

# Thinking Like a Psychological Scientist



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Imagine that the government of Canada hired us to answer a question...

Does being at high altitude hinder decision making and fine motor skills?

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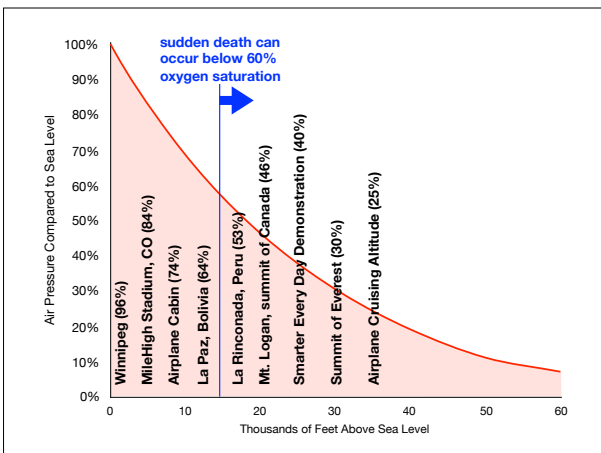
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# How will we answer this question?

Does being at high altitude hinder decision making and fine motor skills?

OpenEnded iClicker

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## 1. Deduction or "First Principles"



1. Brains use oxygen to do all kinds of things.
2. Decreasing the amount of oxygen in the air decreases the amount of oxygen in the brain.
3. Decision making and fine motor skills requires brain functioning.
4. Therefore decreasing the amount of oxygen in the air will hinder decision making and fine motor skills.

This is called **Deductive Reasoning**

A form of reasoning in which **ideas or principles** determines the **conclusion** limited by

- whether the principles apply in this scenario (#2?)
- whether relevant principles are missing

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general principle

**Deductive Reasoning**

Math  
Philosophy  
Theology



belief about something observable

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general principle

**Inductive Reasoning**

Anecdotal Evidence  
Scientific Method



something observable

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## 2. Induction

### Inductive Reasoning

A form of reasoning in which a set of observations lead to a general conclusion.

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## 2a. Previous Experience

		Have you ever been to high altitude?	
		Yes	No
If yes, did the altitude hinder your decision making and fine motor skills?	Yes	A	C
	No	B	

or from other people's experiences...

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“always secure your own mask before assisting another person”

why?

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Why You Should Put YOUR MASK On First (My Brain Without Oxygen)  
Smarter Every Day 157

10 mins long



A square  
Are you sure that's this one?

<https://www.youtube.com/watch?v=kUf2MTnqAw>

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## Previous Experience = "Anecdotal Evidence"

A piece of biased evidence, usually drawn from personal experience, used to support a conclusion that may or may not be correct.

Anecdotal evidence is super interesting... but unconvincing

- can be limited by memory shortcomings (are memories accurate?)
- can be limited by the quality of observations (was it dehydration, fatigue, or altitude?)
- can be limited by the representativeness of observations

"ALTITUDE DECREASES  
COGNITIVE FUNCTIONING"



A square  
Are you sure that's this one?

anecdote  
Destin @ 25,000'



"ALTITUDE DECREASES  
COGNITIVE FUNCTIONING"



case of interest  
Team Canada @ 5,000'

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## 2c. Scientific Method



a way of thinking

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Does being at high altitude  
hinder decision making  
and fine motor skills?

- A. no "null hypothesis"  
B. yes "alternative hypothesis"

**Hypothesis**

A prediction that is testable

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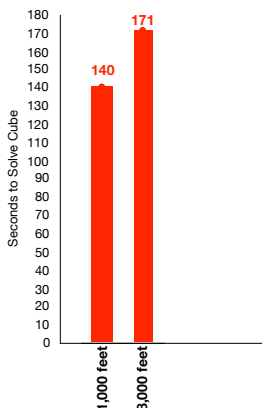
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Let's interpret these results.  
What effect does high altitude  
have on performance?

- A. speeds it up  
B. has no effect  
C. slows it down  
D. it's inconclusive

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# randomness

- lucky or unlucky Rubik's cube orientation
- lucky or unlucky hand at poker
- a cold just before an exam
- two exams on the same day
- got distracted by some noise

how to eliminate randomness:

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# Get a Sample

## Sample

In research, a *number* of observations selected from a population to serve as an example of that population.

- In a sample, randomness in one observation tends to cancel out randomness in another observation
- In Rubik's cubing, a sample = solve it more than once

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# Rubik's Cube sampling

How many times should Dr. Frimer solve the cube at each altitude?

Numeric iClicker

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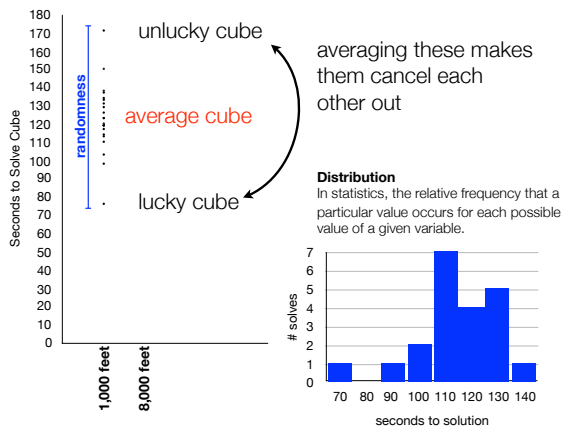
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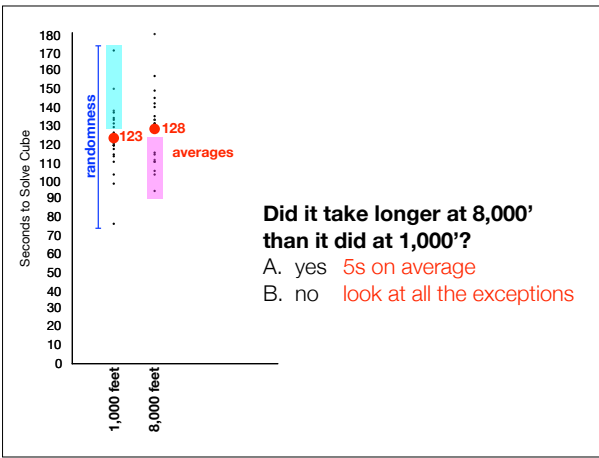
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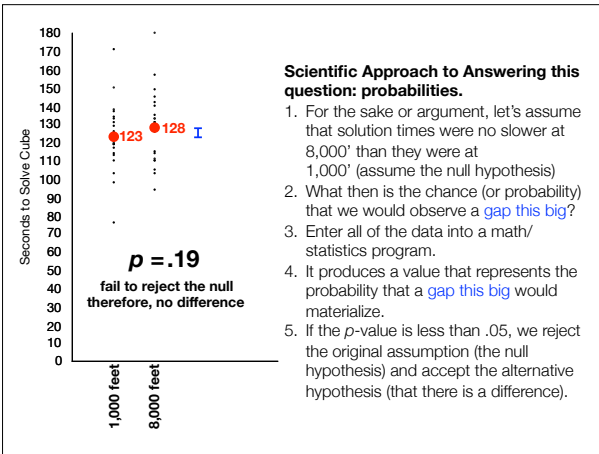
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**Probability,  $p$ -value**  
 A measure of the degree of certainty of the occurrence of an event.

**Null-hypothesis significance testing (NHST)**  
 In statistics, a test created to determine the chance that two distributions would be as different as observed if the null hypothesis were actually true.

**Probability values**  
 In statistics, the established threshold for determining whether a given value occurs by chance.  
 - typical is .05

**$p$ -values**  
 < .05 - there is a difference  
 > .05 - there is no difference

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**$p$ -values**  
 < .05 - there is a difference  
 > .05 - there is no difference

too  
 conservative  
 ?

**Probability values**  
 In statistics, the established threshold for determining whether a given value occurs by chance.  
 - typical is .05

**False Negative or "Type II Error"**  
 In statistics, the error of failing to reject the null hypothesis when it is false.

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		in reality, there is...	
		a relationship (altitude affects performance)	no relationship (altitude does not affect performance)
the researcher finds...	a relationship (alternative hypothesis $p < .05$ )	accurate detection	false positive finding OR "Type I Error"
	no relationship (null hypothesis $p > .05$ )	false negative finding OR "Type II Error"	accurate detection

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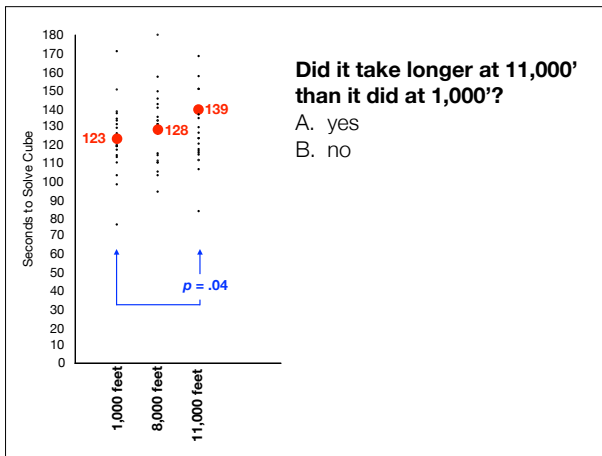
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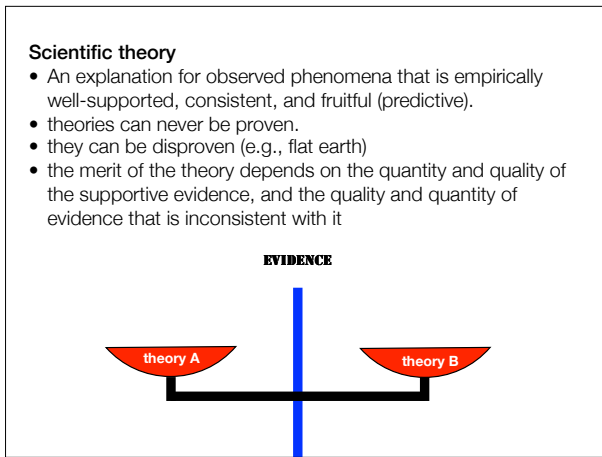
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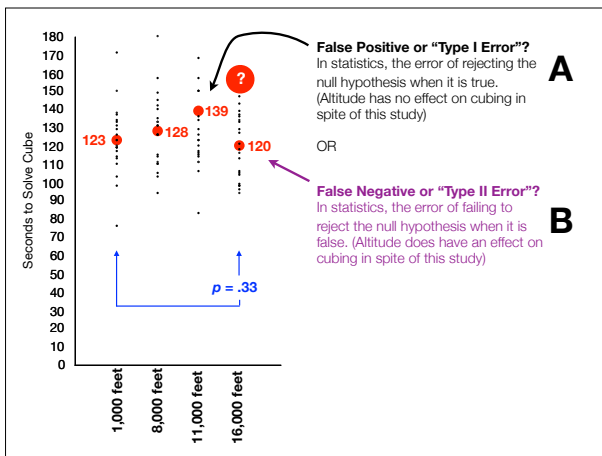
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**Scientific theory**

- An explanation for observed phenomena that is empirically well-supported, consistent, and fruitful (predictive).

unlike the “high altitude decreases brain function” theory “acclimatization” theory can potentially explain...

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## thinking like a psychological scientist

1. **Humility:** I don't know the answer
2. **Curiosity:** How can I find out?
3. **Design:** What would be a fair test?
4. **Rigour & Objectivity:** What might make the test unfair? How can I reduce or eliminate these factors?
5. **Effort:** Let's go do the work to find out
6. **Reflection:** What answer do the results support? What new questions arise?

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