Lab #12: Exam 3 Review Key

1) **a.** Probability - Refers to the likelihood that an event will occur. Ranges from 0 to 1.
b. Sampling Distribution - A probability distribution of the possible values of some sample statistic which would occur if we were to draw all possible samples of a fixed size from a given population. Tells two things: all possible outcomes & their probability.
c. Dichotomous Variable - A discrete categorical variable with two possible values.
d. Binomial Distribution - A sampling distribution of a dichotomous variable.
e. Alpha Level - The arbitrary level of significance that statisticians have chosen to distinguish probable from improbable.
f. Standard Error - The standard deviation of the distribution of sample means.
g. Sampling Error - Refers to the error we can expect due to using a sample statistics to estimate population parameters.
h. Degrees of Freedom - The number of calculations in its computation that are free to vary.
i. Critical Region - Area of the sampling distribution which indicates that the null hypothesis should be rejected.

2) **a.** We reject the null and "assert" the alternative. We don't accept the alternative because we didn't test it. We tested the null by assuming its truth.
b. We fail to reject the null. We don't accept the null because maybe our test wasn't sensitive enough to provide the occasion for its rejection.

3) **1. <u>Research Question</u>**
Does Statidote improve statistics ability?

2. <u>Hypotheses</u>

	Symbols	Words
H_O	$\mu_1=\mu_2$	Statidote does not effect statistics ability.
H_A	$\mu_1\neq\mu_2$	Statidote does effect statistics ability

3. <u>Assumptions</u>
1. H_o.
2. Subjects were chosen randomly.
3. DV is normally distributed in the population.
4. Scores of the two conditions are correlated.

4. <u>Decision Rules</u>
Alpha = .05, two-tailed test, df=N-1=9, t_{crit} = 2.262
If $t_{obs} \leq -2.262$ or $t_{obs} \geq 2.262$, then reject H_O.
If $t_{obs} > -2.262$ and $t_{obs} < 2.262$, then do not reject H_O.

5. <u>Computation</u>
First we describe the data by computing the means for each condition/group.

While we are at it, we might as well compute the difference scores and their squares (since we will need them for the analysis).

Subj	Placebo	Drug	D	D^2
1	5	4	1	1
2	7	8	-1	1
3	6	9	-3	9
4	7	8	-1	1
5	8	6	2	4
6	5	7	-2	4
7	7	8	-1	1
8	10	6	4	16
9	4	8	-4	16
10	5	9	-4	16
	$\sum=64$	$\sum=73$	$\sum D=-9$	$\sum D^2=69$

$$\bar{X}_{Placebo} = \frac{\sum X}{N} = \frac{64}{10} = 6.4 \qquad \bar{X}_{Drug} = \frac{\sum X}{N} = \frac{73}{10} = 7.3$$

It looks like the drug improves performance a little bit.

$$t = \frac{\sum D}{\sqrt{\frac{N\sum D^2 - \left(\sum D\right)^2}{N-1}}} = \frac{-9}{\sqrt{\frac{10\times 69 - 9^2}{10-1}}} = \frac{-9}{\sqrt{\frac{690-81}{9}}}$$

$$t = \frac{-9}{\sqrt{\frac{609}{9}}} = \frac{-9}{\sqrt{67.67}} = \frac{-9}{8.23} = -1.094$$

6. **Decision**
Since -1.094 (t_{obs}) does not fall within the critical region, we fail to reject H_o. Statidote does not improve statistics ability.

4) 1. **Research Question**
Are today's teens getting more sleep than teens of the past?

2. **Hypotheses**

	Symbols	Words
H_O	μ=7.5	Today's teens sleep the same amount as teens of the past.
H_A	$\mu\neq$7.5	Today's teens do not sleep the same as teens of the past.

3. **Assumptions**
1. Ho.
2. Sample is randomly selected.

3. Population of IQ is normal.

4. **Decision Rules**
Alpha = .05, two-tailed test, N=12 (df=N-1=11), t_{crit}=2.201
If $t_{obs} \leq$ -2.201or $t_{obs} \geq$ 2.201, then reject H_O.
If t_{obs} > -2.201and t_{obs} < 2.201, then do not reject H_O.

5. **Computation**

X	X^2
4	16
5	25
5	25
5	25
6	36
6	36
6	36
6	36
7	49
8	64
8	64
9	81
$\sum X$=75	**$\sum X^2$=493**
N=12	

$$\bar{X} = \frac{\sum X}{N} = \frac{75}{12} = 6.25$$

The mean for amount of sleep per night for today's teens is less than the mean of past teens, that is, 6.25 is less than 7.5.

$$s = \sqrt{\frac{N\sum X^2 - \left(\sum X\right)^2}{N(N-1)}} = \sqrt{\frac{(12 \times 493) - (75^2)}{12(12-1)}} = \sqrt{\frac{5916 - 5625}{12(11)}}$$

$$s = \sqrt{\frac{5916 - 5625}{132}} = \sqrt{\frac{291}{132}} = \sqrt{2.2045} = 1.485$$

$$t = \frac{\bar{X} - \mu}{\frac{s_x}{\sqrt{N}}} = \frac{6.25 - 7.5}{\frac{1.485}{\sqrt{12}}} = \frac{-1.25}{\frac{1.485}{3.464}} = \frac{-1.25}{.428} = -2.916$$

6. **Decision**
Since -2.916 (t_{obs}) $\leq$ -2.201 (t_{crit}), we reject H_O and assert the alternative. Current teens are getting less sleep than teens of the past.

5) 1. Research Question

Does involvement in school clubs reduce truancy?

2. Hypotheses

	Symbols	Words
H_O	$\mu_1=\mu_2$	School club involvement is not related to truancy.
H_A	$\mu_1\neq\mu_2$	School club involvement is related to truancy.

3. Assumptions

1. H_o
2. Subjects chosen randomly.
3. DV is distributed normally.
4. Groups are independent.
5. Homogeneity of variance.

4. Decision Rules

Alpha = .05, two-tailed test, df = N_1+N_2-2 = 8+8-2 = 14, $t_{crit}=2.145$

If $t_{obs} \leq -2.145$ or $t_{obs} \geq 2.145$, then reject H_O.

If $t_{obs} > -2.145$ and $t_{obs} < 2.145$, then do not reject H_O.

5. Computation

Subject	No School Clubs (1)	NSC^2	School Clubs (2)	SC^2
1	0	0	0	0
2	2	4	1	1
3	3	9	1	1
4	4	16	2	4
5	5	25	2	4
6	5	25	3	9
7	6	36	4	16
8	7	49	7	49
$\sum$	32		20	
N	8		8	
$\bar{X}$	4.0		2.5	
$\sum X^2$		164		84

It appears that those involved in school clubs are truant somewhat less often.

$$s_1^2 = \frac{N\sum X^2 - \left(\sum X\right)^2}{N(N-1)} = \frac{8\times164-32^2}{8(8-1)} = \frac{1312-1024}{8(7)} = \frac{288}{56} = 5.143$$

$$s_2^2 = \frac{N\sum X^2 - \left(\sum X\right)^2}{N(N-1)} = \frac{8\times84-20^2}{8(8-1)} = \frac{672-400}{8(7)} = \frac{272}{56} = 4.857$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(N_1-1)s_1^2 + (N_2-1)s_2^2}{N_1+N_2-2}\right)\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}}$$

$$t = \frac{4-2.5}{\sqrt{\left(\frac{(8-1)5.143 + (8-1)4.857}{8+8-2}\right)\left(\frac{1}{8}+\frac{1}{8}\right)}}$$

$$t = \frac{1.5}{\sqrt{\left(\frac{(7)5.143 + (7)4.857}{14}\right)\left(\frac{2}{8}\right)}} = \frac{1.5}{\sqrt{\left(\frac{36.001+33.999}{14}\right)(.25)}}$$

$$t = \frac{1.5}{\sqrt{\left(\frac{70}{14}\right)(.25)}} = \frac{1.5}{\sqrt{(5)(.25)}} = \frac{1.5}{\sqrt{1.25}} = \frac{1.5}{1.118} = 1.342$$

6. **Decision**
Since 1.342 tobs > -2.145 (tcrit), we do not reject H_o. Truancy for students involved in school clubs is no different than truancy for students not involved in school clubs.

6) 1. **Research Question**
Do people think statistics lab is the highlight of the week?

2. **Hypotheses**
Let h=probability of stats test being the highlight of the week, and t=probability of stats test not being the highlight of the week

	Symbols	Words
H_O	h=t	Statistics lab is not the highlight of the week.
H_A	$h \neq t$	Statistics lab is the highlight of the week.

3. **Assumptions**
1. H_o

4. **Decision Rules**
Alpha = .05, two-tailed test, N=12
If the probability of what we observe $\leq .05$, we will reject H_o

5. **Computation**
In terms of describing the data, 10/12 or 83% believed the stat lab is the highlight of the week when we would expect something closer to 50% if there was no opinion.

The problem involves a dichotomous variable, so we need Pascal's triangle for N=12 in order to obtain the relevant sampling distribution so we can perform the binomial test.

N	Coefficients	N+1	2^N
1	1 1	2	2
2	1 2 1	3	4
3	1 3 3 1	4	8
4	1 4 6 4 1	5	16
5	1 5 10 10 5 1	6	32
6	1 6 15 20 15 6 1	7	64
7	1 7 21 35 35 21 7 1	8	128
8	1 8 28 56 70 56 28 8 1	9	256
9	1 9 36 84 126 126 84 36 9 1	10	512
10	1 10 45 120 210 252 210 120 45 10 1	11	1024
11	1 11 55 165 330 462 462 330 165 55 11 1	12	2048
12	1 12 66 220 495 792 924 792 495 220 66 12 1	13	4096

Thus, the relevant binomial distribution is:

$H^{12}T^{0}$	$H^{11}T^{1}$	$H^{10}T^{2}$	$H^{9}T^{3}$	$H^{8}T^{4}$	$H^{7}T^{5}$	$H^{6}T^{6}$	$H^{5}T^{7}$	$H^{4}T^{8}$	$H^{3}T^{9}$	$H^{2}T^{10}$	$H^{1}T^{11}$	$H^{0}T^{12}$
1/4096	12	66	220	495	792	924	792	495	220	66	12	1
.001	.003	.016	.054	.121	.193	.226	.193	.121	.054	.016	.003	.001

Event	Probability
12 Heads	.001
11 Heads	.003
10 Heads	.016
10 Tails	.016
11 Tails	.003
12 Tails	.001
Total=	**.040**

6. **Decision**
The probability of observing an event as rare as what we obtained = .04. Since this is less than the alpha level of .05, we reject H_o and conclude that the outcome we have observed is improbable due to chance. Thus, the class indeed believes that the statistics lab is the highlight of their week ;)

7) 1. **Research Question**
Do psych majors have a higher IQ than normal people?

2. **Hypotheses**

	Symbols	Words
H_O	μ=100	Psych majors are no different in IQ than normal people.

H_A	$\mu \neq 100$	IQ is different for psych majors compared to normal people.

3. **Assumptions**
   1. Population has μ=100 and σ=15 (i.e., H_o).
   2. Sample is randomly selected.
   3. DV is normally distributed in the population.

4. **Decision Rules**
   Alpha = .05, two-tailed test, Z_{crit} =1.96
   If $Z_{obs} \leq -1.96$ or $Z_{obs} \geq 1.96$, then reject H_O.
   If $Z_{obs} > -1.96$ and $Z_{obs} < 1.96$, then do not reject H_O.

5. **Computation**

X
115
107
132
97
95
118
118
89
121
110
101
92
112
94
97
131
99
117
$\sum$**X**=1945
N=18
$\bar{X}$=108.1

$$z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{N}}} = \frac{108.1 - 100}{\frac{15}{\sqrt{18}}} = \frac{8.1}{\frac{15}{4.2426}} = \frac{8.1}{3.5355} = 2.291$$

6. **Decision**
   Since 2.291 (Z_{obs}) > 1.96 (Z_{crit}), we reject H_O. Psych majors have a higher IQ than the rest of the population ☺ (fictitious data that is not based on fact).