Example Problems: Independent Samples Test

California State University Northridge vs. UCLA Bruins

Example 1: A couple of male grad students met at the annual American Psychological Association conference last year, one of them was a grad student from CSUN and the other was a grad student at UCLA. After a short period they began discussing the joys of going to school in southern California and after a few drinks the conversation quickly turned into an argument about which school CSUN or UCLA had a more attractive psychology undergraduate female population. The CSUN grad argued that CSUN undergraduate females in psychology at CSUN are more attractive and the UCLA grad argued that the UCLA undergraduate females in psych are more attractive. So as graduate students they decided to use their research abilities and answer the questions scientifically. They both randomly selected 35 undergraduate female psych students and asked them if they were willing to participate. Of the 35 solicited from each school, 33 agreed to participate from UCLA and 30 from CSUN. Each participant's photo was shown to a panel of judges and the average score (out of 10) is shown for each participant in the table below. Which school has the more attractive psychology undergrad population?

UCLA		CSUN	
Subject	**Rating**	**Subject**	**Rating**
1	4	**1**	8
2	6	**2**	7
3	6	**3**	7
4	8	**4**	8
5	3	**5**	5
6	3	**6**	6
7	7	**7**	6
8	4	**8**	6
9	3	**9**	7
10	5	**10**	9
11	7	**11**	7
12	6	**12**	8
13	8	**13**	6
14	6	**14**	7
15	8	**15**	6
16	4	**16**	8
17	3	**17**	7
18	5	**18**	7
19	7	**19**	8
20	3	**20**	7
21	6	**21**	8
22	4	**22**	9
23	6	**23**	8
24	3	**24**	7
25	5	**25**	8
26	2	**26**	7
27	4	**27**	6
28	6	**28**	7
29	5	**29**	7
30	7	**30**	7
31	4		
32	2		
33	3		
Mean	**4.939**	**Mean**	**7.133**
StDev	**1.784**	**StDev**	**0.937**

1. **State Null Hypothesis** $h_0 : \mu_{UCLA} - \mu_{CSUN}$ _____ 0
2. **Alternative Hypothesis** $h_1 : \mu_{UCLA} - \mu_{CSUN}$ _____ 0
3. **Decide on α (usually .05)** α **=** _____
4. **Decide on type of test (distribution; *z*, *t*, etc.)**
   Questions to ask:
   a. Can we treat the scores as independent (e.g. they are NOT from the same person, they are NOT matched subjects, they are NOT related subjects, etc.)?
      If Yes, then continue with the independent samples t-test
      If No, STOP you may need to perform a dependent samples t-test
   b. Can we assume a normally distributed sampling distribution?
      In other words, do we have 30+ participants in each group OR a normally distributed population(s)?
      If yes, then continue.
      If no, do not continue, the test cannot be performed.
   c. Do the two groups have homogenous variances?

      $F_{MAX} = \frac{s^2_{\text{Largest}}}{s^2_{\text{Smallest}}} = \frac{\_\_\_\_\_}{\_\_\_\_\_} =$ _____ , if this value is smaller than 3 pool the variance, if it is larger than 3 do not pool the variance.
   d. What is the pooled variance?

      $s^2_{pooled} = \frac{[(n_1 - 1) * s_1^2] + [(n_2 - 1) * s_2^2]}{n_1 + n_2 - 2} = \frac{[(\_\_\_ - 1) * \_\_\_] + [(\_\_\_ - 1) * \_\_\_]}{\_\_\_ + \_\_\_ - 2} =$
   e. What is the standard error of the difference?

      $$s_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{s^2_{pooled}}{n_1} + \frac{s^2_{pooled}}{n_2}} \; or \; \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \sqrt{\frac{\_\_\_\_\_}{\_\_\_} + \frac{\_\_\_\_\_}{\_\_\_}} =$$
5. **Find critical value & state decision rule**
   <u>Critical Value</u>
   Questions to ask:
   a. Is this a 1-tailed or a 2-tailed test? _____
   b. It is a t-test, so what are the degrees of freedom (If homogenous variances, DF = $n_1 + n_2 - 2$, if heterogenous variances DF = smaller n - 1)? _____
      Use alpha, the number of tails and the degrees of freedom to look up the critical value in a t-table.
   <u>Decision Rule</u>
   In words: If $t_{observed}$ is larger than $t_{critical}$ reject the null hypothesis

   In numbers: If _____ > _____ *reject the null hypothesis.*
6. **Calculate test**

   $$t_{\bar{X}_1 - \bar{X}_2} = \frac{\bar{X}_1 - \bar{X}_2}{s_{\bar{X}_1 - \bar{X}_2}} = \frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_} =$$
7. **Apply decision rule**
   Since, _____(i.e. observed value) ____ (i.e. >, <) _____ (critical value), _____(i.e. **DO or DO NOT)** reject the null hypothesis.

Example #2: A cognitive psychologist was reminiscing about graduate school and remembers that he probably would have never made it through had it not been for "energy drinks" like Monster. Many endless nights of writing, reading or both were followed by long days of classes, running subjects and more reading and writing and it was drinks like Monster energy drink that kept him from crashing. As he thought more about it, it seemed that Monster helped him more than most of his classmates who drank coffee. Sure, they were awake but their cognitive abilities always seemed a little more taxed than his or other folks' that drank Monster. To test this hypothesis he randomly selected 24 students and had them "pull an all nighter", he than randomly assigned them to either drink coffee or Monster. He tested their cognitive ability using the CSB (cognitive skills battery), which is known to have a normal distribution in the population, and the results are shown in the table below. Does drinking Monster lead to higher cognitive functioning after a night of little or no sleep when compared to coffee (use an alpha level of .01)?

Coffee		**Monster**	
Subject	**Score**	**Subject**	**Score**
1	30	**1**	35
2	42	**2**	50
3	27	**3**	51
4	37	**4**	53
5	31	**5**	55
6	28	**6**	63
7	30	**7**	45
8	36	**8**	53
9	42	**9**	50
10	39	**10**	44
11	51	**11**	71
12	38	**12**	47
Mean	**35.917**	**Mean**	**51.417**
StDev	**7.090**	**StDev**	**9.170**

1. **State Null Hypothesis** $h_0 : \mu_{Monster} - \mu_{coffee}$ ____ 0
2. **Alternative Hypothesis** $h_1 : \mu_{Monster} - \mu_{coffee}$ ____ 0
3. **Decide on α (look in the text)** α **=** _____
4. **Decide on type of test (distribution; *z*, *t*, etc.)**
   Questions to ask:
   a. Can we treat the scores as independent (e.g. they are NOT from the same person, they are NOT matched subjects, they are NOT related subjects, etc.)?
      If Yes, then continue with the independent samples t-test
      If No, STOP you may need to perform a dependent samples t-test
   b. Can we assume a normally distributed sampling distribution?
      In other words, do we have 30+ participants in each group OR a normally distributed population(s)?
      If yes, then continue.
      If no, do not continue, the test cannot be performed.
   c. Do the two groups have homogenous variances?

      $F_{MAX} = \frac{s^2_{\text{Largest}}}{s^2_{\text{Smallest}}} = \frac{\_\_\_\_\_}{\_\_\_\_\_} =$ _____ , if this value is smaller than 3 pool the variance, if it is larger than 3 do not pool the variance.
   d. What is the pooled variance?

      $s^2_{pooled} = \frac{[(n_1 - 1) * s_1^2] + [(n_2 - 1) * s_2^2]}{n_1 + n_2 - 2} = \frac{[(\_\_\_ - 1) * \_\_\_] + [(\_\_\_ - 1) * \_\_\_]}{\_\_\_ + \_\_\_ - 2} =$
   e. What is the standard error of the difference?

      $$s_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{s^2_{pooled}}{n_1} + \frac{s^2_{pooled}}{n_2}} \; or \; \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \sqrt{\frac{\_\_\_\_\_}{\_\_\_} + \frac{\_\_\_\_\_}{\_\_\_}} =$$
5. **Find critical value & state decision rule**
   <u>Critical Value</u>
   Questions to ask:
   a. Is this a 1-tailed or a 2-tailed test? _____
   b. It is a t-test, so what are the degrees of freedom (If homogenous variances, DF = $n_1 + n_2 - 2$, if heterogenous variances DF = smaller n - 1)? _____
      Use alpha, the number of tails and the degrees of freedom to look up the critical value in a t-table.
   <u>Decision Rule</u>
   In words: If $t_{observed}$ is larger than $t_{critical}$ reject the null hypothesis

   In numbers: If _____ > _____ *reject the null hypothesis.*
6. **Calculate test**

   $$t_{\bar{X}_1 - \bar{X}_2} = \frac{\bar{X}_1 - \bar{X}_2}{s_{\bar{X}_1 - \bar{X}_2}} = \frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_} =$$
7. **Apply decision rule**
   Since, _____(i.e. observed value) ____ (i.e. >, <) _____ (critical value), _____(i.e. **DO or DO NOT)** reject the null hypothesis.