1. Topic Description and Objectives:

- **CASE 1:** An Investigation Of The Power Of Student's Independent T For Studying The Differences Between Two Mutually Independent Random Samples Drawn From Normal Distributions
- The student will be able to determine the power of the Student's Independent t test (Pooled Variance), in the case of studying the differences between two mutually independent groups having the following characteristics:
- ***Large Effect Size, Equal variances and equal sample sizes.***

2. MC2G Program Setup (verify the following input before running analysis):

	Group 1	Group 2		Value
Population Mean =	0.80	0.0	**Number of Means to Keep =**	N/A
Population SD =	1.0	1.0	**Statistical Test =**	POOLED t
Group Size =	25	25	**Correlation bet. Measures =**	0
Distribution =	NORMAL	NORMAL	**Directionality of Hypothesis =**	TWO-TAILED
Reliability =	1.0	1.0	**Alpha Level =**	0.05
Integer Data =	UNCHECKED	UNCHECKED	**Automatically set...Seed... =**	UNCHECKED
Minimum =	N/A	N/A	**Integer Seed =**	1804
Maximum =	N/A	N/A	**Number of MC Samples =**	10000

3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run Monte Carlo analysis.
- If the two groups had equal means, the study becomes an investigation of the level of type I error of Student's Independent t, which would be similar to the cases presented in the section of this paper describing and dealing with Type I error.

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

# Rejections =	7933	**Actual Mean Grp 1 Means =**	0.7980
Actual ALPHA / POWER =	0.7933	**Actual Mean Grp 2 Means =**	-0.0013
Desired =	higher is better	**Actual SE of Grp 1 Means =**	0.1999
		Actual SE of Grp 2 Means =	0.1983

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

- Remember that there are two groups of equal variances and equal sample sizes.
- The power is 0.793.
- When examining the magnitude of the power given the conditions used in this section, the test is considered to be powerful since a power value of 0.80 or more is considered to be adequate in order to detect the differences between the means.
- Therefore, our decision is that the Student's Independent t test is powerful in detecting the differences in the means of two groups with similar sample sizes (as long as there exists a real difference between the means.)

Power Analysis (by Abdulbaset Abdulla)

1. Topic Description and Objectives:

- **CASE 2:** An Investigation Of The Power Of Student's Independent T For Studying The Differences Between Two Mutually Independent Random Samples Drawn From Normal Distribution
- The student will be able to determine the power of the Student's Independent t test (Pooled Variance), in the case of studying the differences between two mutually independent groups having the following characteristics:
- *Large Effect Size, Equal variances but unequal sample sizes.*

2. MC2G Program Setup (verify the following input before running analysis):

	Group 1	Group 2		Value
Population Mean =	0.80	0.0	**Number of Means to Keep =**	N/A
Population SD =	1.0	1.0	**Statistical Test =**	POOLED t
Group Size =	10	25	**Correlation bet. Measures =**	0
Distribution =	NORMAL	NORMAL	**Directionality of Hypothesis =**	TWO-TAILED
Reliability =	1.0	1.0	**Alpha Level =**	0.05
Integer Data =	UNCHECKED	UNCHECKED	**Automatically set...Seed... =**	UNCHECKED
Minimum =	N/A	N/A	**Integer Seed =**	1804
Maximum =	N/A	N/A	**Number of MC Samples =**	10000

3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run Monte Carlo analysis
- If the two groups had equal means, the study becomes an investigation of the level of type I error of Student's Independent t, which would be similar to the cases presented in the section of this paper describing and dealing with Type I error.

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

# Rejections =	5492	**Actual Mean Grp 1 Means =**	0.7995
Actual ALPHA / POWER =	0.5492	**Actual Mean Grp 2 Means =**	-0.0020
Desired =	higher is better	**Actual SE of Grp 1 Means =**	0.3190
		Actual SE of Grp 2 Means =	0.1984

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

- Remember that there are two groups of equal variances and unequal sample sizes
- The power is 0.549
- When examining the magnitude of the power, given the conditions used in this section, we see that the power significantly dropped down from the case when the sample sizes were equal. The magnitude of the power is however still acceptable (0.549) but is much lower than the desirable level of 0.80
- Decision is that the Student's Independent t test is not as powerful in detecting differences in the means of two groups with different sample sizes as that of the case of two groups with similar sample sizes

Power Analysis (by Abdulbaset Abdulla)

1. Topic Description and Objectives:

- **CASE 3:** An Investigation Of The Power Of Student's Independent T For Studying The Differences Between Two Mutually Independent Random Samples Drawn From Normal Distributions
- The student will be able to determine the power of the Student's Independent t test (Pooled Variance), in the case of studying the differences between two mutually independent groups having the following characteristics:
- ***Large Effect Size, Unequal variances but equal sample sizes.***

2. MC2G Program Setup (verify the following input before running analysis):

	Group 1	Group 2		Value
Population Mean =	0.80	0.0	**Number of Means to Keep =**	N/A
Population SD =	5.0	1.0	**Statistical Test =**	POOLED t
Group Size =	25	25	**Correlation bet. Measures =**	0
Distribution =	NORMAL	NORMAL	**Directionality of Hypothesis =**	TWO-TAILED
Reliability =	1.0	1.0	**Alpha Level =**	0.05
Integer Data =	UNCHECKED	UNCHECKED	**Automatically set...Seed... =**	UNCHECKED
Minimum =	N/A	N/A	**Integer Seed =**	1804
Maximum =	N/A	N/A	**Number of MC Samples =**	10000

3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run Monte Carlo analysis.
- If the two groups had equal means, the study becomes an investigation of the level of type I error of Student's Independent t, which would be similar to the cases presented in the section of this paper describing and dealing with Type I error.

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

# Rejections =	1230	**Actual Mean Grp 1 Means =**	0.7902
Actual ALPHA / POWER =	0.1230	**Actual Mean Grp 2 Means =**	-0.0013
Desired =	higher is better	**Actual SE of Grp 1 Means =**	0.9996
		Actual SE of Grp 2 Means =	0.1983

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

- Remember that there are two groups of unequal variances but equal sample sizes.
- The power is 0.123.
- When examining the magnitude of the power, given the conditions used in this section, we see that the power dropped down considerably from the case when the variances were equal. The magnitude of the power is very small (0.123) which is very far away from the desirable level of 0.80.
- Decision is that the Student's Independent t test is not practical or not robust to violations of the assumption of equality of variance when the sample sizes of the groups are equal.

Power Analysis (by Abdulbaset Abdulla)

1. Topic Description and Objectives:

- **CASE 4:** An Investigation Of The Power Of Student's Independent t For Studying The Differences Between Two Mutually Independent Random Samples Drawn From Normal Distributions
- The student will be able to determine the power of the Student's Independent t test (Pooled Variance), in the case of studying the differences between two mutually independent groups having the following characteristics:
- ***Large Effect Size, Unequal variances and unequal sample sizes (larger variability in group with smaller N)***

2. MC2G Program Setup (verify the following input before running analysis):

	Group 1	Group 2		Value
Population Mean =	0.80	0.0	**Number of Means to Keep =**	N/A
Population SD =	5.0	1.0	**Statistical Test =**	POOLED *t*
Group Size =	10	25	**Correlation bet. Measures =**	0
Distribution =	NORMAL	NORMAL	**Directionality of Hypothesis =**	TWO-TAILED
Reliability =	1.0	1.0	**Alpha Level =**	0.05
Integer Data =	UNCHECKED	UNCHECKED	**Automatically set...Seed... =**	UNCHECKED
Minimum =	N/A	N/A	**Integer Seed =**	1804
Maximum =	N/A	N/A	**Number of MC Samples =**	10000

3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run Monte Carlo analysis.
- If the two groups had equal means, the study becomes an investigation of the level of type I error of Student's Independent t, which would be similar to the cases presented in the section of this paper describing and dealing with Type I error. Make sure that the larger variability is with the group of the smaller sample size.

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

# Rejections =	2734	**Actual Mean Grp 1 Means =**	0.7974
Actual ALPHA / POWER =	0.2734	**Actual Mean Grp 2 Means =**	-0.0020
Desired =	higher is better	**Actual SE of Grp 1 Means =**	1.5950
		Actual SE of Grp 2 Means =	0.1984

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

- Remember that there are two groups of unequal variances and unequal sample sizes.
- The group with the smaller sample size has more variability than the group with larger sample size.
- The power is 0.273.
- When examining the magnitude of the power, given the conditions used in this section, we see that the power slightly improved from the case when the variances were unequal and the sample sizes were similar. Even though the magnitude of the power is still small, the improvement in its size may be attributed to the differences in the sample characteristics where the group with the larger sample has less variability than the group with the smaller sample.
- Decision is that the Student's Independent t test may be somewhat useful in detecting differences between groups with unequal sample sizes where the group with the larger size has less variability than the group with the small sample size.

Power Analysis (by Abdulbaset Abdulla)

1. Topic Description and Objectives:

- **CASE 5:** An Investigation Of The Power Of Student's Independent T For Studying The Differences Between Two Mutually Independent Random Samples Drawn From Normal Distributions
- The student will be able to determine the power of the Student's Independent t test (Pooled Variance), in the case of studying the differences between two mutually independent groups having the following characteristics:
- ***Large Effect Size, Unequal variances and unequal sample sizes (larger variability in group with larger N)***

2. MC2G Program Setup (verify the following input before running analysis):

	Group 1	Group 2		Value
Population Mean =	0.80	0.0	**Number of Means to Keep =**	N/A
Population SD =	5.0	1.0	**Statistical Test =**	POOLED t
Group Size =	25	10	**Correlation bet. Measures =**	0
Distribution =	NORMAL	NORMAL	**Directionality of Hypothesis =**	TWO-TAILED
Reliability =	1.0	1.0	**Alpha Level =**	0.05
Integer Data =	UNCHECKED	UNCHECKED	**Automatically set...Seed... =**	UNCHECKED
Minimum =	N/A	N/A	**Integer Seed =**	1804
Maximum =	N/A	N/A	**Number of MC Samples =**	10000

3. Steps Necessary to Run Analysis:

- Click **RUN** or press **F5** to run Monte Carlo analysis.
- If the two groups had equal means, the study becomes an investigation of the level of type I error of Student's Independent t, which would be similar to the cases presented in the section of this paper describing and dealing with Type I error. Make sure that the larger variability is with the group of the larger sample size.

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

# Rejections =	167	**Actual Mean Grp 1 Means =**	0.8151
Actual ALPHA / POWER =	0.0167	**Actual Mean Grp 2 Means =**	-0.0034
Desired =	higher is better	**Actual SE of Grp 1 Means =**	0.9957
		Actual SE of Grp 2 Means =	0.3169

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

- Remember that there are two groups of unequal variances and unequal sample sizes.
- The group with the smaller sample size has less variability than the group with larger sample size.
- The power is 0.017.
- When examining the magnitude of the power, given the conditions used in this section, we see that the power dropped down dramatically from the case when the variances were unequal and the sample sizes were similar. The magnitude of the power is extremely small (0.05), which may be attributed to the differences in the sample characteristics where the group with the larger sample has more variability than the group with the smaller sample.
- Decision is that the Student's Independent t test is not useful at all (not robust) in detecting differences between groups with unequal sample sizes where the group with the larger size has more variability than the group with the small sample size.

Power Analysis (by Abdulbaset Abdulla)