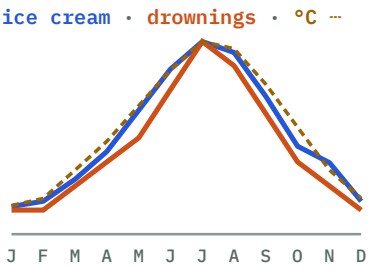
Does ice cream cause drowning? What else changed?

Two numbers that rise and fall together are **correlated**. That alone never says that one **causes** the other: a third thing can move both, the link can run backwards, or it can be luck. Question 5 of the ten to ask a number.

1 Correlation

moving together

- **Correlation** (written `r`) = how closely two numbers rise and fall together · from **−1** (opposite) to **+1** (in step) · says **nothing about why**
- **Coralia Gazette** (the toy island's newspaper): "ice cream sales and drownings rise together · ban ice cream at the beach?"
- 12 months: ice cream 10 → **70** thousand cones (July) → 12 · drownings 1 → **8** → 1 ⇒ `r = 0.99`
- **Causation** = one thing really makes the other happen



2 Confounder

the third thing

- **Confounder** = a third thing that moves both numbers · `ice cream ← weather → drownings` · July 27 °C (81 °F), January 4 °C (39 °F)
- **Test: compare like with like** · March and November, both 9 °C (48 °F) → 20 and 26 thousand cones → **2** drownings each ⇒ ban ice cream → drownings ≈ **the same**
- Practice: sunglasses and sunburns ← **hours of sun** · January and December, 80 hours each → 800 and 1,200 sunglasses → 2 sunburns each · cocoa and sledding accidents ← **snow**

3 Three ways to be fooled

+ needs a test

Way	Means	Examples
Third thing	something else moves both	shoe size and reading (age) · umbrellas and accidents (rain) · gray hair and back pain (age) · storks and births (country size)
Backwards (reverse causation)	the "effect" causes the "cause"	illness → medicine · struggling → tutoring · theft → guards · floods → flood walls
Chance	a match by luck	usual test lets **1 in 20** unrelated pairs pass ⇒ 100 pairs → ≈ **5** · 200 → ≈ **10** ⇒ test again on new data
Needs a test	a cause is possible, unproven	sleep and grades · fertilizer and harvests · stretching and injuries

4 Real charts

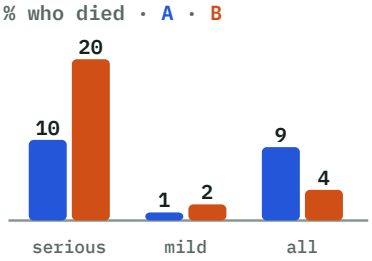
chocolate · storks

- **Franz Messerli** (Swiss-born heart doctor in New York), *New England Journal of Medicine*, **2012**: chocolate eaten per person ↔ Nobel prizes (top world prizes: science, medicine, writing, peace) per person, 23 countries, `r = 0.79` · his own words → a starting idea, not proof · backwards possible (clever people eat more chocolate?) · a third thing possible (how rich a country is) · only a **randomized trial** (chance decides who gets it) can test it
- **Robert Matthews** (Aston University, England), *Teaching Statistics*, **2000**: stork pairs ↔ births, 17 European countries, `p = 0.008` ≈ 1 time in 125 by luck · "significant" (unlikely to be luck) ≠ a cause · third thing → **size of the country**

5 Simpson's paradox

the total flips

- Pattern in **every group** → flips in the **total**, because a third thing differs between groups · named after **Edward Simpson**, British statistician, 1951
- Hospital A: 91 of 1,000 died (≈ 9%) · B: 38 of 1,000 (≈ 4%) → "A is deadlier"?
- Seriously ill: A **10%** (90 of 900) · B 20% (20 of 100) · mildly ill: A **1%** (1 of 100) · B 2% (18 of 900) ⇒ A better in **both** · A just gets 900 seriously ill patients



6 So what?

question 5 of 10

- **Ten questions to ask a number** · 1 · Where does the axis start, and what is its scale? · 2 · Average of what: the mean or the median? · 3 · Percent of what? Percent or percentage points? · 4 · Real or nominal: did prices change too? · **5 · What else changed? Could something else explain both?**
- Gazette rewritten → "Ice cream sales and drownings both rise in summer, when more people go to the beach. The weather moves both; banning ice cream would not be expected to change drownings."
- Met before: Development Lesson 2 (good institutions = a country's rules, courts, safe property · rich countries: which came first?) · Finance Lesson 8 (a fund manager who beats the whole stock market a few years may be lucky) · what proves a cause → Lesson 6

Watch out: a correlation is a hint, not a proof · a high `r` or a tiny `p` still says nothing about why · before blaming one number for another, ask what else changed · compare like with like, inside each group