

## AP Stats – Chap 20

### More About Tests

The **P-value** is the probability that the event would re-occur (if we chose additional samples) if the null hypothesis (the fact that the situation is boring) were true.

We're looking for extremely low P-values. The lower the P-value, the *more comfortable* we feel about our decision to reject the null...but that doesn't make the null "more false." Either the null is true or it isn't, and our sample doesn't change that fact.

## Alpha Levels - $\alpha$

Although there remains NO magical P-value (below which is too low), we can define a **rare event** as one falling below a certain threshold for our P-value; reject the null.

That threshold is known as an **alpha level (significance level)**, and must be set before looking at the data. If our P-value falls below the alpha level, we say the results are **statistically significant**; reject the null.

Common alpha levels are **.10**, **.05**, and **.01**. Remember the example .08 meaning different things for a study on teenage smoking and rivets of an airplane's wings – same thing here!

In addition to using the P-value, take a look at the hypothesized proportion. If it is within the confidence interval, you will probably fail to reject the null. If it lies outside the confidence interval, you will probably reject the null.

# Errors, Power, and Effect Size

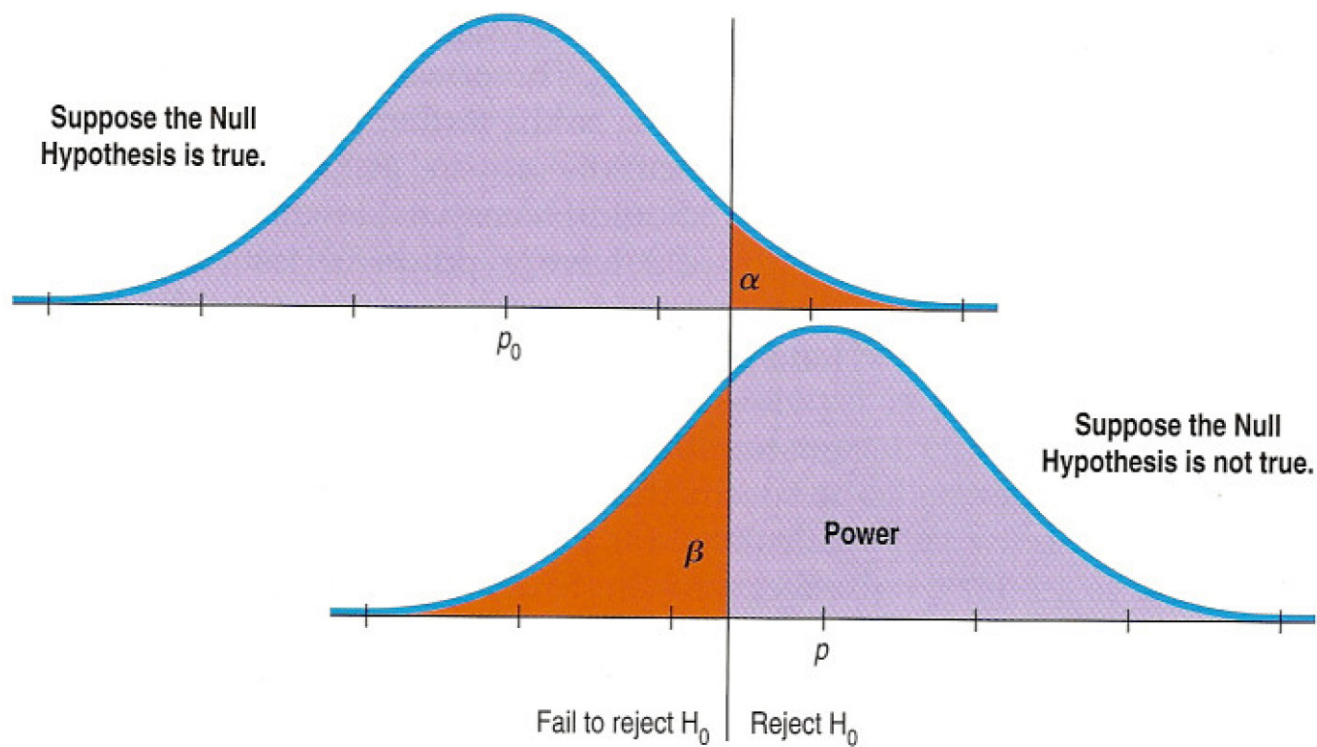
**Type I Error** – The null is true, but we mistakenly reject it (the jury convicted an innocent defendant). The probability of a Type I Error is  $\alpha$ .

**Type II Error** – The null is false, and we fail to reject it (the jury failed to convict a guilty defendant). The probability of a Type II Error is  $\beta$ .

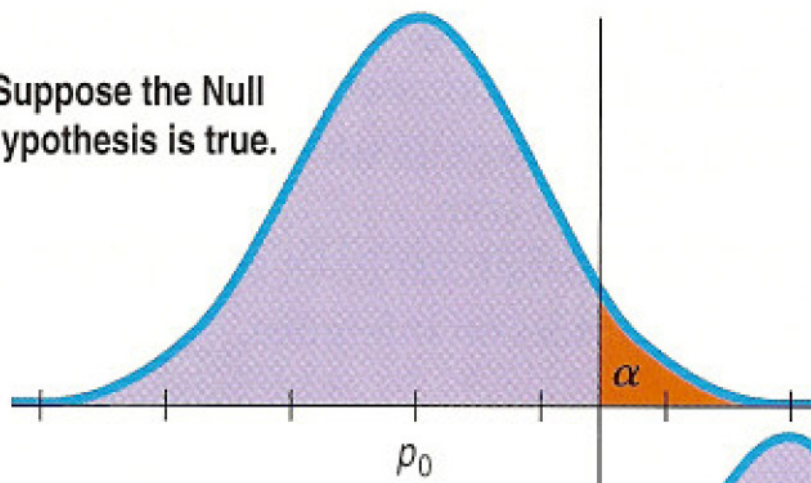
The **power** of a test is the test's ability to detect a false null hypothesis.

The **effect size** is the distance between the null hypothesis value,  $p_0$ , and the truth,  $p$ .

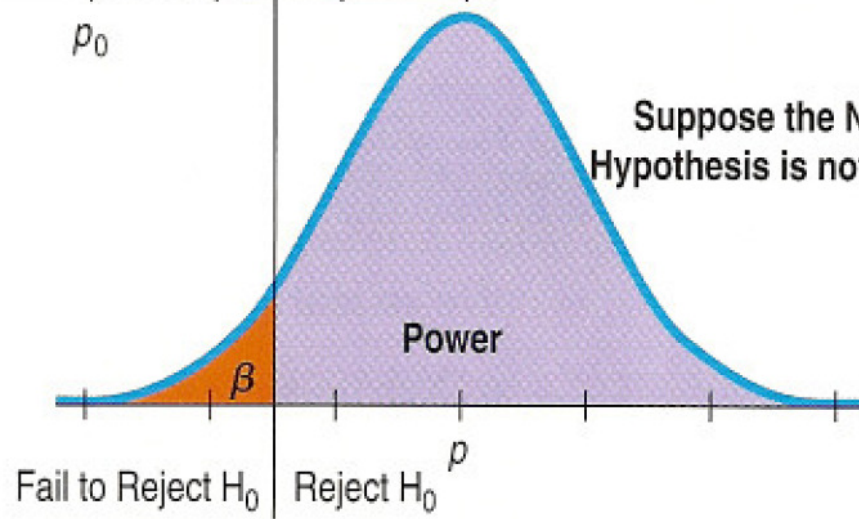
		The Truth	
		$H_0$ True	$H_0$ False
My Decision	Reject $H_0$	Type I Error	OK
	Fail to reject $H_0$	OK	Type II Error



Suppose the Null Hypothesis is true.



Suppose the Null Hypothesis is not true.



# Crest Toothpaste



**The board of directors for Procter and Gamble (based in Cincinnati, Ohio!!!!) is concerned that only 19.5% of the people who use toothpaste use Crest. A marketing director suggests that the company invest in a new marketing campaign which will include advertisements and new labeling for the toothpaste. The research department conducts product trials in test markets for one month to determine if the market share increases with the new labels.**

- a.** Using notation, write the company's null and alternative hypotheses.
  
  
  
  
  
  
  
  
  
  
- b.** In this context, describe a Type I Error and the impact such an error would have on the company.

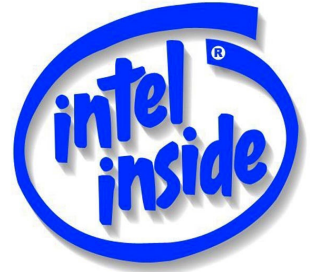
- c.** In this context, describe a Type II Error and the impact such an error would have on the company.
  
  
  
  
  
  
  
  
  
  
- d.** Based on the data they collected during the trial, the research department found that a 98% confidence interval for the proportion of all consumers who might buy Crest toothpaste was (16% , 28%). What conclusion should the company reach about the new marketing campaign?
  
  
  
  
  
  
  
  
  
  
- e.** What level of confidence (alpha level) did the research department use?

- f.** Describe to the board of directors an advantage and a disadvantage of using a 5% alpha level of significance instead.
- g.** The board of directors asked the research department to extend the trial period so that the decision can be made on two months worth of data. Will the power increase, decrease, or remain the same. Why?



- h.** Over the trial month the market share in the sample rose to 22% of shoppers. The company's board of directors decided this increase was significant. Now that they have concluded that the new marketing campaign works, why might they still choose not to invest in the campaign?

# Computer Chips



**The company that manufactures computer chips for Intel finds that 8% of all chips are defective. Intel is concerned that employee inattention is partially responsible for the high defect rate. In an effort to decrease the percentage of defective chips, management decides to offer incentives to employees who have lower rates on their shifts. The incentive program is instituted for one month. If successful, Intel will continue with the incentive program.**

- a.** Write the company's null and alternative hypotheses.
  
- b.** In this context, describe a Type I Error and the impact such an error would have on the company.

- c.** In this context, describe a Type II Error and the impact such an error would have on the company.
  
  
  
  
  
  
  
  
  
  
- d.** Based on the data they collected during the trial program, management found that a 95% confidence interval for the percentage of defective chips was (5.0% , 7.0%). What conclusion should management reach about the new incentive program?
  
  
  
  
  
  
  
  
  
  
- e.** What level of confidence (alpha level) did the management use?

- f.** Describe to management an advantage and a disadvantage of using a 1% alpha level of significance instead.
- g.** Management decided to extend the incentive program so that the decision can be made on three months of data instead of only one month. Will the power increase, decrease, or remain the same?

- h.** Over the trial month, 6% of the computer chips manufactured were defective. Management decided that this decrease was significant. Why might management choose not to permanently institute the employee incentive program?