Stat 411/511

Sign Tests

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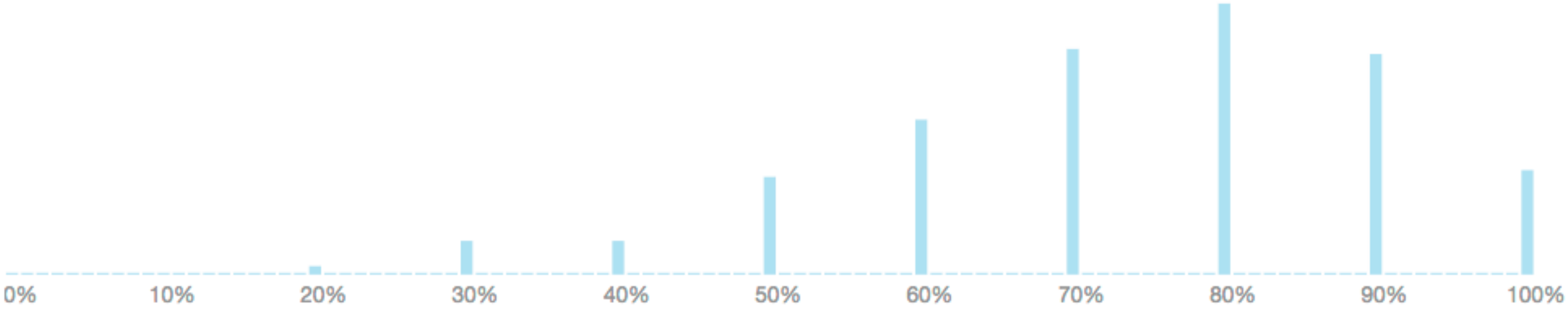
Quiz #2

Average Score	High Score	Low Score	Standard Deviation	Average Time
74%	100%	20%	1.74	23:22



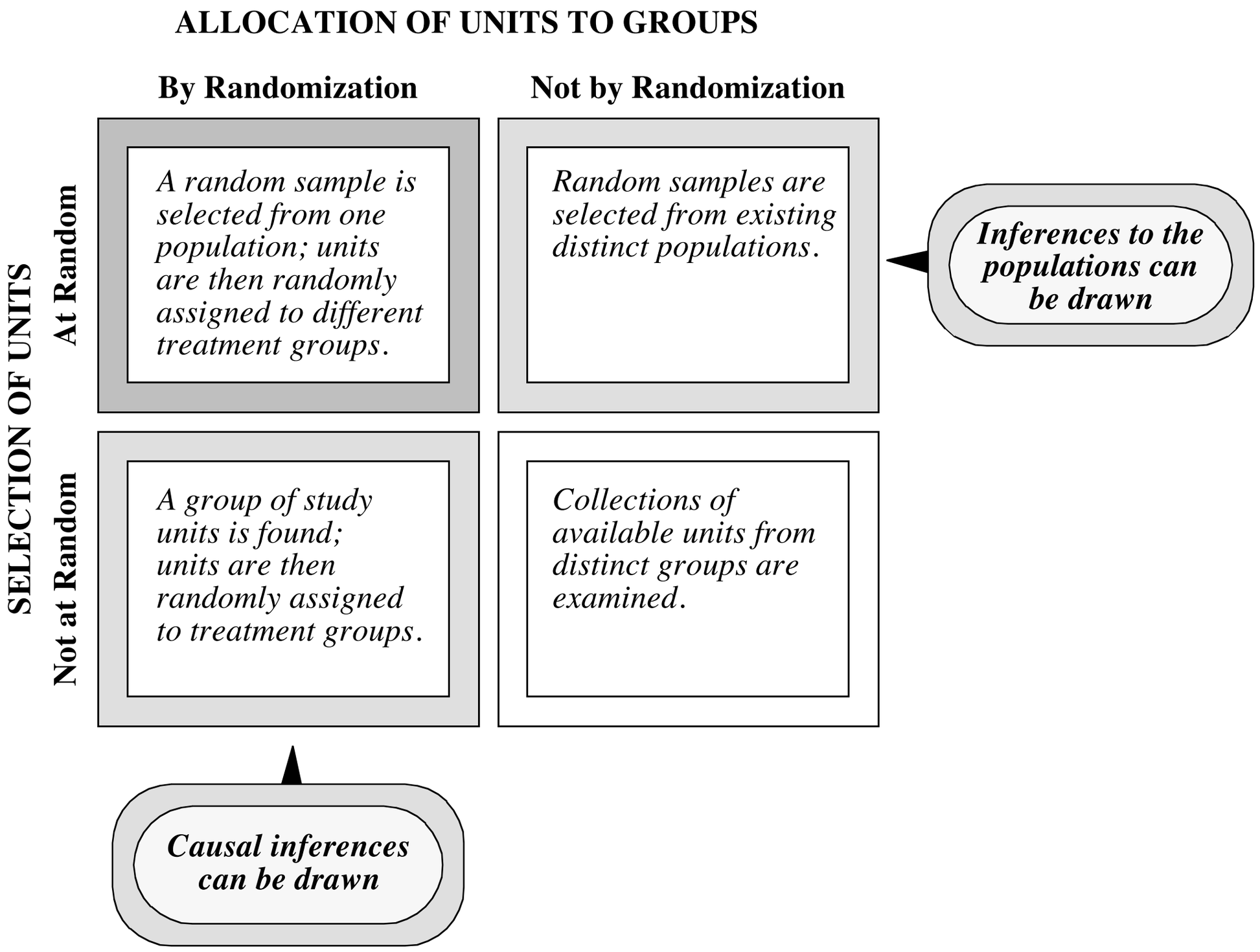
Quiz #2

Researchers are interested in the effect of using a bike for transport to the grocery store on the amount people spend at the store for people in Corvallis.

- They stand outside Trader Joe's in Corvallis, and interview people as they leave.
- They record whether the person travelled by car or bike, and how much they spent in the store.

What kind of inferences will the researchers be able to make?

Statistical inferences permitted by study designs



Ask yourself

What is the population of interest? Were people randomly sampled from this population?

What are the treatments/groups? Were people randomly assigned to these treatments/groups?

Researchers are interested in the effect of Seasonal Affective Disorder (SAD) lights on the mood of OSU students.

- They randomly sample 100 OSU students.
- All 100 students are asked to attend a daily 5pm hour long seminar on student success for two weeks in January.
- Fifty of the students are randomly assigned to a seminar room with normal lighting. The other fifty attend the seminar in a room with SAD lights.
- All 100 students conduct a mood evaluation before and after the two weeks of seminar and the researchers record their change in mood score.

What kind of inferences will the researchers be able to make?

Data Analysis #1

Posted today along with a rubric.

Read the rubric, a significant fraction of your score is the presentation of the analysis not the analysis itself.

Pay attention to the submission requirements. This time a Word doc or pdf **report** is the primary deliverable. You must also attach an R script as supporting information.

411 students, keep an eye out for where your assignment differs.

Due next Friday at midnight.

Instead of a homework.

Data Analysis #1

You can discuss with each other.

But the report you submit, must be in your own words.

Identical reports, or identical parts of reports will be considered acts of academic dishonesty.

HW #4

1. SHow histograms + normal probability plots
2. Talk about how reasonable assumption of Normality and assumption of equal population SDs is. Comment on anything else unusual.
3. Comment on robustness for each assumption.

Week	M	W	F	Assessment
6 Nov 2	Multiple Groups	One way ANOVA	ANOVA F-test	Quiz #3 DA #1 Due
7 Nov 9	ANOVA assumptions	**Veteran's Day**	Linear Combinations	HW #5 Due
8 Nov 16	Multiple Comparisons	Simple Linear Regression	SLR Estimation	Quiz #4 DA #2 Due
9 Nov 23	SLR Inference	SLR Assumptions	**Thanksgiving**	**BREAK**
10 Nov 30	Lack of Fit F-test	Review		DA #3 Due

Final Thu Dec 10th at 6pm

Back to paired data

We will now talk about two resistant **paired sample tests.**

Either a two independent sample test is appropriate **or** a paired sample test is appropriate, **never both**.

technically, you can do a paired test on unpaired data, it just isn't as powerful

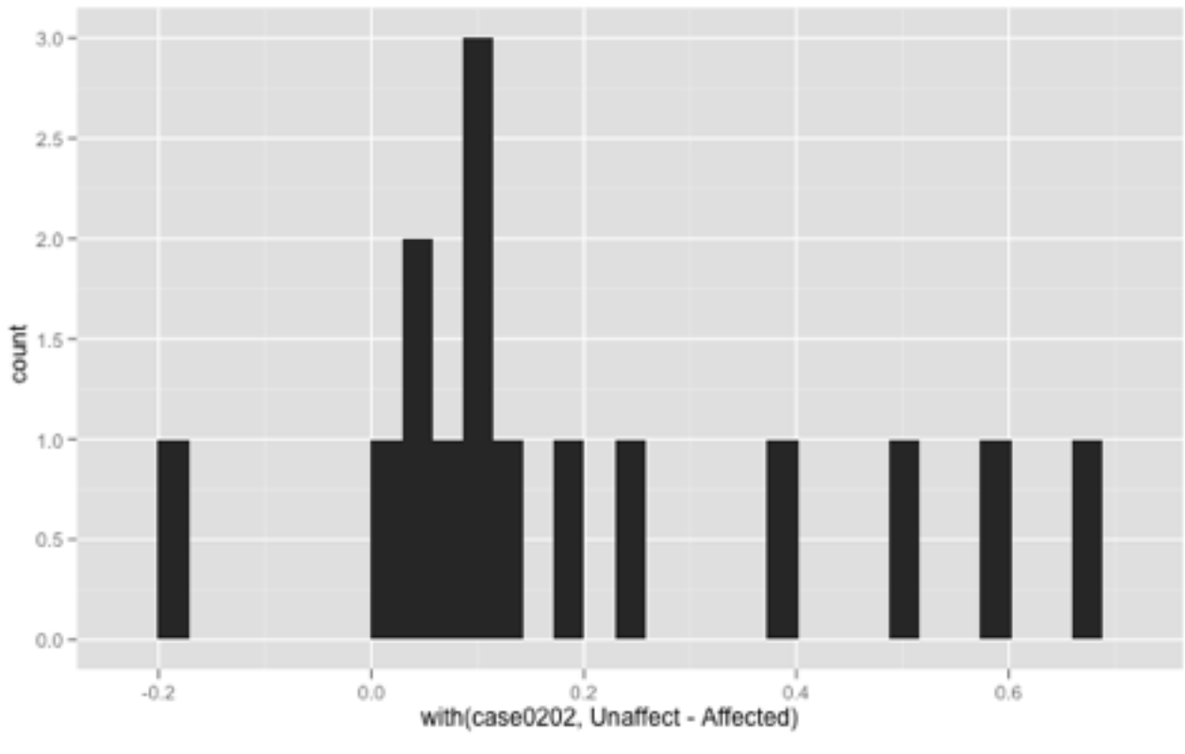
But, within the two independent sample tests, more than one test may be appropriate, same with paired sample tests.

Schizophrenia Case Study

One sample of differences.

The difference in brain volume between a non-schizophrenic and their schizophrenic twin.

```
with(case0202,
  Unaffect - Affected)

0.67 -0.19  0.09  0.19
0.13  0.40  0.04  0.10
0.50  0.07  0.23  0.59
0.02  0.03  0.11
```



Sign Test

Your turn

Imagine we just have one pair of twins.

If schizophrenia has no relationship to brain volume, what is the probability the difference (schizophrenic volume - non-schizophrenic volume) is positive?

If we have two sets of twins, what is the probability both differences are positive?

Sign test

Null: Median difference is zero. (Or no treatment effect).

Test statistic: the number of positive differences.

Under the null hypothesis, seeing positive differences should be like seeing heads in a fair coin flip.

Schizophrenia Case Study

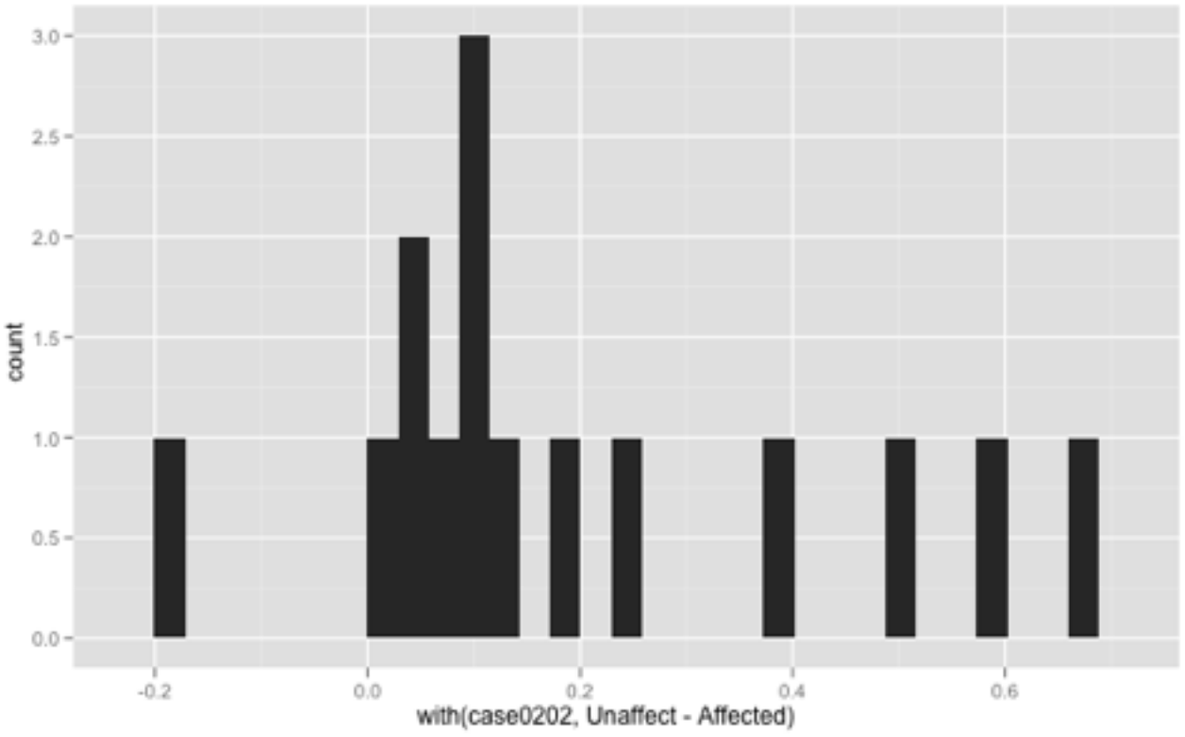
Null: Median difference in brain volume between a non-schizophrenic and their schizophrenic twin is zero.

Under the null, the probability of seeing 14 positive differences is the same as the probability of seeing 14 heads in 15 fair coin flips. the p-value

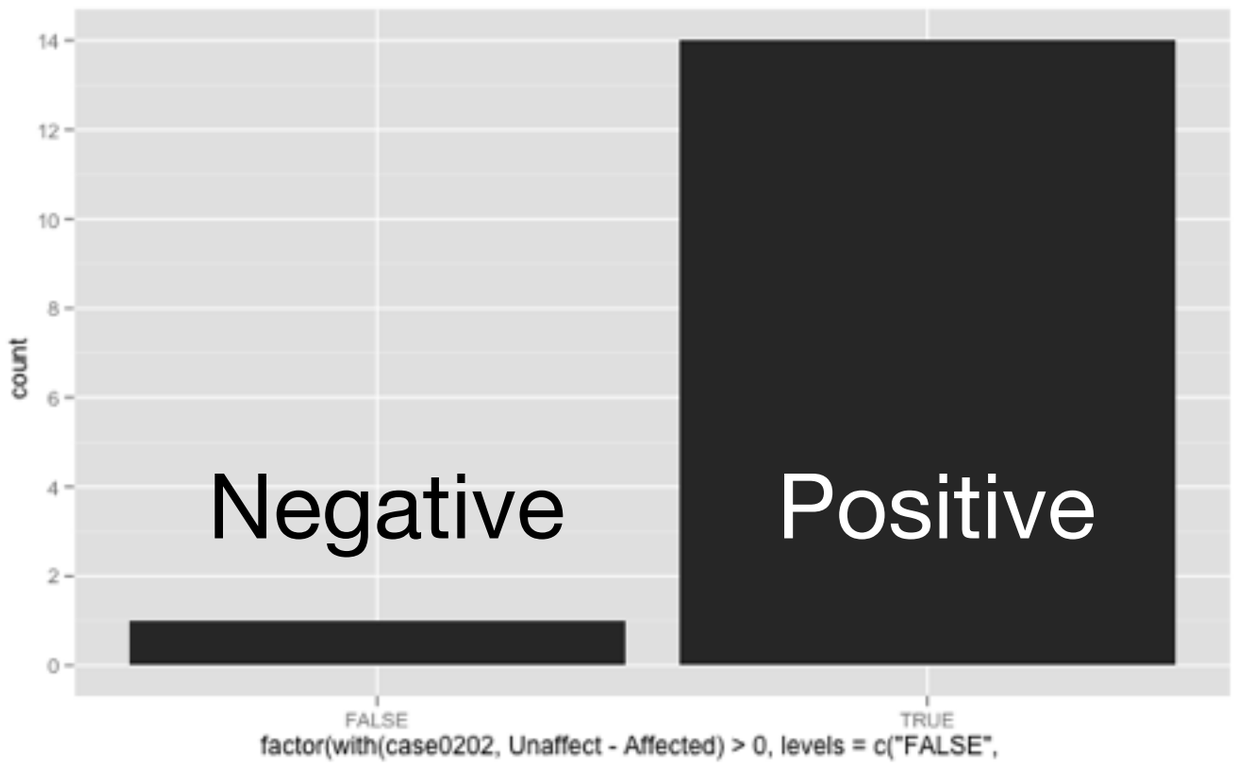
```
> binom.test(14, 15)

   Exact binomial test

data:  14 and 15
number of successes = 14, number of trials = 15,
p-value = 0.0009766
alternative hypothesis: true probability of
success is not equal to 0.5
95 percent confidence interval:
 0.6805154 0.9983136
sample estimates:
probability of success
             0.9333333
```

Sleuth does a Normal approximation
(useful but you don't need to know it)

Takes this:



And simplifies to this:



No Normality assumption

Very resistant to outliers

But throws a lot of information away

Sign Test

	Sign test
Null hypothesis*	Median difference is zero. OR The treatment effect is zero.
Assumptions	•Independence of subjects within groups.
Robust to assumptions?	No
Resistant to outliers?	Resistant
Test statistic	Number of positive differences

Wilcoxon Signed Rank Test

Uses ranks and signs

Wilcoxon Signed Rank Test

Null: The differences are symmetric about zero.

(Or no treatment effect).

Test statistic: the sum of the ranks of the **positive** differences.

Alternative: The differences are symmetric about some number not equal to zero.

0.67		0.02
-0.19		0.03
0.09		0.04
0.19		0.07
0.13		0.09
0.40		0.10
0.04		0.11
0.10	⟶	0.13
0.50		-0.19
0.07		0.19
0.23		0.23
0.59		0.40
0.02		0.50
0.03		0.59
0.11		0.67

Step 1:

Using absolute values of the differences order the differences from smallest to largest.

```
0.02
0.03
0.04
0.07
0.09
0.10
0.11
0.13
-0.19
 0.19
 0.23
 0.40
 0.50
 0.59
 0.67
```

Your turn

Step 1.5:

Drop any zeros from the list.

Step 2:

Rank the absolute values from smallest to largest (just like in Wilcoxon rank sum test, give ties the average rank).

Diffs	Rank
0.02	1.0
0.03	2.0
0.04	3.0
0.07	4.0
0.09	5.0
0.10	6.0
0.11	7.0
0.13	8.0
-0.19	9.5
0.19	9.5
0.23	11.0
0.40	12.0
0.50	13.0
0.59	14.0
0.67	15.0

Step 3:

Add up the ranks of the positive differences.

= 110.5

The Wilcoxon Signed Rank test-statistic

Under the null, we expect the test statistic to be about:
n(n+1)/4 = 15*16 /4 = 60

```
wst <- wilcoxsign_test(Unaffect ~ Affected,
  data = case0202, alternative = "greater",
  distribution = exact(),
  zero.method = "Wilcoxon")

> wst

   Exact Wilcoxon-Signed-Rank Test

data:  y by x (neg, pos)
    stratified by block
Z = 2.8966, p-value = 0.001007
alternative hypothesis: true mu is greater than 0

> statistic(wst, "linear")

neg 111
```

Exact p-value

Weird rounding issue with this data

Wilcoxon Signed Rank Test

	Wilcoxon Signed Rank test
Null hypothesis*	Differences are symmetric about zero. OR The treatment effect is zero.
Assumptions	•Independence of subjects within groups.
Robust to assumptions?	No
Resistant to outliers?	Resistant
Test statistic	Sum of the rank of positive differences