

## Chi square test of independence

- We can *eyeball* differences between percentages to determine whether they seem large enough to be “important”
- Better: Are differences in percentages *statistically significant*?
- *Statistical significance*: are observed differences significantly different from zero that they could not occur by chance?

## Chi square test of independence

- Use chi square test of independence for cross classification tables
- Chi square test tells you whether two variables are *statistically associated*
- Are the differences we observe in the sample likely to persist in the population?

## Association

- *Association*: two variables covary, either positively or negatively
- We test for *significant* association by comparing our observed frequencies to a model that assumes *statistical independence*

## Statistical independence

Belief in life after death	Religious affiliation (hypothetical)			
	Protestant	Catholic	Jewish	Other
Yes	120	90	30	60
No	80	60	20	40
	200	150	50	100

## Statistical independence

Belief in life after death	Religious affiliation (hypothetical)			
	Protestant	Catholic	Jewish	Other
Yes	120 (60%)	90 (60%)	30 (60%)	60 (60%)
No	80	60	20	40
Total	200	150	50	100

*Interpretation:* religious affiliation has no effect on whether one believes in life after death

## Statistical association (statistical dependence)

Percentage believing in life after death by religious affiliation				
Belief in life after death	Religious affiliation			
	Protestant	Catholic	Jewish	Other
Yes	75.0	86.7	10.0	15.0
N	(200)	(150)	(50)	(100)

## Chi square test of independence

- Do these differences by religious affiliation reflect true differences in the population?
- Are the observed differences large enough that we're sure they're not due purely to chance?

## Chi square test of independence

- Chi square tests for independence between two nominal (or ordinal) variables
- $H_0$ : statistical independence (no differences across religious affiliation)
- $H_a$  : statistical dependence (association between religious affiliation and attitudes toward life after death)

## Chi square

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

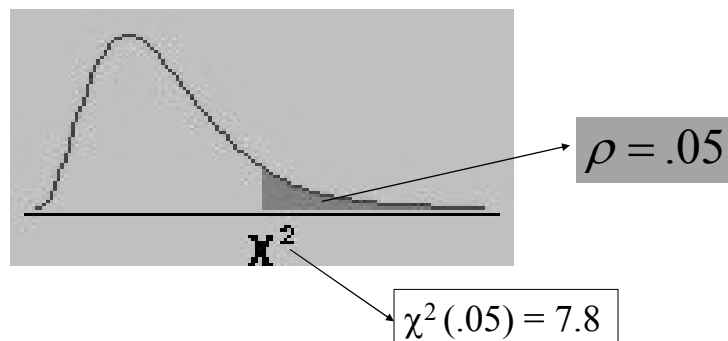
## Chi square: evaluation

- If  $H_0$  of no association is *true*, then  $f_o$  and  $f_e$  will be close and the chi square value small
- If  $H_0$  of no association is *false*,  $f_o$  and  $f_e$  should be relatively farther apart, and hence the chi square value larger
- Chi square value = 0 when  $f_o = f_e$

## Chi square distribution

- GSS provides p values for you
- Want  $p \leq .05$  (indicates significance)
- $p$  = probability, when  $H_0$  is true, of getting a value at least as large as the observed  $\chi^2$

## Chi square distribution



Note:  $\chi^2$  never negative

## Chi square test of independence

Percentage believing in life after death by religious affiliation

Belief in life after death	Religious affiliation			
	Protestant	Catholic	Jewish	Other
Yes	75.0	86.7	10.0	15.0
	(200)	(150)	(50)	(100)
	$\chi^2 : p \leq .0001$			

## Interpretation

Substantively:

Religious affiliation is *significantly* associated with belief in life after death