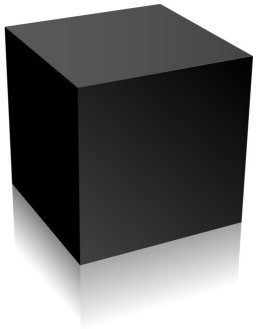
16. Scientific Explanation: Covering Law Account

Instrumentalism: Scientific theories are devices for helping us deal with experience. They are instruments ("black boxes") used to make and test predictions.



- *But*: Isn't there more to science than prediction?
  - Doesn't science aim at *explaining* phenomena?

What is it for a scientific theory to explain something?

Terminology

- *Expanandum* = whatever is being explained.
- *Explanans* = the thing that is doing the explaining.

1. Covering Law Account: DN and IS

Hempel, C. & P. Oppenheim (1948) "Studies in the Logic of Explanation"

Covering Law Account: To explain something is to show how to derive it in a logical argument that makes use of a law of nature, such that:

- The conclusion is the *explanandum*.
- The premises are the *explanans*.
- The premises contain at least one statement of a *law of nature*.
- The premises are true.

explanans	$L_1, L_2, \ldots$	*law(s)*
	$C_1, C_2, \ldots$	*conditions underwhich laws are applicable*
	———	
explanandum	$\therefore\ O_1, O_2, \ldots$	*observed phenomena*

General Characteristics

(i) *Argument Thesis*: Explanations are *arguments*.

(ii) *Nomic Expectability Thesis*: To explain something is to show that it is nomically (lawfully) expected.

(iii) *Explanation/Prediction Symmetry Thesis*: Every explanation is a potential prediction; every prediction is a potential explanation.

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Two versions, depending on whether the argument is deductive or inductive:

(a) Deductive-Nomological (DN)

(b) Inductive-Statistical (IS)

1a. Deductive Nomological (DN) Explanations

Ex. 1: Why do ice skaters spin faster as they bring their arms towards their body?

DN explanation:

1.	Angular momentum is conserved.	$L_i = L_f$	*law*
2.	Skater doesn't interact with external objects.	$L_i = I_i\omega_i, \quad L_f = I_f\omega_f$	*conditions*
3.	Skater has non-zero initial angular momentum.	$L_i \neq 0$	
4.	Skater brings arms in towards body.	$I_f < I_i$	
∴	Skater spins faster.	$\omega_i > \omega_f$	*observation*

Ex. 2: Why did Jan's bracelet melt when it was heated to 1063° C?

DN expanation:

1.	Gold melts at 1063° C.	*law*
2.	Jan's bracelet is made of gold.	*condition*
∴	Jan's bracelet melted at 1063° C.	*observation*

1b. Inductive Statistical (IS) Explanations

Important Distinction

Universal generalization: All *F*'s are *G*'s

Statistical generalization: *X*% of *F*'s are *G*'s

- The laws that appear in DN explanations are universal generalizations.
- The laws that appear in IS explanations are statistical generalizations.

Ex. 3: Why did Jane Jones recover quickly?

IS explanation:

1. Almost all cases of strep-throat clear up quickly after penicillin treatment. — *law*
2. Jane Jones had strep-throat. } *conditions*
3. Jane Jones received penicillin. } *conditions*

∴ Jane Jones recovered quickly. — *observation*

Initial Concern for IS Explanations: What counts as a strong inductive argument?

- Premises must give a high probability to conclusion?

(A)

1. Almost all cases of strep-throat clear up quickly after penicillin treatment.
2. Jane Jones had strep-throat.
3. Jane Jones received penicillin.

∴ Jane Jones recovered quickly.

(B)

1. Almost all cases of penicillin-resistant strep-throat do not clear up quickly after penicillin treatment.
2. Jane Jones had penicillin-resistant strep-throat.
3. Jane Jones received penicillin.

∴ Jane Jones did not recover quickly.

- Conclusions of (A) and (B) are contradictory!
- *But*: The premises of both give high probabilities to their conclusions.

Which should we believe?

- We are more warranted in believing conclusion of (B).
  - *Premises of* (B) *contain information more relevant to its conclusion than premises of* (A) *to its conclusion.*

Covering Law Account Adequacy Conditions

(1) Must be either a valid-deductive argument, or a strong inductive argument.

(2) *Explanans* must contain a law (universal or statistical).

(3) *Explanans* must have empirical content.

(4) *Explanans* must be true.

(5) All relevant information must be present in the *explanans* that would have an effect on the *explanandum*.

- *Are all explanations that satisfy these conditions scientific explanations?*
- *Do all scientific explanations satisfy these conditions?*

2. Counterexamples

CE 1: Why does the shadow of this flagpole have length ℓ?

DN explanation:

1. Light propagates linearly. — *law*
2. Sun is at certain elevation.
3. <*Relevant trigonometic relations*>.
4. Flagpole has height h.

(2–4: *conditions*)

∴ Shadow has length ℓ. — *observation*

- Consider a DN explanation of the flagpole's height in terms of its shadow's length:

DN explanation:

1. Light propagates linearly. — *law*
2. Sun is at certain elevation.
3. <*Relevant trigonometic relations*>.
4. Shadow has length ℓ.

(2–4: *conditions*)

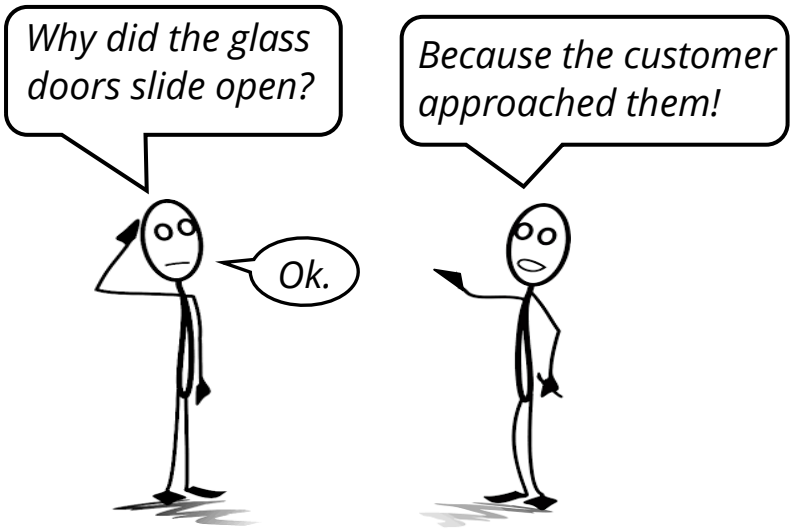
∴ Flagpole has height h. — *observation*

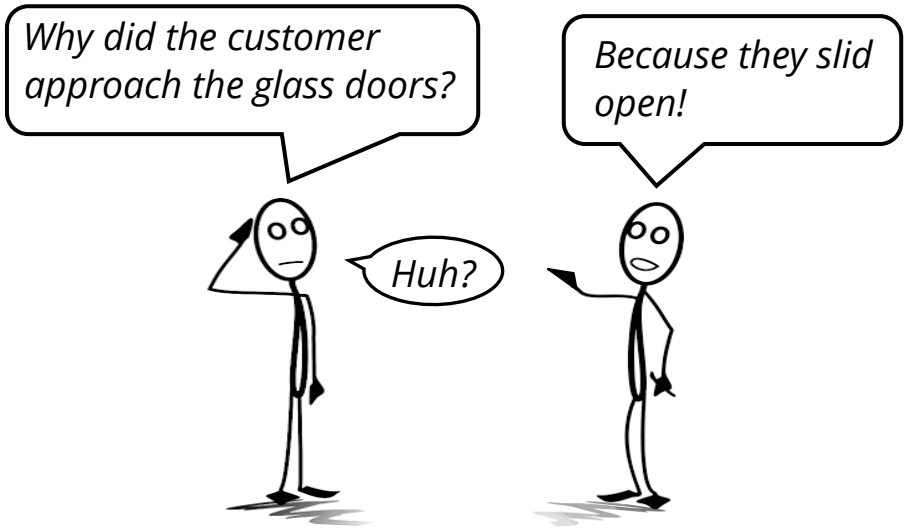
Is this a scientific explanation?

- We normally explain an *effect* (length of shadow) in terms of its *cause* (flagpole's height), and not *vice-versa*.

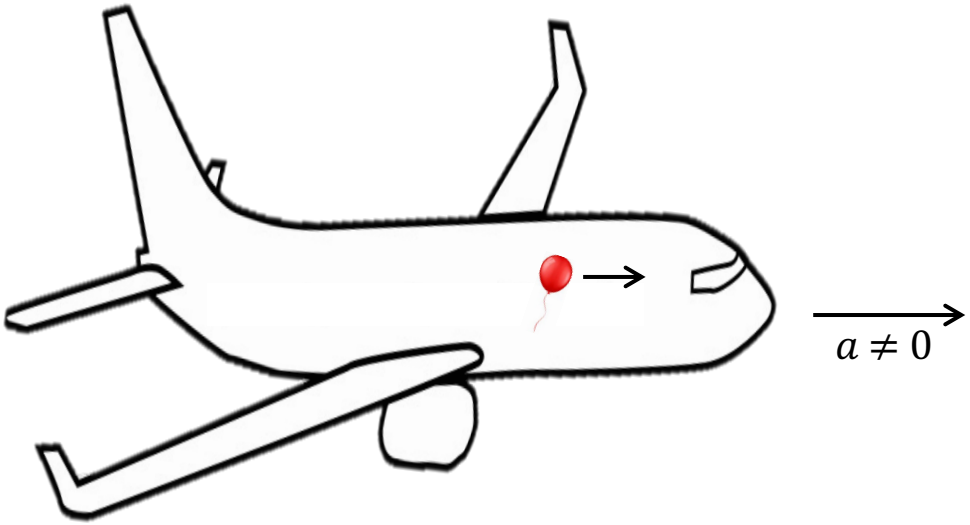
Effect: Automatic glass doors slide open.

Cause: Customer approaches doors.





CE 2: Why does a helium balloon float towards the front of an accelerating airplane as it takes off?



Answer: As the plane accelerates, the air in the cabin experiences an inertial force that compresses it towards the rear, resulting in an area of high pressure toward the rear, and an area of low pressure toward the front. This pressure gradient then causes the helium balloon to float towards the front.

Claim: This is a scientific explanation that is not a DN or IS explanation.

- *It explains the balloon's behavior by identifying its cause.*

CE 3: Why did Wes recover quickly from his cold?

IS explanation:

1. 85% of people with common colds who take massive doses of vitamin C recover quickly.
2. Wes is a person with a cold.
3. Wes took massive doses of vitamin C.

∴ Wes recovered quickly.

Is this a scientific explanation?

- It's a strong inductive argument with premises that seem to contain all relevant information that would have an effect on the conclusion (*explanandum*).
- *But*: Is vitamin C consumption statistically relevant to recovery from the common cold?
  - *If not, then Premise* (3) *is irrelevant to the conclusion.*

Moral: Covering Law Adequacy Conditions still allow irrelevant information to be included in the premise of an IS explanation.

CE 4: Why did Smith develop paresis?

1. 25% of people who have untreated latent syphilis develop paresis.
2. The only way to get paresis is if you have untreated latent syphilis.
3. Smith had untreated latent syphilis.

∴ Smith developed paresis.

Claim: This is a scientific explanation that is not a DN or IS explanation.

- *It is not an IS explanation because it is not a strong inductive argument (the premises give low probability to the conclusion).*