

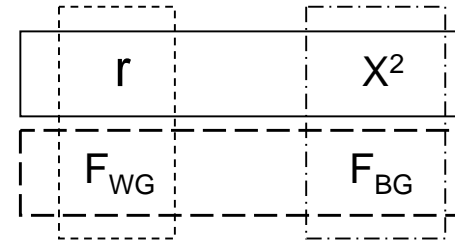
Some Details about Our Bivariate Stats Tests

- Conceptualizing the four stats tests
- Conceptualizing NHST, critical values and p-values
- NHST and Testing RH:
- Distinguishing Type III error from “results contrary to our RH”

Let’s work with this “arrangement” of the 4 tests ...

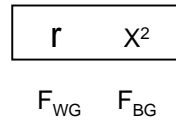
we’ll examine these by contrasting each of the following pairs...

- tests of bivariate association (2 quant vs. 2 qual variables)
- tests of mean differences (between groups vs. within groups)
- analysis of repeated measures data (assoc vs. mean dif.)
- between groups comparisons (quant mean vs. qual pattern dif.)



tests of bivariate association (quant vs. qual variables)

- Both of these ask “whether there is a relationship between the variables in the population represented by the sample”



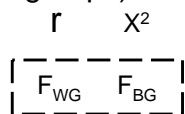
- The difference is whether the two variables are
 - quantitative -- use Pearson’s correlation
 - qualitative/categorical -- use Pearson’s X^2
- H0:s are similar, but have different “key words”
 - r -- There is no linear relationship between the quantitative variables, in the population represented by the sample
 - X^2 -- There is no pattern of relationship between the qualitative variables, in the pop represented by the sample

Example... (which stat for which?) ...

- Is whether or not patients receive therapy related to whether or not they improve ?
- Is #therapy sessions related to decrease in #symptoms ?

tests of mean differences (between groups vs. within groups)

• Both of these ask “whether there is a mean difference on the quantitative variable between the populations represented by the two conditions”



- The difference is whether the two populations are:
 - represented by different sets of parts in each condition -- BG
 - represented by the same set of parts in both conditions - WG
- H0:s are exactly the same, because H0:s are about populations
 - F_{BG} & F_{WG} - the populations represented by the conditions have the same mean on the quantitative variable

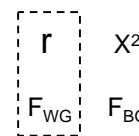
Example... (which stat for which?) ...

- Does the mean anxiety change from before to after therapy ?
- Is the mean anxiety different whether or not patients receive therapy?



analysis of repeated measures data (assoc vs. mean dif.)

• Both of these stats can be applied to the data from a repeated measures design -- but they are used to ask different questions



- F_{WG} -- is used to ask if there is a mean difference between the measure taken during the two different times/treatments
- r -- is used to ask if we can use a participant’s score during one time/treatment to predict their score during the other (prediction based upon the variables being linearly related)

Example... Patients entering therapy for depression were asked to complete the “Beck Depression Inventory” during the first therapy session (pretest) and again during their last session (posttest). The therapist had two questions (which stat for which?) ...

- Is the mean posttest score lower than the mean pretest score?
- Does a person’s pretest score predict their posttest score ?

Let’s take another look at this distinction...

In a study of recall memory in young adults, participants were given a list of 40 common words to study for 5 minutes. Then they were given a blank piece of paper and instructed to write down all the words they could recall from the list. Data were collected for the two kinds of recall errors -- “exclusions” (words on the list that weren’t written down) and “intrusions” (words that weren’t on the list that were written down). The researcher has 2 RH: about how the variables are related.

RH #1 There will be more exclusions than intrusions.

RH #2 Those participants who have more intrusions will also be those that have more exclusions.

Type of research question:
 • mean difference? ←
 • linear relationship ?

Type of research question:
 • mean difference?
 • linear relationship ? ←

Proper Statistic? WG ANOVA

Proper Statistic? correlation

H0: Mean number of exclusions and intrusions are the same in young adults

 RH: Larger mean exclusions than mean intrusions in young adults

H0: No linear relationship between the number of intrusions and exclusions in young adults

 RH: Positive linear relationship between the number of intrusions and exclusions in young adults

Your turn...

I have two questions about the relationship between Exam #1 and Exam #2 scores in this class.

Question #1: Those Psyc 350 students who do poorly on Exam #1 will also do poorly on Exam #2

Stat:

H0:

RH:

Question #2: Psyc 350 students will do better on Exam #2 than on Exam #1

Stat:

H0:

RH:

between groups comparisons (quant mean vs. qual pattern dif.)

• Both of these stats can be applied to the data from a between groups design -- but which is used depends upon the kind of variable being compared

r X^2
 F_{WG} F_{BG}

- F_{BG} -- is used when groups are being compared using a quantitative variable -- examination of mean differences
- X^2 -- is used to when the groups are being compared using a qualitative variable -- examination of response pattern differences

Example... (which stat for which?) ...

- Is whether or not patients receive therapy related to whether or not they improve ?
- Is the mean anxiety different whether or not patients receive therapy?

Let's take another look at this distinction...

The question was whether different types of computers (PCs or Macs) had different "failure rates". The RH: was that PCs would have a higher failure rate". Two different researchers were hired to run experimental evaluations...

Researcher #1 Acquired 50 computers of each type, had researcher assistants (working in shifts & following a prescribed protocol) keep each machine working continually for 24 hours & count the number of times each machine failed and was re-booted.

Researcher #2 Acquired 50 computers of each type, had researcher assistants (working in shifts & following a prescribed protocol) keep each machine working continually for 24 hours or until it failed.

Data for each computer was:

- type of computer
- # failures during the 24 hr test

Data for each computer was:

- type of computer
- whether or not that computer failed during the 24 hr test

H0: PCs will have same # failures as Macs

RH: PCs will have more failures than MACs

H0: Same # of PCs will have failures as Macs

RH: More PCs will have failures than MACs

Stat? F_{BG}

Stat? X^2

Your turn...

The purpose of the research was to compare the efficacy of two therapies, with the RH: that cognitive-behavior therapy (CBT) would “work better” than peer-counseling therapy (PCT). Again two researchers ran independent projects.

Researcher #1: 30 patients each received one type of therapy, after which their therapist determined whether or not they showed improvement.

Stat:

H0:

RH:

Researcher #2: 30 patients each received one type of therapy, after which their score on the Beck Depression Inventory (BDI) was obtained.

Stat:

H0:

RH:

Summary of Information from Correlation, Chi-Square, BG & WG ANOVA

Pearson's r

Pearson's X²

ANOVA

Symbolic H0:

H0: $r = 0$	H0: $X^2 = 0$	H0: $\bar{X}_1 = \bar{X}_2$
Range of possible values	-1.00 to +1.00	0 to ∞
Reject H0: when ...	$ r > r\text{-critical}$ or $p < .05$	$X^2 > X^2\text{-critical}$ or $p < .05$
Relationship Description	direction of linear rel.	specific pattern of relationship

H0: $\bar{X}_1 = \bar{X}_2$

Range of possible values

-1.00 to +1.00

0 to ∞

0 to ∞

Reject H0: when ...

$|r| > r\text{-critical}$
or $p < .05$

$X^2 > X^2\text{-critical}$
or $p < .05$

$F > F\text{-critical}$
 $p < .05$

Relationship Description

direction of linear rel.

specific pattern of relationship

direction of mean dif.

NHST Testing with critical-values & p-values

$|Obt| > \text{Critical}$ $|Obt| \leq \text{Critical}$
or
 $p < .05$ or
 $p \geq .05$

NHST decision ?

Reject H0:	Retain H0:
YES	NO
Statistically significant[^]	Statistically Non-significant*

Decide relationship b/n variables in pop?

Results are ?

[^] Remember: don't say “meaningful” or “important” those are value judgements -- not a statistical description

* Remember: don't say “insignificant” that is a value judgement about the finding -- not a statistical description

Does Rejecting the Null Guarantee Support for the Research Hypothesis???

NO !!! For what two reasons

1) the RH: might be the H0:

– is so, retaining H0: means support for the RH:

2) the RH: is only supported if it matches the pattern of the data

– you can reject H0: and still not find support for the RH:

RH: Those with more experience will do better on the task.

Results #1 $r(87) = .032, p = .85$ Well ?

Results #2 $r(87) = -.32, p = .03$ Well ?

Results #3 $r(87) = .52, p = .01$ Well ?

RH: The 4th graders will have higher geography scores than the 3rd graders

Results #1 4th = 62% 3rd = 58% $F(1,48) = 4.3, p = .02$

Results #2 4th = 62% 3rd = 60% $F(1,18) = 2.3, p = .16$

Results #3 4th = 62% 3rd = 68% $F(1,28) = 5.3, p = .01$

RH: Clowns will prefer confetti, while jugglers will prefer “thuds”

Result #1 $X^2(1) = 2.12, p = .25$

	clowns	jugglers
confetti	25	20
thuds	22	28

Result #2 $X^2(1) = 6.36, p = .02$

	clowns	jugglers
confetti	25	10
thuds	12	31

Result #3 $X^2(1) = 6.12, p = .02$

	clowns	jugglers
confetti	14	10
thuds	15	31

You must distinguish “Statistical Decision Errors” vs. “RH: Disconfirmation”

Type III Statistical Decision Error

- When our significant findings have a direction or pattern different from that found in the population
- A difference between “the effect we found” and “the effect we should have found”

“Results contrary to our RH:”

- When our findings have a direction or pattern different from what we had hypothesized
- A difference between “the effect we found” and “the effect we hypothesized”

Outcomes & “Truth” ...

In the population there are only three possibilities...

... and three possible statistical decisions

In the Population

Decisions	$G1 < G2$	$G1 = G2$	$G1 > G2$
$G1 < G2$	Correctly rejected H_0 :	Type I error	Type III error
$G1 = G2$	Type II error	Correctly retained H_0 :	Type II error
$G1 > G2$	Type III error	Type I error	Correctly rejected H_0 :

outcomes & RH:

There are only three possible Research Hypotheses

... and three possible statistical outcomes

Outcomes	Research Hypotheses		
	G1 < G2	G1 = G2	G1 > G2
G1 < G2			?? ??
G1 = G2			
G1 > G2	?? ??		

So, there are only 9 possible combinations of RH: & Outcomes ...

... of 3 types “effect as expected”
 “unexpected null/effect” ?? ??
 “backward effect”

RH:, statistical conclusions & statistical decision errors ...

Results supported Results not supported

Statistical Decision

	+ direction/pattern	RH: H0:	- direction/pattern
+ direction/pattern (p < .05)	 Correct rejection Type I or Type III	 Correct rejection Type I or Type III	 Correct rejection Type I or Type III
H0: (p > .05)	 Correct retention or Type II	 Correct retention or Type II	 Correct retention or Type II
- direction/pattern (p < .05)	 Correct rejection Type I or Type III	 Correct rejection Type I or Type III	 Correct rejection Type I or Type III

Try this one ...

Our RH: is that there will be a negative correlation between the severity of depression at the beginning of therapy and the amount of improvement a patient shows during the first six weeks of therapy.

We found $r(63) = .27, p = .035$. These results are “contrary to our RH:” -- a significant, relationship in the opposite direction from the RH:

A literature review revealed 34 other studies of these two variables, each of which found a correlation between $-.33$ and $-.41$ (all $p < .05$).

The consistent findings of these other studies suggests that our finding was a Type III error – what we found “doesn’t describe the relationship between these variables in the population”. Our RH: was correct, but not our data!!!

Consider the following three pieces of information...

Our RH: is that there will be a positive correlation between how much a person likes performing practical jokes and the number of close friends a person reports.

We found $r(58) = .30, p < .05$. These results support our RH: -- a significant, positive relationship, as hypothesized

A literature review revealed 12 other studies of these two variables, each of which found a correlation between $-.25$ and $-.32$ (all $p < .05$).

The consistent findings of these other studies suggests that our finding was a Type III error – what we found “doesn’t describe the relationship between these variables in the population”