

1. *Topic Description and Objectives:*

- The Effect of Violating the Homogeneity of Variances Assumption on Type I Error in a One-Way ANOVA
- Using single samples generated from a given population, the effect of violating the homogeneity of variances assumption on Type I error in a one-way ANOVA is illustrated by MC3G Monte Carlo simulation program.

2. *MC3G Program Setup (verify the following input before running analysis):*

	Grp 1	Grp 2	Grp 3		Value
<b>Population Mean =</b>	10	10	10	<b># Means to Keep =</b>	N/A
<b>Population SD =</b>	1.0	2.0	3.0		
<b>Group Size =</b>	100	100	100		
<b>Distribution =</b>	normal	normal	normal	<b>Direction of Hypothesis =</b>	ONE-TAILED
<b>Reliability =</b>	1.0	1.0	1.0	<b>Alpha Level =</b>	0.05
<b>Integer Data =</b>	N/A	N/A	N/A	<b>Automatically set...Seed... =</b>	CHECKED
<b>Minimum =</b>	N/A	N/A	N/A	<b>Integer Seed =</b>	3000
<b>Maximum =</b>	N/A	N/A	N/A	<b>Number of MC Samples =</b>	10000

3. *Steps Necessary to Run Analysis:*

- Click **RUN** or press **F5** to run analysis.

4. *MC2G Program Output (based on Input Above):*

<b># Rejections =</b>	600	<b>Actual Mean Grp 1 Means =</b>	9.999
<b>Actual ALPHA / POWER =</b>	0.060	<b>Actual Mean Grp 2 Means =</b>	9.998
<b>Desired =</b>	0.05	<b>Actual Mean Grp 3 Means =</b>	9.999
		<b>Actual SE of Grp 1 Means =</b>	0.1018
		<b>Actual SE of Grp 2 Means =</b>	0.2002
		<b>Actual SE of Grp 3 Means =</b>	0.3002

5. *Key Points to Interpret from the Monte Carlo Results:*

- Experiment with different values of population SDs and pay attention to its effect on the number of rejections.
- Interpret the number of rejections in terms of Type I error.
- Discuss the consequences of violating the assumptions through illustrations with different combinations of SDs. Do violations increase the chances of making a Type I error?
- Conclude that Type I error is rejecting a true null. In the example, we rejected a true null because sample means were equal. What these tell us about ANOVA? Can we say ANOVA is robust against the violations of homogeneity of variances assumption?

### 1. Topic Description and Objectives:

- The Effect of Meeting the Homogeneity of Variances Assumption and Having Equal Samples for Comparison on Type I Error in a One-Way ANOVA Design
- Using single samples generated from a given population, the effect of meeting homogeneity of variances assumption along with equal group sizes on Type I error in a one-way ANOVA is illustrated by MC3G Monte Carlo simulation program.

### 2. MC3G Program Setup (verify the following input before running analysis):

	Grp 1	Grp 2	Grp 3		Value
<b>Population Mean =</b>	10	10	10	<b># Means to Keep =</b>	N/A
<b>Population SD =</b>	1.0	1.0	1.0		
<b>Group Size =</b>	100	100	100		
<b>Distribution =</b>	normal	normal	normal	<b>Direction of Hypothesis =</b>	ONE-TAILED
<b>Reliability =</b>	1.0	1.0	1.0	<b>Alpha Level =</b>	0.05
<b>Integer Data =</b>	N/A	N/A	N/A	<b>Automatically set...Seed... =</b>	CHECKED
<b>Minimum =</b>	N/A	N/A	N/A	<b>Integer Seed =</b>	5000
<b>Maximum =</b>	N/A	N/A	N/A	<b>Number of MC Samples =</b>	10000

### 3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run analysis.

### 4. MC2G Program Output (based on Input Above):

<b># Rejections =</b>	505	<b>Actual Mean Grp 1 Means =</b>	9.999
<b>Actual ALPHA / POWER =</b>	0.0505	<b>Actual Mean Grp 2 Means =</b>	10.001
<b>Desired =</b>	0.05	<b>Actual Mean Grp 3 Means =</b>	9.998
		<b>Actual SE of Grp 1 Means =</b>	0.1007
		<b>Actual SE of Grp 2 Means =</b>	0.0988
		<b>Actual SE of Grp 3 Means =</b>	0.0992

### 5. Key Points to Interpret from the Monte Carlo Results:

- With equal sample sizes and variances, the number of rejections are found equal to the desired alpha level. Power is .05. These results explain the importance of meeting assumptions in a one-way ANOVA design.
- Experiment with different values of population SDs and pay attention to its effect on the number of rejections.
- Interpret the number of rejections in terms of Type I error.
- Discuss the consequences of violating the assumptions through illustrations with different combinations of SDs
- Can we say meeting assumptions decrease the chances of making a Type I error?

1. *Topic Description and Objectives:*

- The Effect of Severely Violating Homogeneity of Variances and Normality Assumption on Type I Error in a One-Way ANOVA Design.
- Using single samples generated from a given population, the effect of violating assumptions on Type I error in a one-way ANOVA is illustrated by MC3G Monte Carlo simulation program.

2. *MC3G Program Setup (verify the following input before running analysis):*

	Grp 1	Grp 2	Grp 3		Value
<b>Population Mean =</b>	10	10	10	<b># Means to Keep =</b>	N/A
<b>Population SD =</b>	4.0	8.0	10.0		
<b>Group Size =</b>	10	60	40		
<b>Distribution =</b>	normal	normal	normal	<b>Direction of Hypothesis =</b>	ONE-TAILED
<b>Reliability =</b>	1.0	1.0	1.0	<b>Alpha Level =</b>	0.05
<b>Integer Data =</b>	N/A	N/A	N/A	<b>Automatically set...Seed... =</b>	CHECKED
<b>Minimum =</b>	N/A	N/A	N/A	<b>Integer Seed =</b>	5000
<b>Maximum =</b>	N/A	N/A	N/A	<b>Number of MC Samples =</b>	10000

3. *Steps Necessary to Run Analysis:*

- Click **RUN** or press **F5** to run analysis.

4. *MC2G Program Output (based on Input Above):*

<b># Rejections =</b>	258	<b>Actual Mean Grp 1 Means =</b>	10.017
<b>Actual ALPHA / POWER =</b>	0.0258	<b>Actual Mean Grp 2 Means =</b>	9.999
<b>Desired =</b>	0.05	<b>Actual Mean Grp 3 Means =</b>	9.997
		<b>Actual SE of Grp 1 Means =</b>	1.2542
		<b>Actual SE of Grp 2 Means =</b>	1.0267
		<b>Actual SE of Grp 3 Means =</b>	1.5748

5. *Key Points to Interpret from the Monte Carlo Results:*

- Practice with more extreme values of sample sizes and sd's and record the results to make comparisons. Does more dramatic changes lower actual alpha value?
- Interpret the number of rejections in terms of Type I error. Experiment with different group sizes and find out the effect of violating normality assumption on the Type I error.
- Discuss the consequences of violating the assumptions through illustrations with different combinations of group sizes and SDs
- Do violations increase the chances of making a Type I error?

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2. *MC3G Program Setup (verify the following input before running analysis):*

	Grp 1	Grp 2	Grp 3		Value
<b>Population Mean =</b>	10	10	10	<b># Means to Keep =</b>	N/A
<b>Population SD =</b>	1.0	3.0	5.0		
<b>Group Size =</b>	100	50	25		
<b>Distribution =</b>	normal	normal	normal	<b>Direction of Hypothesis =</b>	ONE-TAILED
<b>Reliability =</b>	1.0	1.0	1.0	<b>Alpha Level =</b>	0.05
<b>Integer Data =</b>	N/A	N/A	N/A	<b>Automatically set...Seed... =</b>	CHECKED
<b>Minimum =</b>	N/A	N/A	N/A	<b>Integer Seed =</b>	5000
<b>Maximum =</b>	N/A	N/A	N/A	<b>Number of MC Samples =</b>	10000

3. *Steps Necessary to Run Analysis:*

- Click **RUN** or press **F5** to run analysis.

4. *MC2G Program Output (based on Input Above):*

<b># Rejections =</b>	2402	<b>Actual Mean Grp 1 Means =</b>	10.000
<b>Actual ALPHA / POWER =</b>	0.2402	<b>Actual Mean Grp 2 Means =</b>	9.999
<b>Desired =</b>	0.05	<b>Actual Mean Grp 3 Means =</b>	9.992
		<b>Actual SE of Grp 1 Means =</b>	0.1001
		<b>Actual SE of Grp 2 Means =</b>	0.4254
		<b>Actual SE of Grp 3 Means =</b>	1.0048

5. *Key Points to Interpret from the Monte Carlo Results:*

- Experiment with different values of population SDs and pay attention to its effect on the number of rejections.
- Interpret the number of rejections in terms of Type I error.
- Discuss the consequences of violating the assumptions through illustrations with different combinations of SDs. Do violations increase the chances of making a Type I error?
- Conclude that Type I error is rejecting a true null. In the example, we rejected a true null because sample means were equal. What these tell us about ANOVA? Can we say ANOVA is robust against the violations of homogeneity of variances assumption?