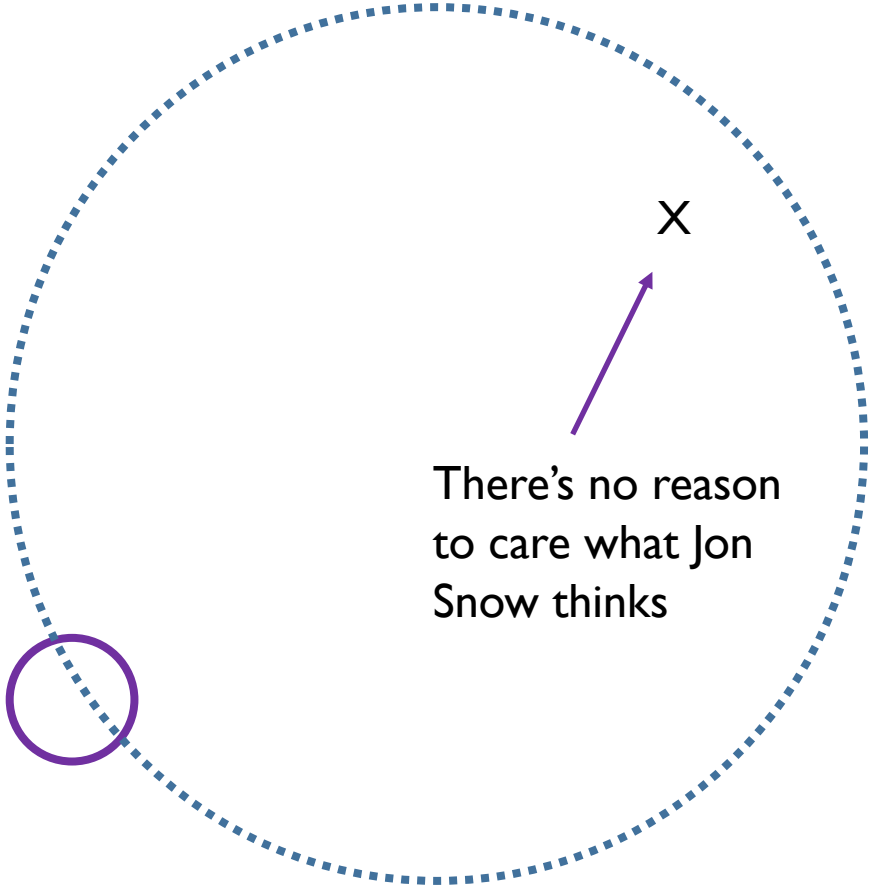
The Bureau of Meteorology has never recorded a temperature of 50 degrees in Sydney … therefore the temperature in Sydney has never reached 50 in living memory

"We have extensive & detailed records of Sydney weather for over a century"


All the possible true facts about Sydney weather
BoM knows most true facts and is rarely wrong
You know nothing Jon Snow



If BoM doesn't know of a 50 degree day, there probably wasn't one



There's no reason to care what Jon Snow thinks

Do people respect the inductive strength of an argument from ignorance?

I [strongly / weakly] believe that this drug [does / does not] have side effects because [one / fifty] experiments reported it

(Oaksford & Hahn 2004)

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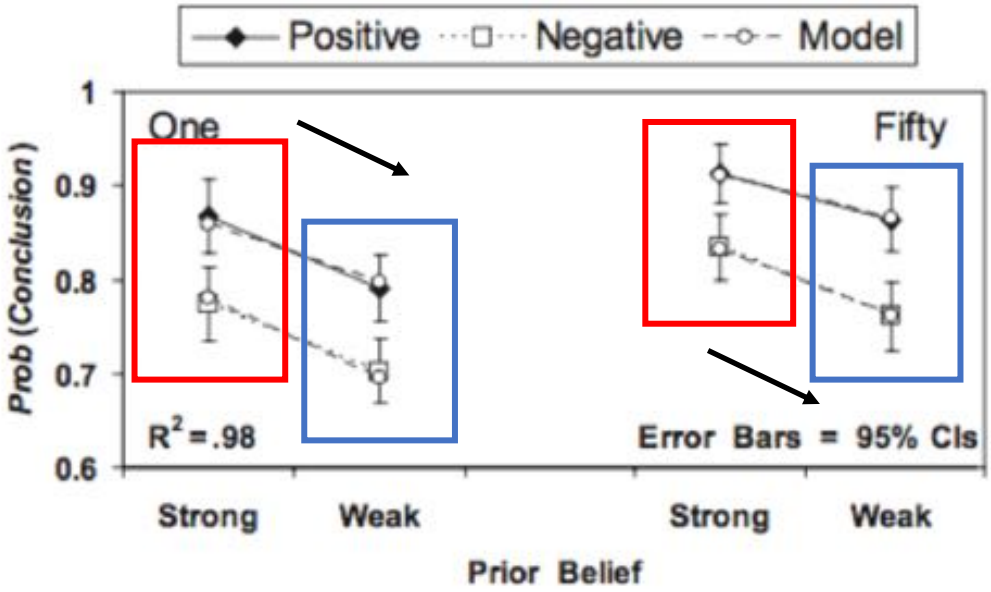

(Oaksford & Hahn 2004)

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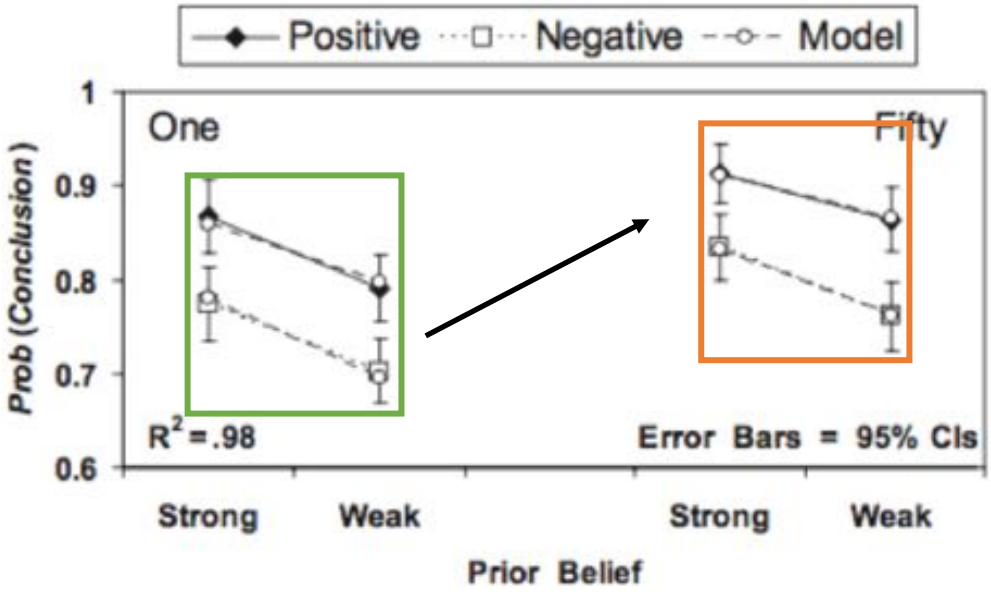

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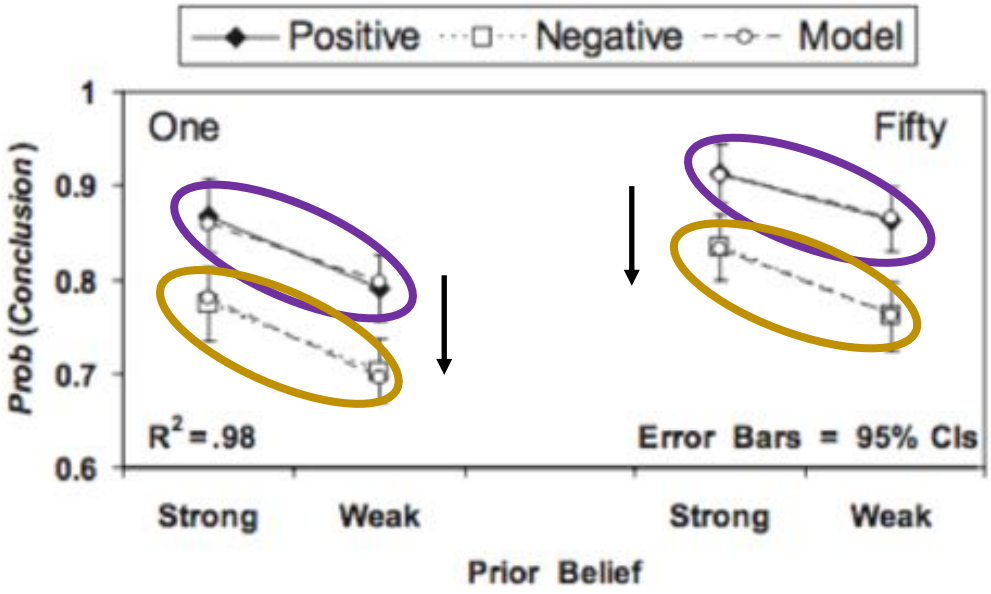


(Oaksford & Hahn 2004)

Circular arguments

"Assuming that X is true in order to prove that X is true"

Circular arguments

God exists because the Bible says so,
and the Bible is the word of God →

Circular arguments

God exists because the Bible says so, and the Bible is the word of God →

← Inductive reasoning is justified because it has worked in the past, so it will work in the future

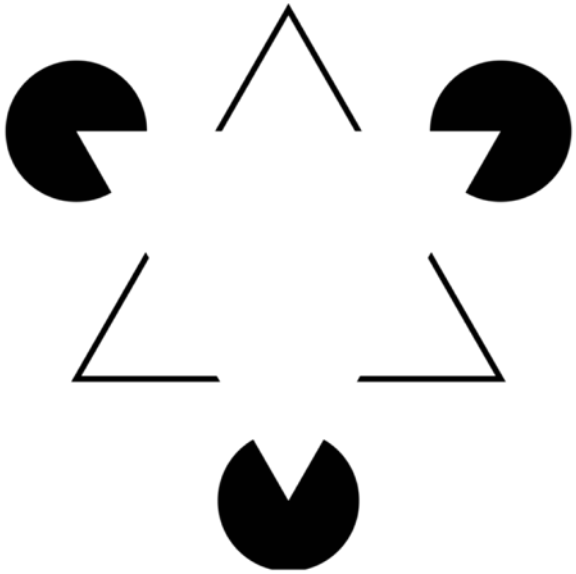
Circular arguments

God exists because the Bible says so, and the Bible is the word of God →

← Inductive reasoning is justified because it has worked in the past, so it will work in the future

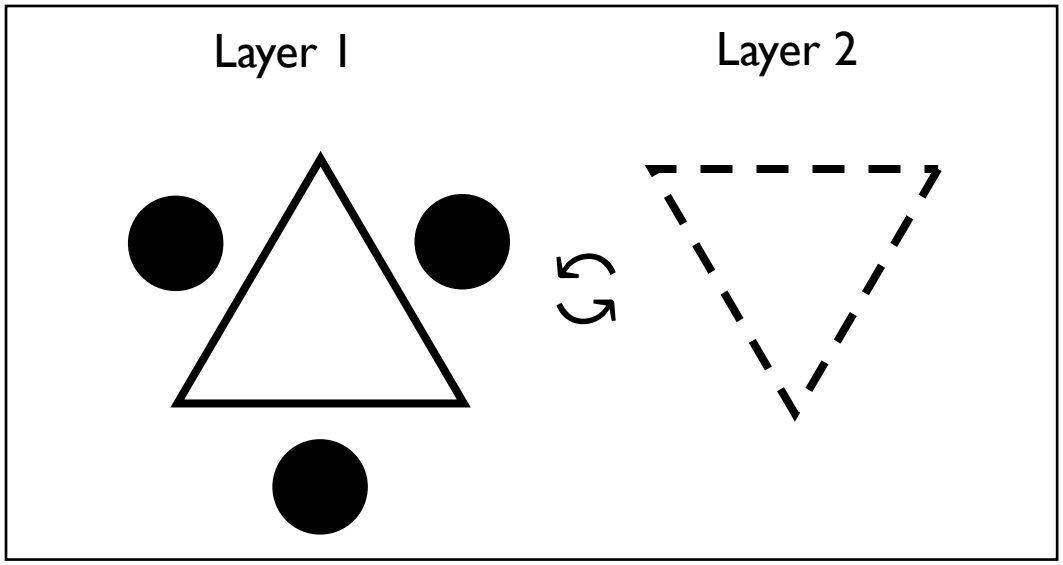
Electrons exist because we can see 3-cm tracks in a cloud chamber, and 3-cm tracks in a cloud chamber are the signatures of electrons →

Hm.



There is a white triangle because it is blocking the black circles and the black triangle… and we assume there's a black triangle and black circles because there's a white triangle blocking them

Constraint satisfaction, simplicity … and circularity?



The simplicity and figural goodness properties of layer 1 provide evidence for the existence of layer 2, and vice versa … mutually reinforcing

Constraint satisfaction, simplicity … and circularity?

The simplicity and figural goodness properties of layer 1 provide evidence for the existence of layer 2, and vice versa … mutually reinforcing

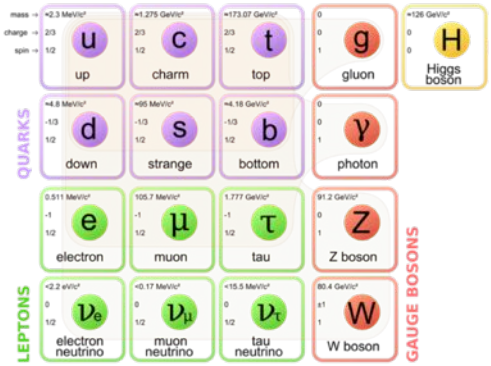
One layer with 6 strange shapes?

I *suppose* this is possible but if that's the best alternative hypothesis I'm going to go with the circular one!

Circular arguments are often an implicit appeal to an explanatory "system"

Christianity ⇒ God + Bible

Physics ⇒ Experiments + Theory



The subjective "strength" of circular arguments depends on how strongly you accept the "system" as an explanation for a larger body of facts

Hahn & Oaksford (2007)

John:	I think there's a thunderstorm
Anne:	What makes you think that?
John:	I just heard a loud noise that could have been thunder
Anne:	That could have been an airplane
John:	I think it was thunder, because I think it's a thunderstorm
Anne:	Well, it has been really muggy around here today

Hahn & Oaksford (2007)

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Anne: That could have been an airplane
John: I think it was thunder, because I think it's a thunderstorm
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Alternative is low plausibility:
"John and Anne are in their camper van at their woodland campsite"

Alternative is high plausibility:
"John and Anne are in their trailer home near the airport"

People rate John's circular argument as more *convincing* when the alternative explanation is less plausible

Alternative is low plausibility:

"John and Anne are in their camper van at their woodland campsite"

Alternative is high plausibility:

"John and Anne are in their trailer home near the airport"

Mini-summary

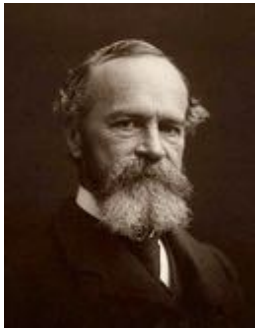
- "Rational" explanations of fallacies?
- Examples:
  - Argument from ignorance (epistemic closure)
  - Circular arguments (appeal to explanatory system)

It is by no means easy to decide just what is meant by reason

- William James (1890)

It is by no means easy to decide just what is meant by reason

- William James (1890)



When is "argument from ignorance" a fallacy and when it it wise?

When is an "inductive inference" warranted and when is it silly?

→

Are people *really* doing the selection task "wrong"?

Let it snow!