Kevin Scharnhorst

Score: 40/40 = 100%

Breakdown

Kevin	Scharnhorst		1	2	3	4	5	Total
		hypotheses	5.0	5.0	5.00	5.00	5.0	100.0
		test justification assumptions	5.0	5.0	5.00	5.00	5.0	
		sig test output reject/fail to reject null	5.0	5.0	5.00	5.00	5.0	
		inference	5.0	5.0	5.00	5.00	5.0	
		subtotal	20.0	20.0	20.00	20.00	20.0	40.0

Kevin Scharnhorst
Med Inf 409
Spring 2011

Mid-Term Exam

DIRECTIONS:
The below attached object contains the original instructions for the mid-term as well as the problems answered within the completed exam.

MidTerm Spring2011.pdf

Problem 1 (20/20)

Hypothesis (5/5)

The problem considers a study which seeks to compare the effects of a new experimental drug on heart rates. In the study, a placebo is compared to the experimental drug as a control treatment. To compare the effects of the experimental drug, a researcher drew from a random sample of 12 patients (so, N=12). The sample population was then randomly divided so that half would receive the new drug therapy and the other half the control treatment.

The research and comparison of the two drug therapies calls for a 95% confidence level. So to reject the null hypothesis, we would have to show a significant statistical difference exists between the experimental therapy and the control therapy. More specifically a significance factor of below 5% would need to exist. The hypothesis that we are testing then is below, where H_0 is the null hypothesis and H_A is the alternative hypothesis.

H_0 – Heart rates are the same between patients on the experimental drug therapy or the placebo (control therapy).
H_A – Heart rates demonstrate a significant difference between the two considered drug therapies.

Statistical Procedure, Tests and Assumptions (5/5)

The conditions of our study, as stated, with its circumstances and hypothesis help us determine the appropriate type of test to do. The primary influencer when considered is that we have two groups that are being compared to find a difference based on some dependent variable. Our test is only as good as the assumptions we make. Given the following assumptions, I feel it would be appropriate to perform an Independent Samples T-Test as all seem to fit.

Assumptions:

- Normally distributed population
- Our observations are independent
- Simple random sample of 12 subjects were taken from the larger normally distributed population
- Equality of variances exist between our groups
- Heart Rate (dependent variable) is continuous (interval or ratio)
- Drug Therapy (independent variable) is categorical, with 2 levels (Placebo & Experimental)

Results (5/5)

In interpreting the results of our Independent Samples T-Test, we can gather some general information from the group statistics table produced from SPSS. Without coming to any conclusions yet, we can see that from the descriptive statistics that the average heart rate (highlighted) in our Placebo group is 71 and 80.17 in the experimental. So already we see that there is a difference with an average higher beat of 9.17 in those that received the experimental drug therapy.

Group Statistics

	Drug Therapy	N	Mean	Std. Deviation	Std. Error Mean
Heart Rate	Placebo	6	71.00	7.616	3.109
	Experimental	6	80.17	5.419	2.212

Further, since we assumed equality of variance between our groups, we can ignore Levene's test. We can then examine the significance factor below in the 2-tailed column and quickly see that we have a result of .037 or 3.7% (highlighted). Since 3% is less than our considered 5% from a 95% confidence level, we reject the null hypothesis and accept the alternative.

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
Heart Rate	Equal variances assumed	.128	.728	-2.402	10	.037	-9.167	3.816	-17.669	-.664
	Equal variances not assumed			-2.402	9.030	.040	-9.167	3.816	-17.794	-.539

Inference (5/5)

The study sought to explain if there was a difference in the effects of a new experimental drug on heart beat versus no treatment (placebo). From the resulting analysis we clearly see that there is a difference and that the experimental drug shows higher heart beat rates than the placebo drug. The study does not seek to explain if more or less heart beats is better, but we do know that the experimental and placebo drug therapies demonstrate a significant statistical difference between each other. The researcher would have to compare the results to the intended affects to know if the drug performed as expected.

Problem 2 (20/20)

Hypothesis (5/5)

The problem considers a research study where a researcher is interested in explaining how trauma impacts different parts of the brain. To measure the effects of trauma, the researcher selected five random candidates (so, N=5) from a random sample population. Each of the five subjects were measured twice with an EEG being the instrument used to collect the results. The EEG was located in two different spots and through two independent tests.

The research and comparison of measurements of the brain across two different locations calls for a 95% confidence level. So to reject the null hypothesis, we would have to show that a significant statistical difference exists between two recorded measurements in the two different locations of the brain when introduced to traumatic event. More specifically a significance factor of below 5% would need to exist. The hypothesis that we are testing then is below, where H_0 is the null hypothesis and H_A is the alternative hypothesis.

H_0 – There **is no difference** between collected measurements in two different locations of the brain when exposed to a traumatic event.
H_A – There **is a significant difference** between collected measurements across two different locations of the brain when exposed to a traumatic event.

Statistical Procedure, Tests and Assumptions (5/5)

As the same test subjects are tested on two different occasions, crossover exists. We can further examine the conditions of the study and conclude our assumptions are as follows.

Assumptions:

- Normally distributed population
- Our observations are dependent (cross over)

- Simple random sample of 5 subjects were taken from the larger normally distributed population
- Equality of variances exist between our groups
- Trauma Effects (dependent variable) is continuous (interval or ratio)
- EEG Location (independent variable) is categorical, with 2 levels (Brain locations 1 & 2)

From our test conditions and stated assumptions, we can confidently conclude that the appropriate test to perform is a Paired Samples T-Test.

Results (5/5)

In considering the resulting descriptive statistics from our Paired Samples T-Test from the table below, we can see a comparison of average EEG scores collected across two different locations of the brain with the same five test subjects shows a clear difference (highlighted). Specifically, we see that the average score is two points higher when considering the second location.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Brain Location 1	4.00	5	1.871	.837
	Brain Location 2	6.00	5	2.449	1.095

We can come to a conclusion that there is a significant difference in trauma impacts between locations of the brain by evaluating the significance factor from the 2-tailed test. There is a value of .022 or 2.2%. Since 2.2% is less than 5% from our consideration of a 95% confidence level, we reject the null hypothesis and accept the alternative.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Brain Location 1 - Brain Location 2	-2.000	1.225	.548	-3.521	-.479	-3.651	4	.022

Inference (5/5)

We can infer from our analysis of the results that traumatic impact on the brain shows significance in different parts of the brain. When traumatic stimuli were introduced, scores were higher in the second brain location recorded. The results might suggest that the second area is more sensitive to traumatic impact or the impact was more severe in the second test location, but we cannot conclusively say. The only thing that our results can infer is that there is a difference. The researcher would have to provide further parameters for us to reproduce and retest if other factors needed to be considered.

Problem 3 (20/20)

Hypothesis (5/5)

The problem considers a simple test in which 10 subjects were randomly selected to test a new thermometer that measures the forehead. The study considers four different devices with each of the 10 test subjects being measured by each device once. The model is built with crossover in that our scored values for temperature are dependent on each other. The study seeks to explain if the same average temperature is reported across the four different devices.

The research and comparison of measurements seek to find if average temperatures are the same across four different thermometer types for a 95% confidence level. So to reject the null hypothesis, we would have to show that a significant statistical difference exists between four recorded measurements in the 10 block subjects. More specifically a significance factor of below 5% would need to exist. The hypothesis that we are testing then is below, where H_0 is the null hypothesis and H_A is the alternative hypothesis.

H_0 – The four devices share the same average temperature collected ($\mu_1 = \mu_2 = \mu_3 = \mu_{4}$).
H_A – The four devices are not the same in average temperatures collected with two or more differing across the blocks.

Statistical Procedure, Tests and Assumptions (5/5)

In consideration of the test scenario and circumstances it is straightforward to conclude the appropriate test to perform by evaluating our stated assumptions.

Assumptions:

- Normally distributed population
- Our groups are dependent (crossover)
- Simple random sample of 10 subjects were taken from the larger normally distributed population
- Equality of variances exist between our groups
- Temperature (dependent variable) is continuous (interval or ratio)
- Thermometer or Device (independent variable) is categorical, with 2 or more groups to compare (4 Devices)

Based on the stated assumptions, it is merited to run a Randomized Block ANOVA Test. If crossover did not exist, a One-Way ANOVA Test would have been possible, but knowing it does, we can confidently choose the Randomized Block ANOVA is the correct test to perform.

Results (5/5)

From the results of our Randomized Block ANOVA test we can quickly evaluate the test results of the Between-Subjects Effects and determine there is no significance from the value of .640 or 6.4%. Since 6.4% is greater than 5% from our 95% confidence level, we would fail to reject the null hypothesis and conclude that the average temperatures are the same between the four thermometer devices.

Tests of Between-Subjects Effects

Dependent Variable:Temperature

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10.264[a]	12	.855	8.213	.000
Intercept	39463.524	1	39463.524	378917.193	.000
Block	10.086	9	1.121	10.760	.000
Device	.178	3	.059	.570	**.640**
Error	2.812	27	.104		
Total	39476.600	40			
Corrected Total	13.076	39			

a. R Squared = .785 (Adjusted R Squared = .689)

Inference (5/5)

Since we failed to reject the null hypothesis, we can conclude that the four thermometers considered resulted in the same average temperatures across the 10 subjects tested.

Problem 4 (20/20)

Hypothesis (5/5)

The problem seeks to explain improvements in average wait times experienced by callers. The model is based on a before and after comparison to validate after adding an additional phone operator, if wait times dropped from the previously known average of 94 seconds.

The research and comparison of measurements seek to find if average wait times improved after the addition of a phone operator for a 95% confidence level. So to reject the null hypothesis, we would have to show that a significant statistical difference exists between the previous recorded average of 94 seconds and the new average after the addition of a new phone operator. More specifically a significance factor of below 5% would need to exist. The hypothesis that we are testing then is below, where H_0 is the null hypothesis and H_A is the alternative hypothesis.

H_0 – There is no change in average call wait time for patients with the addition of a new phone operator call center.
H_A – There was a difference or drop in average call wait time for patients with the addition of a new phone operator in the call center.

Statistical Procedure, Tests and Assumptions (5/5)

In consideration of our stated circumstances, we have a previously known number in which we wish to compare a single sample. This strongly suggests the test that we should run. We must continue to evaluate our list of assumptions that can be made from the known research model. Other assumptions are included below.

Assumptions:

- Normally distributed population
- Outcome variable (average patient wait time) is continuous (interval or ratio)
- We wish to test if our sample observations (average wait times) were drawn from a population of a specific mean value (94 seconds)
- Temperature (dependent variable) is continuous (interval or ratio)
- Thermometer or Device (independent variable) is categorical, with 2 or more groups to compare (4 Devices)

With the stated assumptions, we can conclude that a One Sample T-Test is an appropriate test.

Results (5/5)

From the results of our One Sample T-Test, we can compare the mean of our sample to the previously known mean for the call center. We know the before mean time as it was given to us as 94 seconds. We see that the new mean after adding an additional phone operator is 79.10 seconds (highlighted). That is a decrease in average of 14.9 seconds.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Wait Time	10	79.10	32.539	10.290

However, when we further evaluate the significance factor is .182 or 18.2% from the One-Sample Test results below. 18.2% is greater than 5%, so we fail to reject the null hypothesis.

One-Sample Test

	Test Value = 94					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Wait Time	-1.448	9	.182	-14.900	-38.18	8.38

Inference (5/5)

The analysis of our results at first seem misleading, in that we can see a clear decline in average patient wait time on the phone. However, all we can infer is that significant statistical evidence was lacking to explain that our sample population had a mean of 94. The results infer that there is not sufficient support to say that wait times are any different before the addition of a new phone operator. It would be warranted to revisit and retest. There could have been an outlier which is not accounted for. The new operator might not be performing a proficient level and more training could help that. It could also mean that a more experienced operator was having a bad day and averaging longer calls than normal. There could have been other factors such as a pandemic outbreak that just increased the complexity of the calls. Retesting or collecting more data could help explain the model better.

Problem 5 (20/20)

Hypothesis (5/5)

The research scenario being considered seeks to compare the effects of newborn growth development and to see if there is a significant difference in newborns that were breastfed versus given formula. To compare the effects, the researcher drew 20 infants randomly and further divided the sample populations randomly into four independent groups consisting of five subjects each. Across the groups, one was exclusively breast fed and the other three given exclusive different types of feeding formulas. Growth rate was determined by measuring baby weight in ounces after 2 weeks of study at the same time of day for each baby in their respective group.

The research and comparison of measurements seek to find if newborn growth development are the same across the four groups of babies for a 95% confidence level. So to reject the null hypothesis, we would have to show that a significant statistical difference exists between our four groups recorded measurements. More specifically a significance factor of below 5% would need to exist. The hypothesis that we are testing then is below, where H_0 is the null hypothesis and H_A is the alternative hypothesis.

H_0 – There is no difference in mean of newborn growth compared to the different types of feeding regiments considered across the considered four groups of infants. Stated in formula, it is $\mu_1 = \mu_2 = \mu_3 = \mu_4$

H_A – At least one group mean is different

Statistical Procedure, Tests and Assumptions (5/5)

Because our study seeks to compare a dependent variable across different groups of subjects, it seems appropriate to consider a test such as ANOVA or a Randomized Block ANOVA. Either are appropriate when you have 1 categorical variable (Baby Milk Type) with more than 2 levels (Breast Milk or three different types of formulas) or multiple categorical variables. We would only run the Randomized Block ANOVA if we had cross over. Since all babies in our research study are not tested in a before/after type approach and no baby is tested against any other level of our factor, the study was setup with no crossover. We would conclude then that this would be a typical analysis of variance or ANOVA then. We can gain greater confidence that we are selecting the appropriate test to perform by considering the assumptions that an ANOVA would expect.

Assumptions:

- Normally distributed population
- Our factor is independent
- Simple random sample of 20 subjects were taken from the larger normally distributed population
- Equality of variances exist between our groups
- Newborn growth (dependent variable) is continuous (interval or ratio)
- Feeding type (factor) is categorical, with 2 or more groups to compare (4 milk types considered)

Considering the stated assumptions, I believe ANOVA is the appropriate test to run on the study data collected. Since we are only dealing with one factor (milk type) across multiple levels (breast milk and three different types of formulas), this would be a Single-Factor ANOVA design. As such we can run a One-Way ANOVA test to compare the means.

Results (5/5)

From the results produced from our One-Way ANOVA we can gather at quick glance from our factor of milk type in comparing the means across our levels that breastfed infants show a higher growth measurement in ounces than seen across the other three levels. The three formula types seem roughly to be in the same average mean.

Descriptives

Growth Measurement

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Breastfed	5	**115.80**	3.899	1.744	110.96	120.64	112	121
Formula A	5	104.40	6.580	2.943	96.23	112.57	98	115
Formula B	5	102.80	5.119	2.289	96.44	109.16	97	111
Formula C	5	103.60	7.266	3.250	94.58	112.62	95	115
Total	20	106.65	7.659	1.713	103.07	110.23	95	121

We can further consider the ANOVA results and see that we have a significance factor of .009 or .9%. .9% is lower than 5% so we would reject the null hypothesis and accept the alternative. Knowing that at least one group mean was statistically different, we can further evaluate the results to identify what which of the levels within our factor significantly differed. We can use the Multiple Comparisons table to highlight this or the Homogeneous Subsets does the same. From the table below, we can see that even though we had four different levels in our considered factor, we only have 2 homogeneous subsets. This is because three of our levels are considered statistically equal. Those are the three type of baby formulas. The milk type that was statistically different then from the other three and contributed to our rejection of the null hypothesis was breastfed infants.

Homogeneous Subsets

Growth Measurement

Tukey HSD[a]

Milk Type	N	Subset for alpha = 0.05	
		1	2
Formula B	5	102.80	
Formula C	5	103.60	
Formula A	5	104.40	
Breastfed	5		**115.80**
Sig.		.972	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Inference

The results above and analysis of the Homogeneous Subsets really help us answer the question the research sought to explain. We can see that infants that are exclusively breastfed do on average exhibit higher development growth measures than babies that are fed formula alternatives. **(5/5)**