Testing for mean differences— independent and paired samples t-tests

Differential or Experimental Research Design with 2 groups

Differential

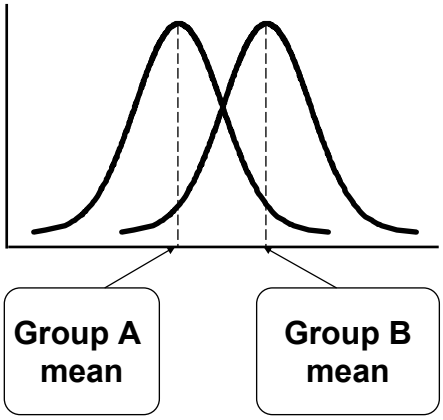
Group(A)→ O_1
Group(B)→ O_1

Experimental

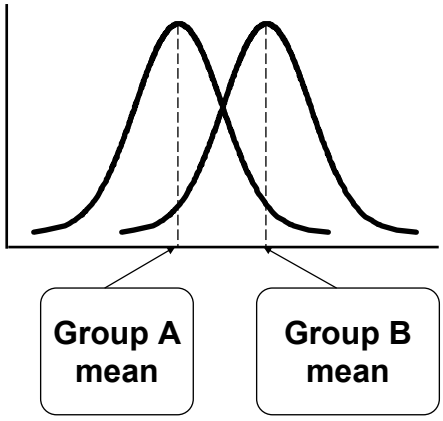
R Group(A)→X_1→O_1
R Group(B) → O_1

- Two groups
- A post-only measure
- Two distributions, each with an average and variation
- Treatment effect = statistical (i.e., nonchance) difference between the groups

Statistical Analysis



Statistical Analysis

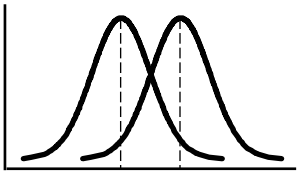


Is there a *difference*?

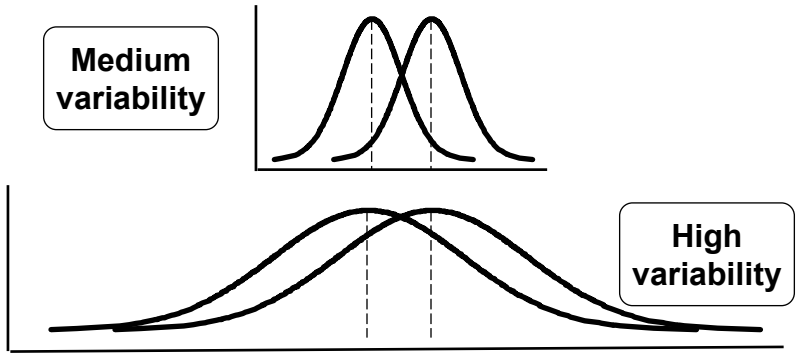
What Does *Difference* Mean?

What Does *Difference* Mean?

Medium variability



What Does *Difference* Mean?



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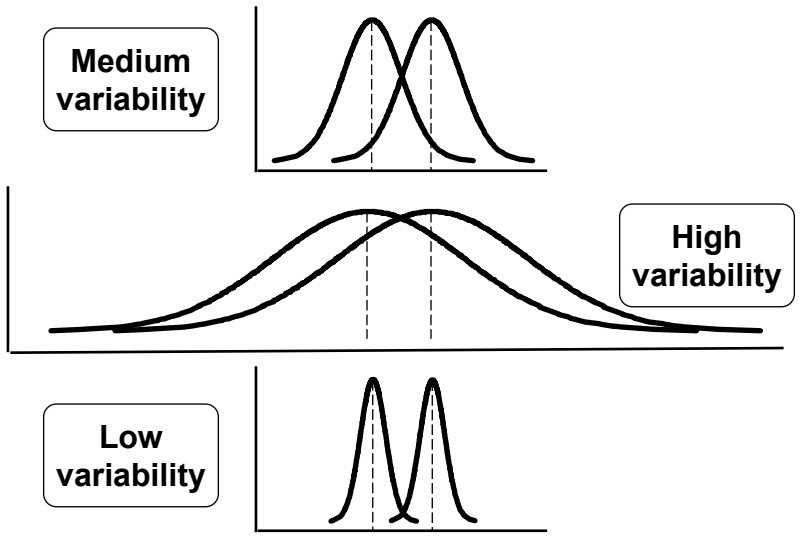

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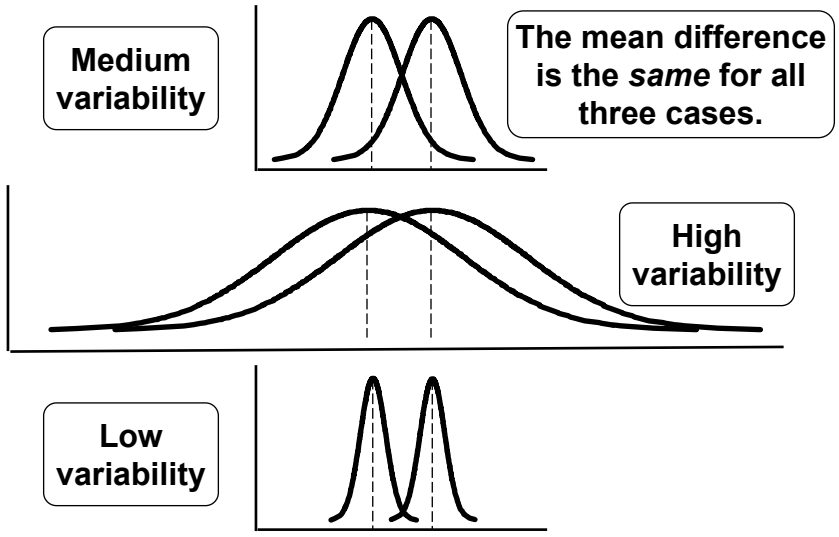

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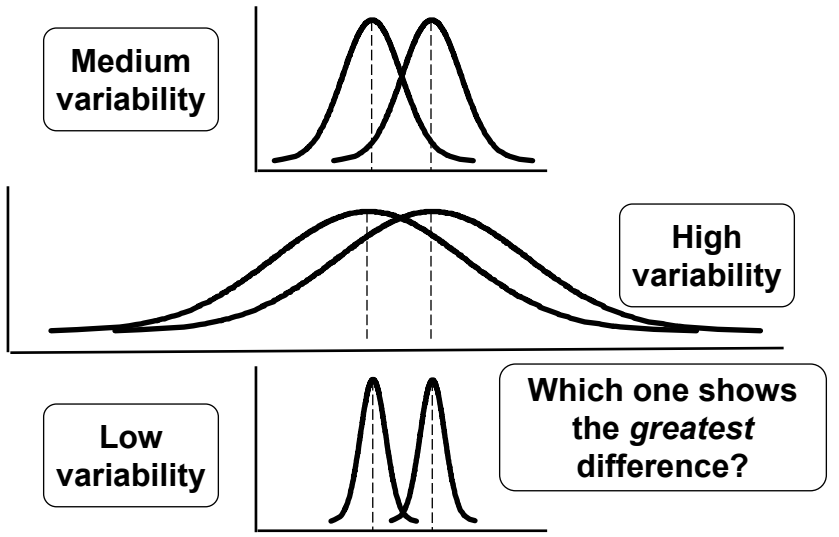
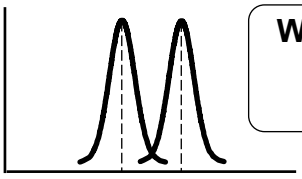


What Does *Difference* Mean?

- A statistical difference is a function of the *difference between means* relative to the *variability.*
- A small difference between means with large variability could be due to *chance.*
- Like a *signal-to-noise* ratio.

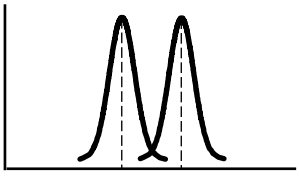
Low variability



Which one shows the *greatest* difference?

What Do We Estimate?

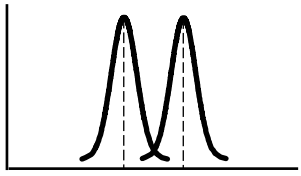
Low variability



What Do We Estimate?

$$\frac{\text{Signal}}{\text{Noise}}$$

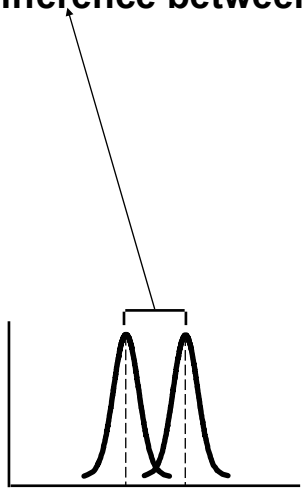
Low variability



What Do We Estimate?

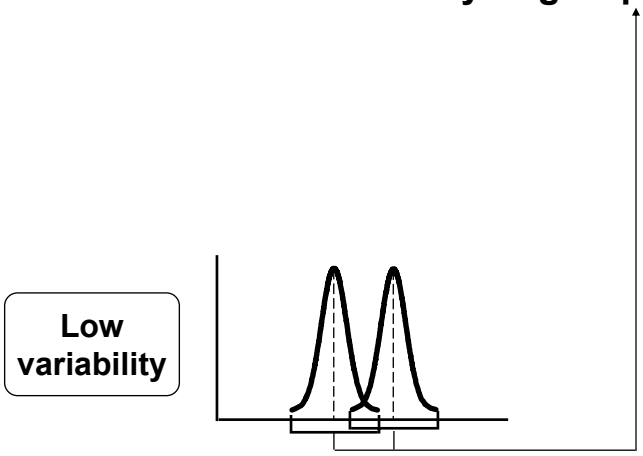
$$\frac{\text{Signal}}{\text{Noise}} = \text{Difference between group means}$$

Low variability



What Do We Estimate?

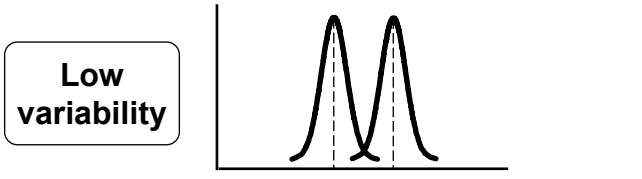
$$\frac{\text{Signal}}{\text{Noise}} = \frac{\text{Difference between group means}}{\text{Variability of groups}}$$



What Do We Estimate?

$$\frac{\text{Signal}}{\text{Noise}} = \frac{\text{Difference between group means}}{\text{Variability of groups}}$$

$$= \frac{\bar{X}_A - \bar{X}_B}{SE(\bar{X}_A - \bar{X}_B)}$$



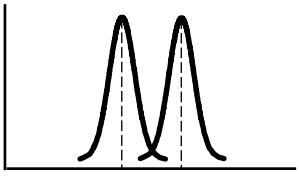
What Do We Estimate?

$$\frac{\text{Signal}}{\text{Noise}} = \frac{\text{Difference between group means}}{\text{Variability of groups}}$$

$$= \frac{\bar{X}_A - \bar{X}_B}{SE(\bar{X}_A - \bar{X}_B)}$$

$$= \text{t-value}$$

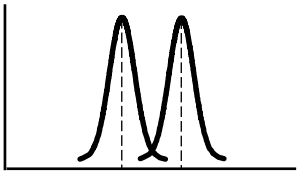
Low variability



What Do We Estimate?

- The t-test, one-way analysis of variance (ANOVA) and a form of regression all test the same thing and can be considered equivalent alternative analyses.

Low variability



2 independent samples t-test in SPSS

Data considerations:

"test variable" (dependent) must be interval or ratio measure

group variable needs to be integer (e.g., 1 and 2)

Found in SPSS under:

Analyze-->Compare means→independent samples t-test

SPSS Output (Age by Gender)

Group Statistics

	gender	N	Mean	Std. Deviation	Std. Error Mean
age	male	134	46.96	14.132	1.221
	female	113	45.41	13.187	1.241

t-statistic **p-value**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
age	Equal variances assumed	1.837	.177	.889	245	.375	1.56	1.751	-1.893	5.004
	Equal variances not assumed			.894	242.470	.372	1.56	1.740	-1.873	4.984

Paired Samples t-test

Using same subjects reduces unsystematic (error or noise) variance making it easier to detect systematic variances (i.e., signal)

Paired samples t-test in SPSS

Data considerations:

paired variables must be interval or ratio measure

Found in SPSS under:

Analyze-->Compare means→paired samples t-test

SPSS Output—Paired Samples

Look at mean differences

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Q21_1	2.934	233	2.1187	.1388
	Q21_2	4.801	233	3.5558	.2329

t-statistic

p-value

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 Q21_1 - Q21_2	-1.867	4.2822	.2805	-2.420	-1.314	-6.655	232	.000