Causation

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14 The Nature of Reality

Causation: the problem

- We find the idea of causation in nearly every area of human thought and activity, e.g., what is cause of AIDS? cause of motion? cause of behavior? cause of that car crash? cause of any mental state?
- The answer is tremendously important. I want to take the pill that causes the disease to go away, not the one correlated with it. We praise/blame causation, not correlation.
- But what is causation? After all, lots of things are correlated in the world; not all correlations are instances of causings, e.g., Venetian sea levels are correlated with British bread prices.

Correlation or Causation?

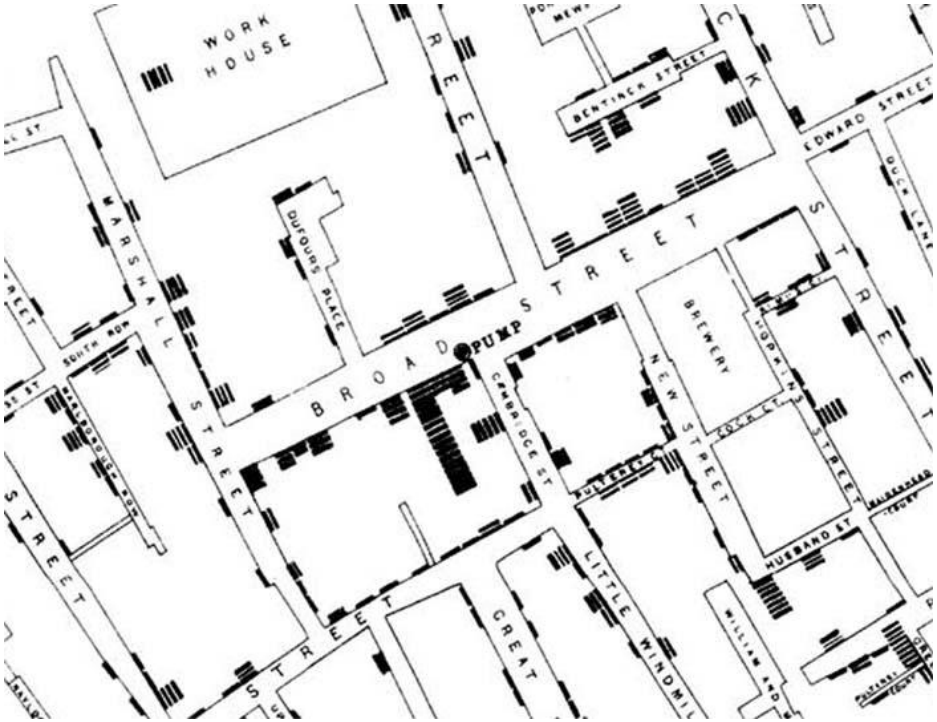
`http://jfmueller.faculty.noctrl.edu/100/correlation_or_causation.htm`

- Collection of links to articles on studies establishing correlations or causal connections, e.g.:
  - "Religious experiences shrink part of the brain"
  - "Church attendance boosts immunity"

Death at the pump

- great cholera epidemics in London 1848-9 and 1853-4
- Question: how can cholera be stopped?
- Assumption at the time: contagious cholera agent air-borne
- John Snow (1813-1858), a London doctor, solved the problem: infection was through fecal-oral transmission of a specific pathogenic agent in contaminated water

Mapping the disease



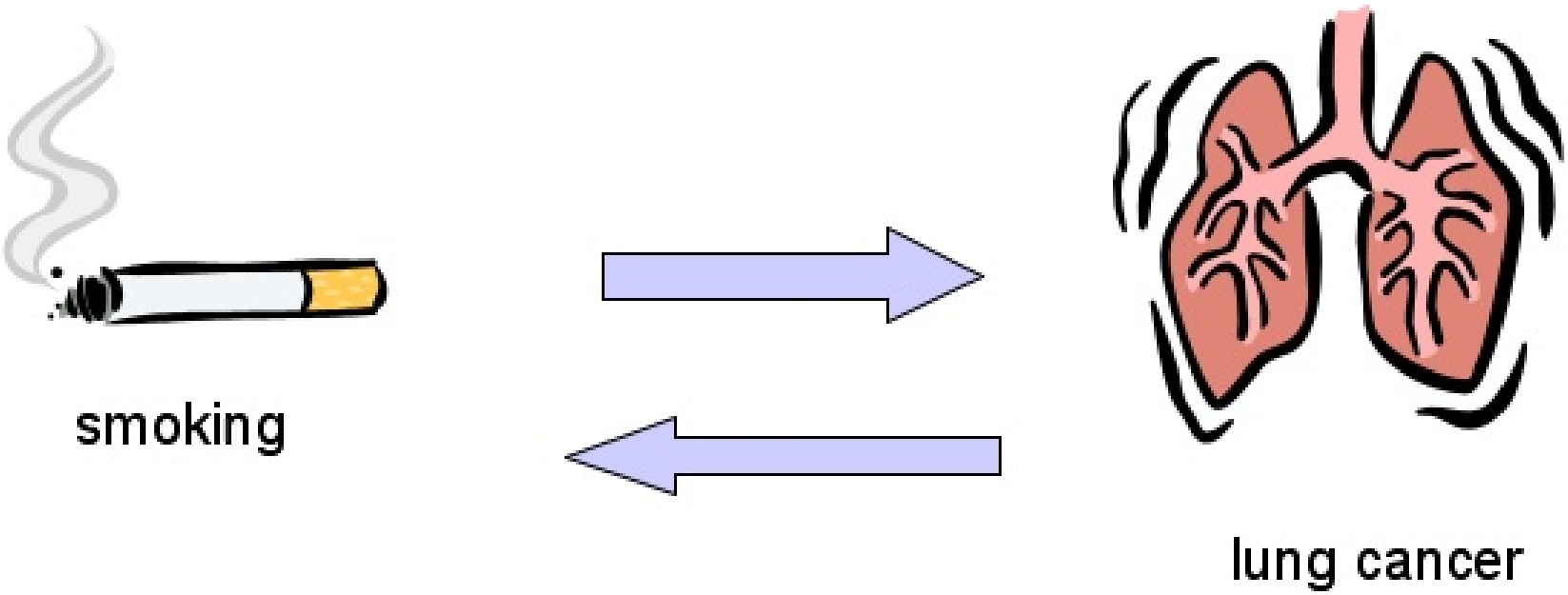
- 'disease map' of the cholera epidemic in Soho in 1854, showing cholera deaths as stacked black lines drawn at the street address of the deceased
- Note the large number of deaths in households near the Broad Street pump.

John Snow's findings

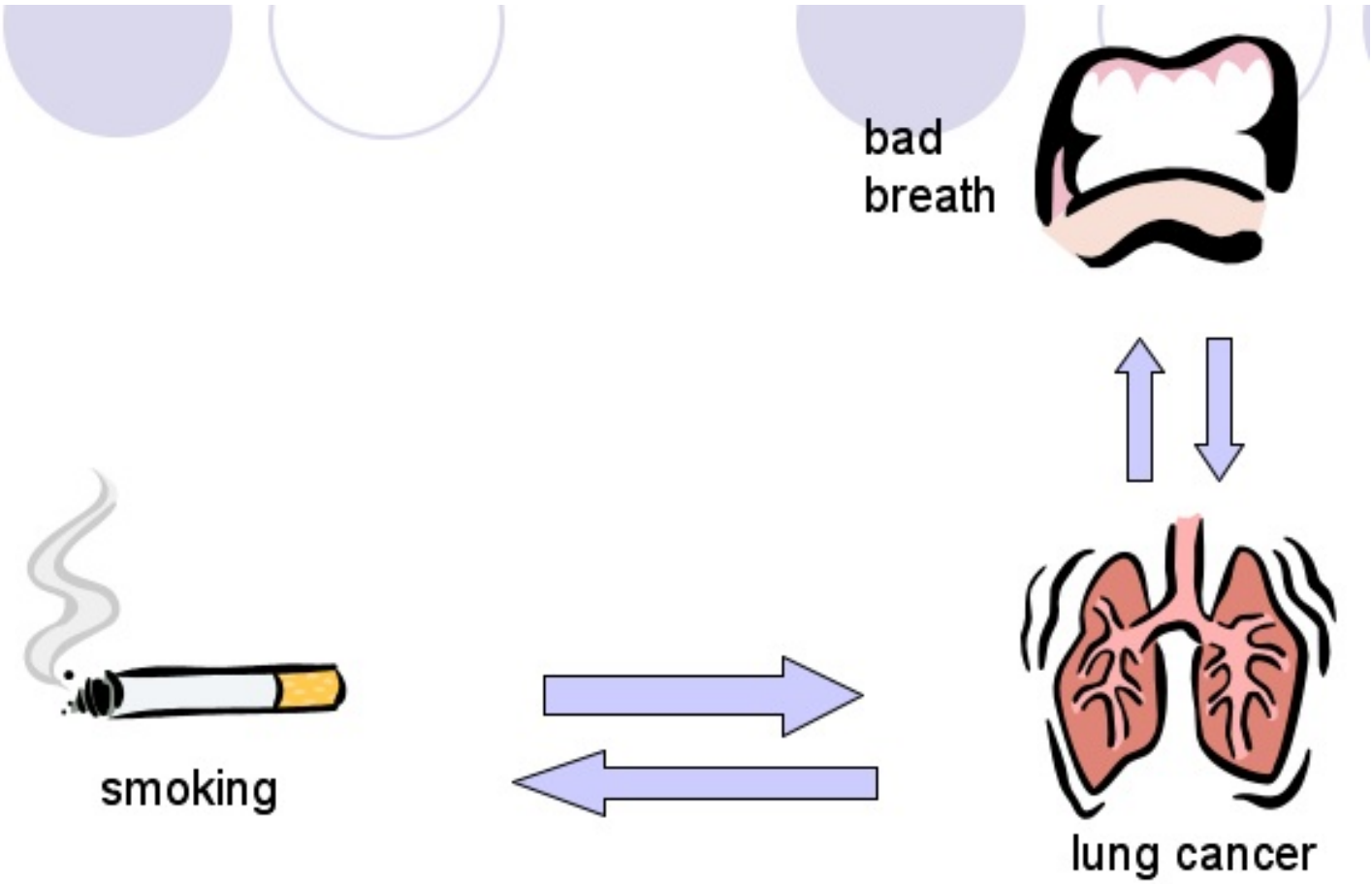
- Snow showed that the use of water from the small hand-operated pump that served up drinking water from a shallow well was a common factor in (almost) all of the cholera deaths.
- Also, the nonuse of that water was characteristic of two groups that were little affected (workhouse residents and brewery workers).

$\Rightarrow$ pioneer of germ theory, 'father of modern epidemiology'

- But: really he only found a correlation; philosophers are interested in identifying and analyzing causation

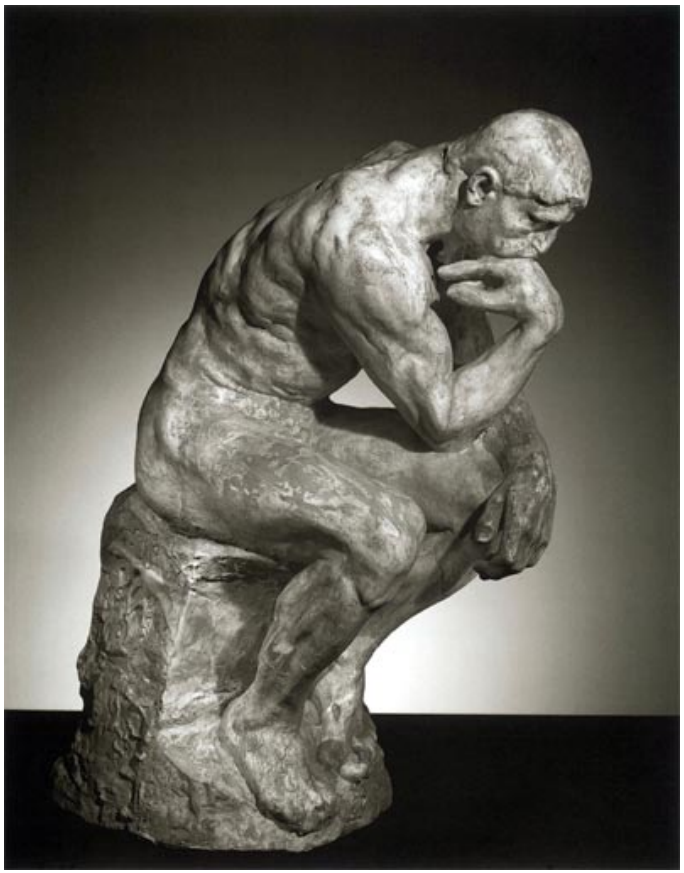


To stop smoking, taking a cancer-preventing drug won't help.



Smoking is highly correlated with lung cancer and bad breath, and hence lung cancer is highly statistically correlated with bad breath, too. But taking a mint won't help with lung cancer.

Rationalism



- reason is ultimate source of knowledge
- Baruch Spinoza (1632-1677)
- Gottfried Leibniz (1646-1716)
- Rene Descartes (1596-1650)
- For Descartes, ideally, by finding the essences of all things, one could then deduce from this knowledge all the mathematical laws needed to explain the physical world

Rationalist answer

- Objects have causal powers or forces. Massive particles have the power to attract other masses. I have the power to produce drawings, not the power to fly...
- A causal power or force is a disposition an object has to behave in certain ways. If the disposition is triggered, it must behave in that certain way.
- Necessary connections. If I strike a billiard ball at the right angle with the right force it must go in the pocket. Causes necessitate their effects.
- We can perceive necessity a priori.

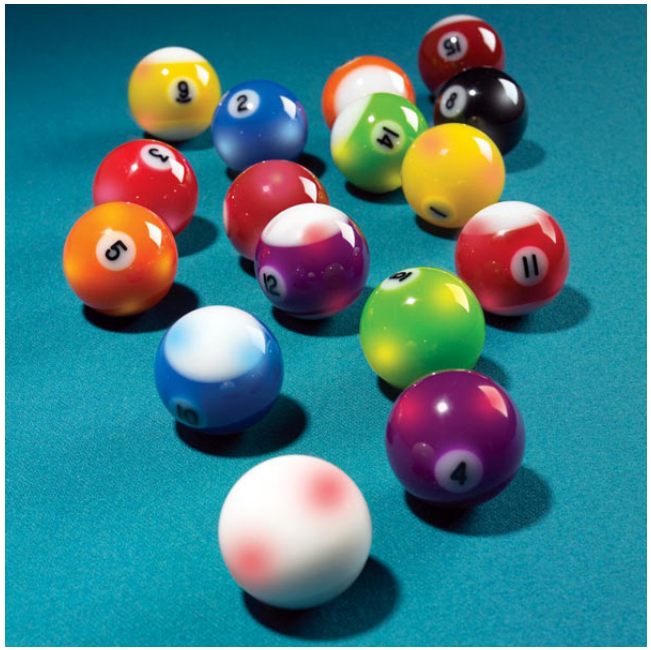
Empiricism

Figure: Louis-Leopold Boilly, Les Cinq Sens (The Five Senses), 1823

- experience is ultimate source of knowledge
- John Locke (1632-1704)
- Bishop Berkeley (1685-1753)
- David Hume (1711-1776)
- Stress on the source of knowledge; no a priori synthetic truths

Hume's Critique

Consider a billiard ball striking another billiard ball, the first causing the second to move. Let's call the event of the first ball moving to the point of contact with the second ball event A and the event of the second ball subsequently moving event B. What kind of connection exists between A and B when we say A causes B? As we have seen, the dominant tradition is to answer that A necessitates B.



But how? A doesn't logically necessitate B, states Hume. No law of logic is violated if A existed and B did not, or if some other event occurred, e.g., event C = the second ball remaining still even after impact, or event D = the ball popping up on Mars. Both A then C or A then D would violate Newtonian mechanics, of course, but violating Newtonian mechanics is not violating logic.

We cannot know by reasoning alone—that is, by a priori means—whether A causes B. So the connection between A and B is not logical.

"From the appearance of an object, we never can conjecture what effect will result from it. But were the power or energy of any cause discoverable by the mind, we could foresee the effect, even without experience; and might, at first, pronounce with certainty concerning it, by the mere dint of thought and reasoning." (VII, p.63)

If not logical then it must be empirical. The problem with this is that there is nothing observable besides the sequence of events A and then B. Necessary connections and powers do not directly arise from sensory impressions. We don't see, hear, smell, taste or feel causation itself. When I watch one billiard ball cause another to move, I don't directly sense the power of the first ball, nor do I directly sense the necessary connection between the two events.

Hume concludes...

- So there are no causal powers, dispositions, or forces!
- (Or at least... there is no reason to think so, says Hume.)
- There is nothing 'holding the universe together'. There are patterns in what we observe, but there are no powers or forces bringing them about.

Doesn't science show us that there are fundamental causings/forces? If Newton were right, for instance, wouldn't there be a gravitational force between any two massive bodies? Isn't this (or an analogous one based on contemporary physics) a good argument for forces? Maybe. But at the observable level, what we have are correlations and arguably no forces:

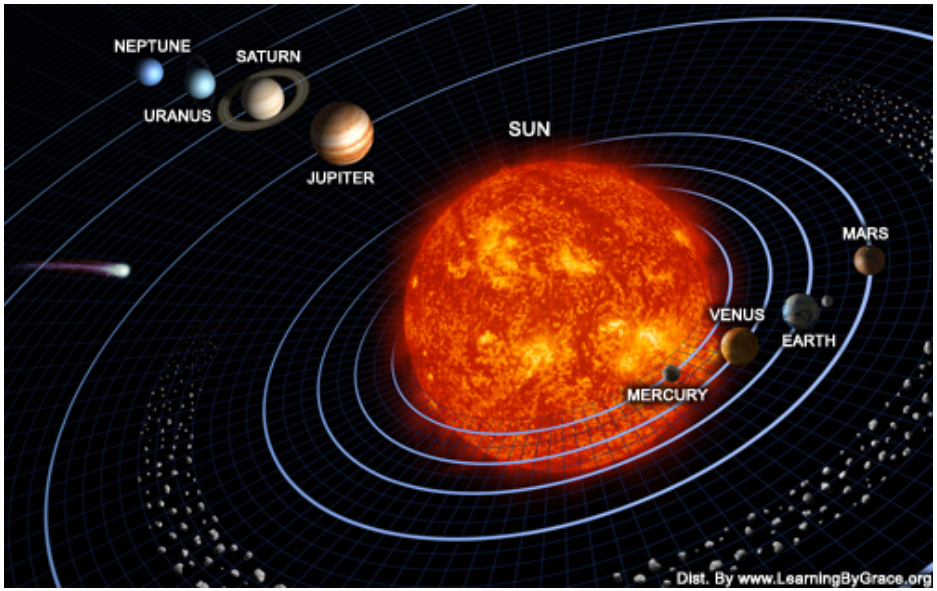
$$F = ma$$

$$a = dx/dt$$

$$F_{12} = Gm_1m_2/r^2$$

Cross out F's

$$mdx/dt = Gm_1m_2/r^2$$



All we notice, says Hume, is that the following three relations occur whenever we say that an event A causes an effect B:

1. Contiguity: A and B are always close together.
2. Priority in time: The cause A always precedes B.
3. Constant conjunction: We always see A-type events followed by B-type events.

The first billiard ball touches the second, the 'cause' is before the 'effect', and whenever we see billiard balls so arranged and events like A we regularly also see events like B. That is all we observe, says Hume. Indeed, things might even look exactly the same in cases without causation between the two balls. For instance, we might place iron fillings in the balls, move the first ball with a magnet to the second ball, and then with another magnet move the second ball away from the first in such a way as to reproduce the original motion. Everything would look the same even in the absence of causation. We don't sense necessary connections. Nor are necessary connections implied by contiguity, temporal priority or constant conjunction. Necessary connections, therefore, are neither logical nor empirical relations. So what are they?

Hume: causation as habits of association

Hume answers that they are "habits of association" produced in the mind by the repetition of instances of A and B. We constantly observe events of type A being followed by events of type B from our childhood on. This creates in our mind a strong expectation of seeing B whenever we see instances of A. This expectation is so strong that it impels us to imagine a kind of 'force' or 'power' or 'necessary connection' between A and B, and moreover, to suppose this force exists outside of the mind in the objects themselves. But such an inference is, however natural, erroneous. We confuse the expectation we project onto the world with necessitation in the world.

Humean causation

Hume actually posits three conceptions of causation; let's look at two:

- Regularity: "An object precedent and contiguous to another, and where all the objects resembling the former are plac'd in like relations of precedency and contiguity to those objects, that resemble the latter" (*Treatise*, Book I, Part III, Section XIV, 170)
- Psychological Necessitation or Projectivism: "the idea of the one determines the mind to form the idea of the other" (ibid.)

Focusing on the first...

- Too inclusive?
  - Day follows night (Thomas Reid; but consider replies by Thomas Brown and J.S. Mill)
  - Common causes, e.g., alarm clock always wakes up mosquito on my nose before waking me up...
- Too narrow?
  - Excludes singular causes (Hume himself suspected this in talking about a child burnt by a candle)

Reliance on similarity introduces element of subjectivity:

"Such repetitions as we actually find set before us are results of two factors, one contributed by nature the other partly contributed by ourselves... Nature... as Leibniz was fond of insisting, never exactly repeats herself. But she does the next best thing for us. She gives us repetitions—sometimes very frequent, sometimes very scarce, according to the nature of the phenomena—of all the important elements, only leaving it to us to decide what these important elements are." (John Venn (1889), *The Principles of Empirical or Inductive Logic*, MacMillan, 98)

Is causation observable?

Ducasse's example

- Curt John Ducasse (1881-1969) denies that no connection between cause and effect is ever perceived
- Glowing parcel example
- Hume: "tho' we are here suppos'd to have had only one experiment of a particular effect, yet we have many millions to convince us of this principle; *that like objects, plac'd in like circumstances, will always produce like effects*" (*Treatise*, Book I, Part III, Section VIII, 105)

Ducasse's own analysis

Analysis (Ducasse's analysis of causation)

C caused E, where C and E are changes, means

1. *The change C occurred during a time and through a space terminating at the instant I at the surface S.*
2. *The change E occurred during a time and through a space beginning at the instant I at the surface S.*
3. *No change other occurred in those places/times.*

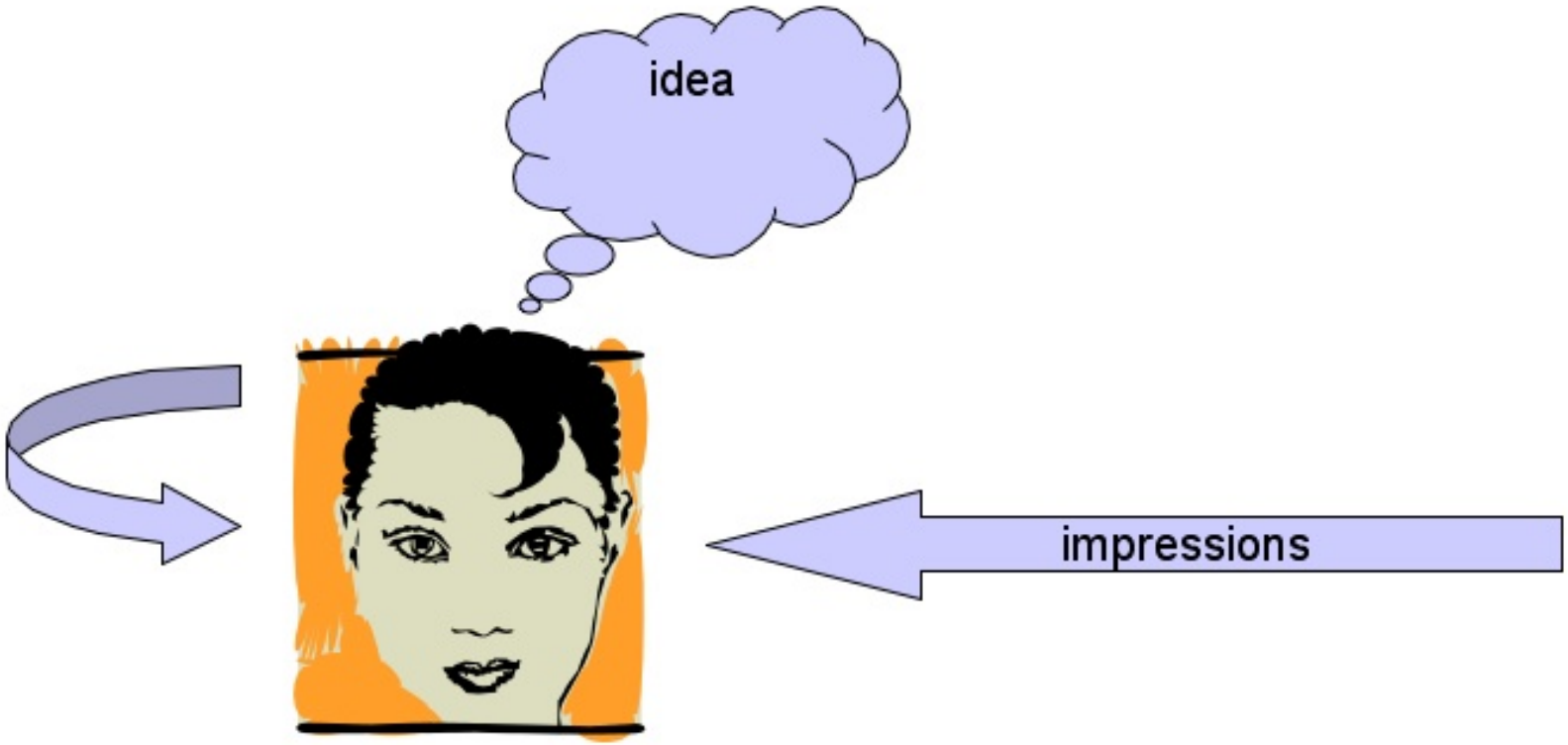
- Problem: If a brick strikes a window at the same time that sound waves emanating from a canary do so, one wants to be able to say that it is the brick's striking the window that causes it to shatter. But this is precluded by Ducasse's analysis.
- Problem (Tooley): Is it not logically possible, for example, for there to be spatiotemporal events which are uncaused?
- Problem: Causal action-at-a-distance

Peter Menzies

1. If causation consists in an observable intrinsic link between events, then it should be possible for a person who has never previously experienced the causal relation to infer with certainty the effect from the cause.
2. It is not possible to make such a priori causal inferences from cause to effect.

$\therefore$ Causation cannot consist in such an observable intrinsic link.

Humean psychology



Observation

- Is observation a completely non-inferential and informationally encapsulated process? (Is theory—cognitive processes—irrelevant to what we actually see?)
- No:
  - Pencil experiment: bent pencil or refraction in water (`http://en.wikipedia.org/wiki/Refraction`)
  - Beaker experiment: we infer presence or absence of penny
    - Demo: `http://www.youtube.com/watch?v=uz99SnUl2lo`
    - explanation: `http://physicscentral.com/experiment/askaphysicist/physics-answer.cfm?uid=20101216091531`

$\Rightarrow$ Distinction between perception and cognition...

Observable v. unobservable

- the perceptual analysis is not penetrated by all the background information available to the perceiver
- Penetrated v. non-penetrated distinction

Examples of non-penetrated cases

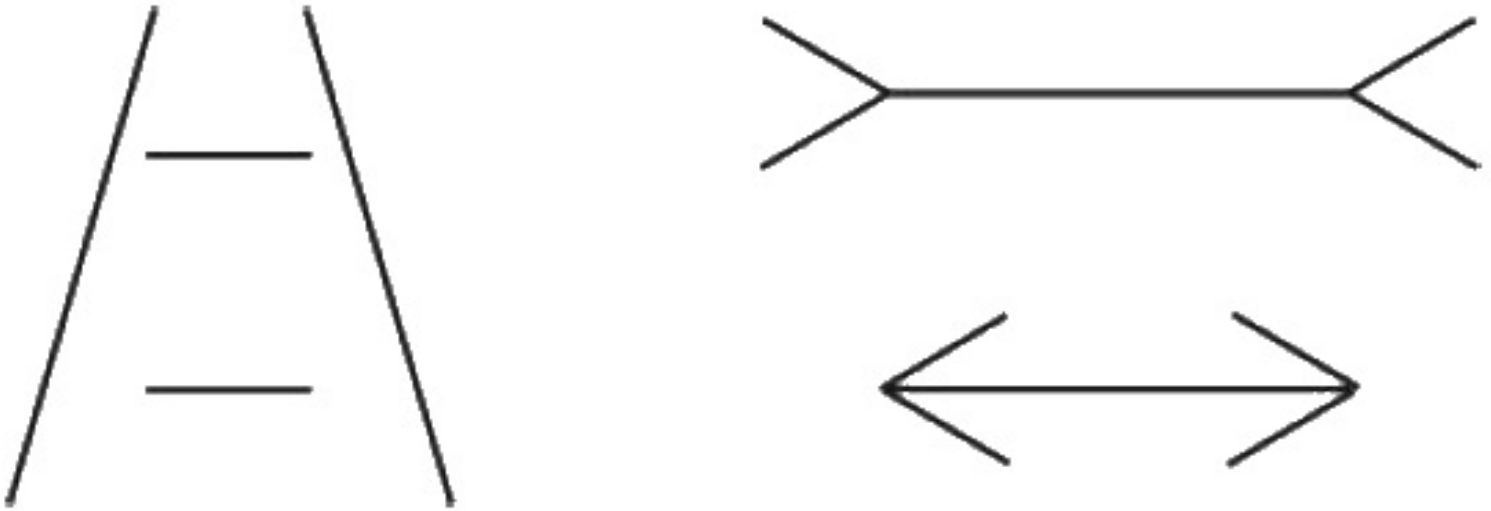
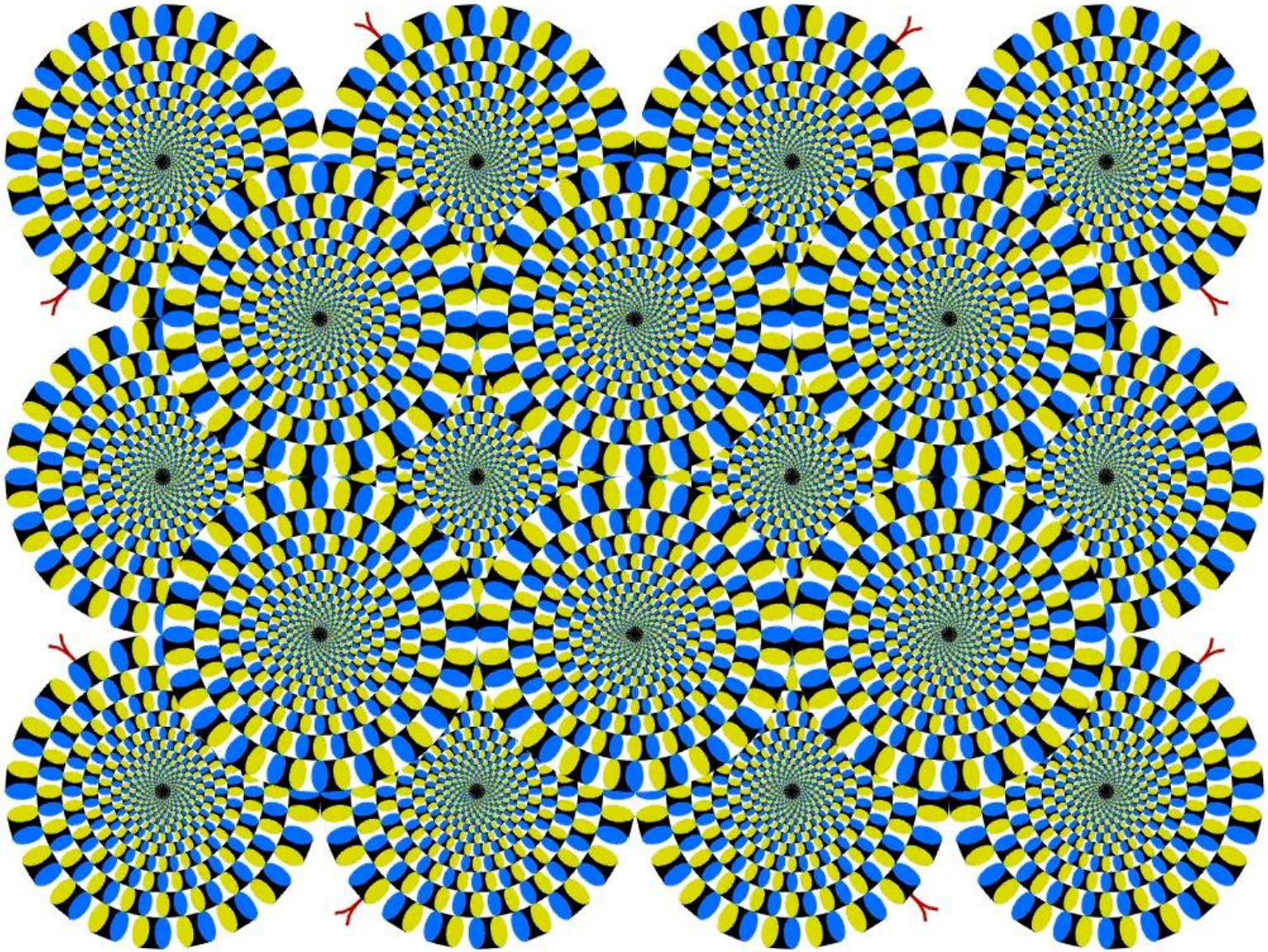
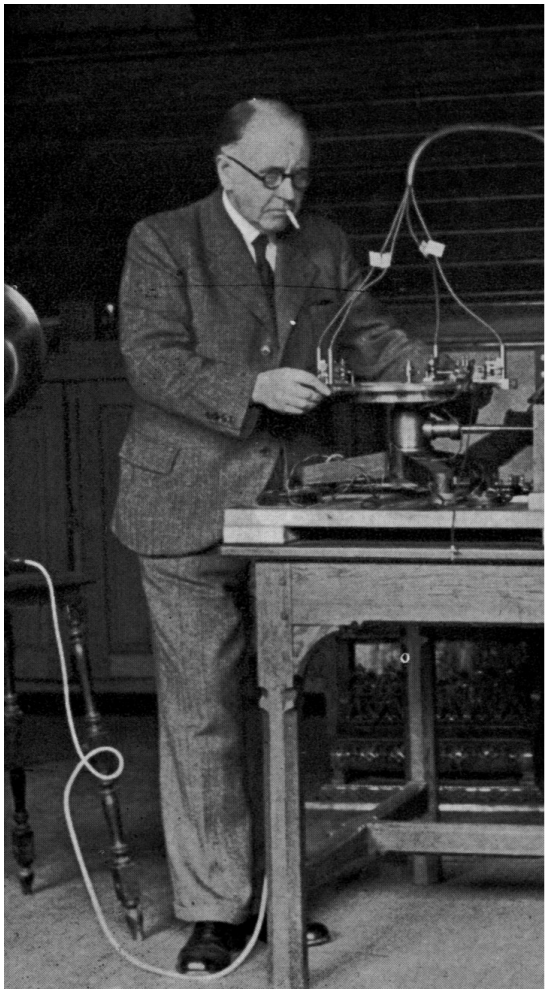


Figure: The Ponzo Illusion (left) and the Müller-Lyer Illusion (right).



Albert Michotte (1881-1965)

Albert Michotte (1963), *The Perception of Causality*. London: Methuen. (English translation of Michotte, 1954).



"[I]t seems certain that Hume did not realise that there was such a thing as a causal impression." (1963, 255)

`Weblink to Michotte demonstrations`

If A goes from red to green just before B moves, people don't judge it to be the cause; if A hits B but B goes in perpendicular path, A is not viewed as causing B

Not penetrated by theory

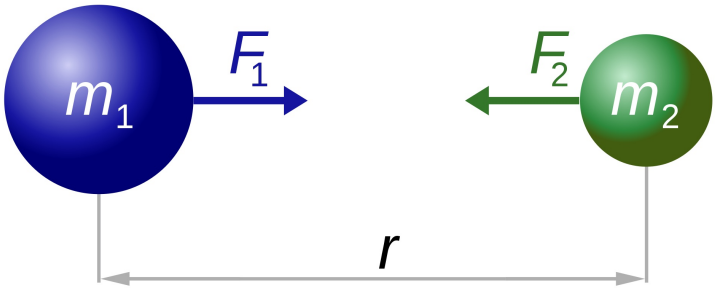
What is a law of nature?

Alex Rosenberg (2012). Why laws explain. In his *Philosophy of Science: A Contemporary Introduction*, Routledge: New York and London, 61-79.

Laws do important explanatory work—but just what is a law?

- first pass: true generalization, universal statement
- not merely true by definition, makes contingent claims about nature, not about merely local facts
- need to distinguish generalizations that are accidentally true from 'laws'
- example of accidental truth: 'All faculty members of the Department of Philosophy are right-handed', 'All fruits in the garden are apples'
- example of law: 'All gases expand when heated under constant pressure'

Newton's Law of Universal Gravitation



$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

"Every point mass attracts every single other point mass by a force pointing along the line intersecting both points. The force is proportional to the product of the two masses and inversely proportional to the square of the distance between them."

(Proposition 75, Theorem 35, p. 956)

Newton, *Principia*. I.Bernard Cohen and Anne Whitman (trans.), University of California Press, 1999.

Bode's Law

Johann Elert Bode (1747-1826)

"This latter point seems in particular to follow from the astonishing relation which the known six planets observe in their distances from the Sun. Let the distance from the Sun to Saturn be taken as 100, then Mercury is separated by 4 such parts from the Sun. Venus is 4+3=7. The Earth 4+6=10. Mars 4+12=16. Now comes a gap in this so orderly progression. After Mars there follows a space of 4+24=28 parts, in which no planet has yet been seen. Can one believe that the Founder of the universe had left this space empty? Certainly not. From here we come to the distance of Jupiter by 4+48=52 parts, and finally to that of Saturn by 4+96=100 parts."

Johann Elert Bode (1772). *Anleitung zur Kenntniss des gestirnten Himmels*.

Bode's Law

Law ((Titius-) Bode)

"The law relates the semi-major axis a of each planet outward from the Sun in units such that the Earth's semi-major axis is equal to 10:

$$a = 4 + n$$

where $n = 0, 3, 6, 12, 24, 48...$ *with each value of* $n > 3$ *twice the previous value."*

(`http://en.wikipedia.org/wiki/Titius-Bode_law`*, accessed 16 October 2013)*

Bode's 'Law'?

- You might be inclined to dismiss this as pure coincidence...
- ... but then
  - William Herschel discovered Uranus in 1781—at about a distance from the sun by $4 + 192 = 196$ parts!
  - And in 1801, Ceres is found at the location predicted by Bode, i.e., at $4 + 24 = 28$ parts

$\Rightarrow$ Triumph?

- Not quite...:
  - Neptune is discovered in 1846 at a location far off from where Bode's Law predicted (where, however, Pluto in found in 1930!).
  - And many objects other than Ceres are found in the Asteroid Belt, disrobing Ceres from status as planet.

Distances of planets in the Solar System

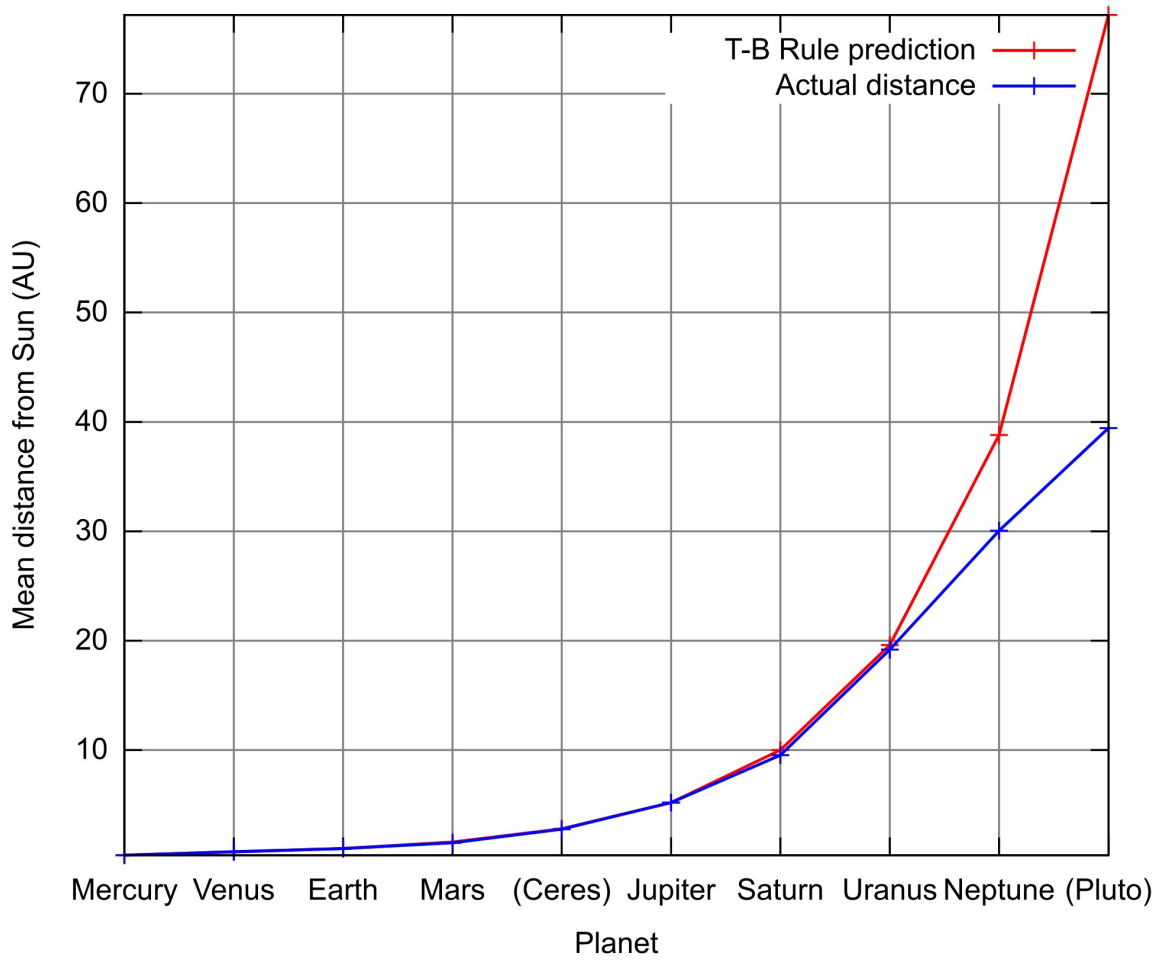
Planet	k	T-B rule distance (AU)	Real distance (AU)	% error (using real distance as the accepted value)
Mercury	0	0.4	0.39	2.56%
Venus	1	0.7	0.72	2.78%
Earth	2	1.0	1.00	0.00%
Mars	4	1.6	1.52	5.26%
Ceres[1]	8	2.8	2.77	1.08%
Jupiter	16	5.2	5.20	0.00%
Saturn	32	10.0	9.54	4.82%
Uranus	64	19.6	19.2	2.08%
Neptune	128	38.8	30.06	29.08%
Pluto[2]	256	77.2[2]	39.44	95.75%

[1] Ceres was considered a planet from 1801 until the 1860s. Pluto was considered a planet from 1930 to 2006. Both are now classified as dwarf planets.

[2] While the difference between the T-B rule distance and real distance seems very large here, if Neptune is 'skipped,' the T-B rule's distance of 38.8 is quite close to Pluto's real distance with an error of only 1.62%.

from Wikipedia at `http://en.wikipedia.org/wiki/Titius-Bode_law`

Distances of planets in the Solar System



from Wikipedia at `http://en.wikipedia.org/wiki/Titius-Bode_law`

A litmus test for lawhood: counterfactual support

Consider the following two counterfactuals, of which both antecedents (and both consequents) are false:

1. "If it were the case that the Moon is made of pure plutonium, it would be the case that it weighs less than 100,000 kilos." (63)
2. "If it were the case that the Moon is made of pure gold, it would be the case that it weighs less than 100,000 kilos." (64)

- First counterfactual seems clearly true, while the second seems false. But what underwrites this difference?
- The first is supported by the universal truth about plutonium, but the second isn't supported by the universal truth about gold.

$\Rightarrow$ counterfactual support is indicative of lawhood—but this doesn't explain difference yet!

- Rosenberg: difference is found in physical or nomic necessity (not in logical!)

The causal connection

- Nomic necessity seems to be closely tied to causal connection we noticed before and which the logical positivists tried to avoid—it's metaphysics!
- But if it is something like this necessity which is responsible for the difference between explanatory laws and merely accidental generalizations, metaphysics cannot be avoided!
- recall: Humean vs. non-Humean accounts of laws of nature
- example of Humean approach: best-systems analysis
- example of non-Humean approach: universalism

Best-systems analysis of laws

Best-system analysis of laws

Position (Best-system analysis)

A universal proposition is a law if and only if it is an axiom or a theorem in that true deductive system that best combines simplicity (e.g., least number of axioms) and strength (e.g., most informational content) (or, in the case of a tie, which is an axiom or a theorem in all 'best' systems).

- metaphysically lean, Humean: doesn't require undetectable 'glue'
- reduces nomic necessity to logical necessity
- gives a principled distinction between nomic and accidental generalizations
- allows for a link to counterfactuals: what we take to be true counterfactuals is given by our best theories

Problems

1. Main problem: What is simple? What is strength? These seem to be language-dependent, perhaps subjective criteria.
2. Generally, there will not be a shared maximum for both criteria $\Rightarrow$ needs balance between them. But how do we balance them?
3. Challenge for any Humean: *X*-particles and *Y*-fields

X-particles and *Y*-fields

John Carroll; cf. Beebee, §5

Consider two (allegedly) possible worlds:

World W_1: consists of *X*-particles and *Y*-fields such that no *X*-particle ever enter a *Y*-field; (only) Law L_1: All *X*-particles in *Y*-fields have spin up.

World W_2: consists of *X*-particles and *Y*-fields such that no *X*-particle ever enter a *Y*-field; (only) Law L_2: All *X*-particles in *Y*-fields have spin down.

$\Rightarrow$ occurrent facts are the same at W_1 and W_2, but still laws L_1 and L_2 differ

- From this, we are supposed to infer that laws cannot just depend on occurrent facts and that hence the Humean conception of laws is mistaken.

Helen Beebee's response on behalf of the Humean

"...Carroll's counter-example doe *not* show that the Ramsey-Lewis view fails *by it own lights*: it isn't as if the Ramsey-Lewis view *entails* that w_1 and w_2 are possible, thus undermining its own claim to respect the supervenience of laws of nature on particular matters of fact. The Ramsey-Lewis view *itself* judges w_1 and w_2 to be impossible [or at least not different if possible]... Carroll's alleged counter-example, then, is really just a restatement of [the] basic anti-Humean intuition, and as such poses no threat to the Humean." (584f)