

# Power and Type I Error

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## Learning Objectives

- Define Type I error.
- Define Type II error
- Define power.

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A **type I error** is an incorrect rejection of the null hypothesis,  $H_0$

	True $H_0$	False $H_0$
Fail to reject	Correct decision	Type II error
Reject	Type I error	Correct decision

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**A type II error is an incorrect acceptance of the null hypothesis,  $H_0$**

	True $H_0$	False $H_0$
Fail to reject	Correct decision	Type II error
Reject	Type I error	Correct decision

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**Decision Errors in Research**

A **Type I error** is a false positive, i.e., saying there is a difference when there is not.

A **Type II error** is a false negative, i.e., saying there is no difference when there is one.

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**Power is the probability of rejecting the null hypothesis,  $H_0$**

	True $H_0$	False $H_0$
Fail to reject	Correct decision	Type II error
Reject	Type I error	Correct decision

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**Non-statisticians often define power as the probability of a correct rejection**

	True $H_0$	False $H_0$
Fail to reject	Correct decision	Type II error
Reject	Type I error	Correct decision ← POWER

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**Power curves display the impact of changing study properties**

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**Power never falls below the Type I error rate, alpha**

\*Except for bad tests  
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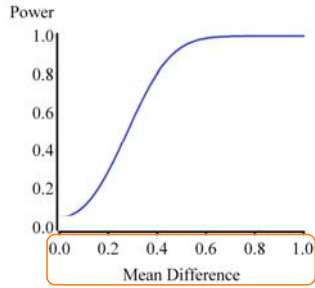
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**Null and alternative hypotheses are indexed by mean differences**



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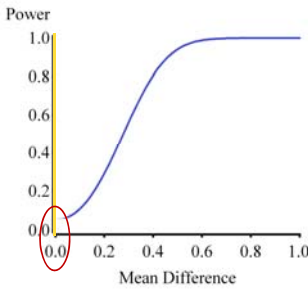
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**A mean difference of zero implies the null hypothesis is true**



	True $H_0$	False $H_0$
Fail to reject	Correct decision	Type II error
Reject	Type I error	Correct decision

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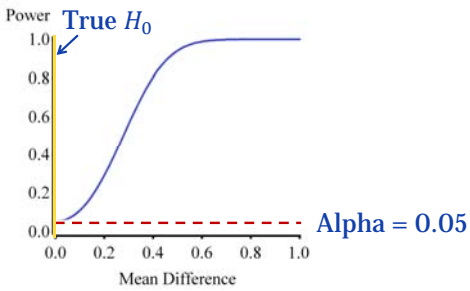
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**Power is equal to the Type I error rate, alpha, when the null hypothesis is true**



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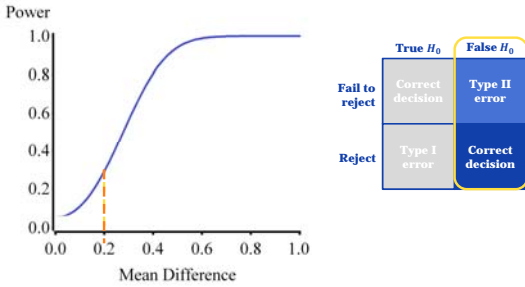
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**A mean difference not equal to zero reflects an alternative hypothesis**



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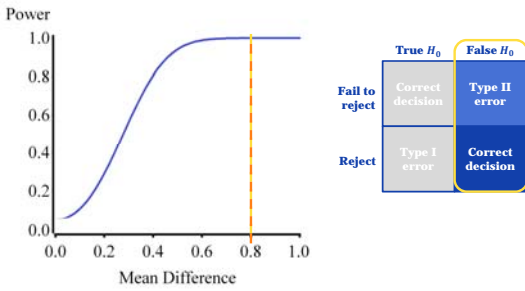
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**The horizontal axis values of the power curve below reflect many possible alternative hypotheses**



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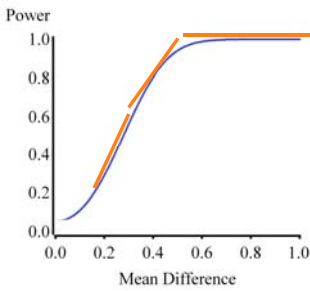
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**The power curve eventually flattens out as the mean difference gets larger**



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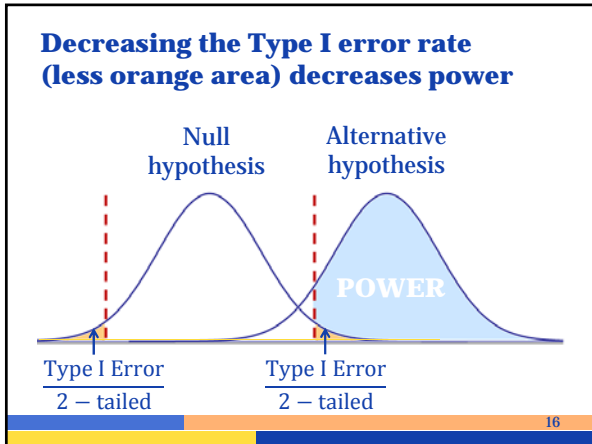
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**Lowering the Type I error rate requires a greater sample size to achieve the same power**

The effect is very modest in many applications, including correcting for a handful of multiple outcomes.

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- Review Summary**
- A **type I error** is an incorrect rejection of the null hypothesis
  - A **type II error** is an incorrect acceptance of the null hypothesis
  - In this course, we define **Power** as the probability of rejecting the null hypothesis
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