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## **Logical Leaps From Associations**

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## **Agenda**

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The distinction between association and causation is central to statistics. Yet the grammar used to describe this difference often creates confusion.

Students can't distinguish association from causation.

This paper identifies ways in which statistical associations are open to "logical leaps."

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## **Describing Associations by Statisticians**

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**Statisticians:** Feature abstract ideas.

**Generic form:**  
*The correlation between X and Y is ...  
X is correlated (linked, associated) with Y.*

**Two-group form:**  
*The risk of Y is [y%] more in X than non-X.  
Average Y is [y%] more in X than non-X.*

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## **Describing Associations by Journalists (concrete)**

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**Two-group comparison:**

1. *X has a [y%] more Y [than non-X].*

**Slope comparisons:**

2. *The more/bigger X, the more/bigger Y.*
2. *As X increases [by x], Y increases [by y].*
2. *For every extra x, Y increases by y.*

**Active-verb association:**

3. *Doing X cuts (your) Y [by y].*

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## **Three Logical Leaps**

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These journalists forms have side-effects. They all allow (encourage?) these logical leaps

1. from simultaneous to temporal  
(From cross-sectional to longitudinal)
2. from group differences to individual changes.
3. from association to causation

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## **1) Two Group Compare**

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*Infants who listen to classical music have higher IQ.*

Logical Leap: *If you want your infant to be intelligent, then they should listen to classical music.*

1. Ignores possible common causes.
2. Ignores differences between your infant and those who live in homes that listen to classical music.

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### **1) Two Group Compare**

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*Africa: Circumcised men are two to three times less likely to contract HIV [than non-circumcised men].*

Logical Leap: *If you a young African male and want avoid HIV, you should get circumcised.*

1. Ignores alternate explanations.
2. May still be true.

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### **Internet Explorer users have lower IQs**

Relaxnews - Fri, Jul 29, 2011

Using Microsoft's Internet Explorer (IE) to browse the web? Your IQ score is likely to be lower than someone using Firefox, Chrome, Safari or Opera.

A new study published by online psychometric testing company AptiQuant Psychometric Consulting Co. has found that a user's choice of web browser is related to their cognitive ability.

"There was a clear indication...that the subjects using any version of Internet Explorer ranked significantly lower on an average than others," said AptiQuant. Out of all the IE versions, "subjects using IE 8 [fared] a little better."

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### **2) Slope Comparisons**

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- 2a. **The more/bigger X, the more/bigger Y.**
- 2b. **As X increases [by x], Y increases [by y].**
- 2c. **For every extra x, Y increases by y.**

Used when X and Y are both quantitative.

More/more (as/as) comparisons of quantities.

No groups specified.

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### **2) As Weight ↑, Height ↑: Kids vs. Adults**

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The graph shows a positive linear relationship between weight and height. Three icons are plotted: a small child icon at the bottom left, a medium young adult icon in the middle, and a tall adult icon at the top right. The axes are labeled 'Height' and 'Weight'.

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### **As X increases/decreases Between groups? Within Person?**

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As self-awareness increases, so does self-esteem

As bandwidth increases, new applications emerge.

Mortgages: loan values decrease as equity increases.

As group size increases, social loafing increases.

As the price of bananas increases, the quantity of apples you buy also increases.

Bus usage declines as income increases.

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### **3) Action Verb Associations**

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- Weddings **boost** mood: study.
- Expanding waist **worsens** kids' sleep apnea.

Before-after studies are possible

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- Estratest **doubles** breast cancer risk
- Gene **increases** depression risk

Before-after studies are impossible.

Journalists should distinguish these two cases.

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### 3) Action Verb Association

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“Research shows that the headgear **reduces** the concussion rate by more than 50 percent.”

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### 3) Action-Verb Compare

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Slope-compare restated with action verb:  
*Each hour of television watched per day at ages 1-3 **increases** the risk of attention problems, such as ADHD, by almost 10 percent at age 7.*

*Active verbs imply causation.*

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### Action-verbs are Common

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Causation (8%): *cause, effects, results, prevents*  
 Association (2%): *associate, relate, correlate,*  
 Between (67%):  
     37%: *Action verbs: ups, cuts, raises, increases .../*  
     13%: *Two-group compare: more/less, \*er*  
     9%: *Sufficient: prevent, stop, end, start, kill, cure ...*  
     3%: *Temporal: before/after, lead/follows ...*  
     3%: *Others: due to, because of, attributed to*  
     1%: *Connect: link, help*

Schild and Raymond (2009) study of 2,000 newspaper headlines that involved quantities.

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### Conclusion

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Statistical educators should

1. teach ways of presenting associations
2. help students distinguish from causation
3. identify related logical leaps.
4. oppose the use of active verb claims when causation is not justified.
5. formalize #4 in ASA code of ethics.

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### 3) Action-Verb Association

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Two-group compare restated with action verb:

Two-groups: People who read home and fashion magazines are more likely to get pregnant than people who read car and hunting magazines.

Action Verb: Reading home and fashion magazines **ups** chances of getting pregnant.

*Active verbs imply causation.*

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### 2) Slope Compare

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**Kids: temporal association within each subject.**  
*As kids get heavier, they tend to get taller.*

**Adults: Non-temporal association between groups**  
*Heavier people tend to be taller than lighter people.*

**Logical leap:**  
**Adults: temporal association within a subject.**  
*As adults gain weight, they tend to grow taller. ☺*

1. Obviously false. We know better.

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**As X Changes  
Shift in Focus? Different Subjects?**

Belief that as price increases, quality improves.

Average fixed cost declines as output increases.

Black-white income gap narrows as education increases.

Standard of living actually goes up as trade increases.

The need for more roads increases as traffic increases.

'Inferior Good' purchases decrease as income increases.

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**1) Two Group Compare**

*Kids taking Algebra in 8<sup>th</sup> grade do better in college*

Logical Leap: *If you want your child to do better in college, then they should take Algebra in 8<sup>th</sup> grade.*

1. Ignores possible common cause (smarter)
2. Ignores any differences between your child and those children who take Algebra in 8<sup>th</sup> grade.

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