Exam 1 PS 217, Spring 2008

1. In class, we talked about the poor woman who was pregnant in San Diego. She argued that she had a *very* long gestation period (i.e., 308 days). Essentially, she is claiming that her gestation period was sampled from the normal population ($\mu = 268$ days and $\sigma = 16$ days). When faced with a situation such as this, a statistician has to make a decision. Assuming that he couldn't simply conduct a DNA test, if the husband approached you for statistical advice, what would you do and what would you tell him? What kind of error might you be making with your decision? Why is it that you can never make a Type I Error *and* a Type II Error on the same decision? [5 pts]

I would first compute a *z*-score: $z = \frac{308 - 268}{16} = 2.5$

I would then tell him that the probability of a woman carrying a child that long or longer is .0062 (or about 6 women in 1000). Thus, while it's not impossible, it's certainly an unlikely gestation period. In essence, I'd be testing H_0: $\mu = 268$. With $z = 2.5$, I would reject H_0, claiming that it's more likely that his wife is lying (i.e., a gestation period of ~268 days and a later conception date). In so doing, of course, I could be making a Type I error (claiming that H_0 is false, when it is actually true). When I reject H_0, the only kind of error I can make is Type I. Alternatively, when retaining H_0, the only kind of error I can make is Type II. Thus, with any decision, I can make only one kind of error or the other.

2. If you think of IQ scores as normally distributed with $\mu = 100$ and $\sigma = 15$, you should be able to answer the following questions: [3 pts each]

a. What proportion of IQ scores would fall between 115 and 130? **.4772 - .3413 = .1359**

***z*-score**	$z = \frac{115 - 100}{15} = 1.0$	$z = \frac{130 - 100}{15} = 2.0$
proportion b/w mean and *z*	**.3413**	**.4772**

b. What proportion of IQ scores would fall below 90? **.2514**

$$z = \frac{90 - 100}{15} = -0.67$$

c. If you wanted to consider yourself smarter than 95% of people, what IQ score would you need to earn? **124.675**

$$z = 1.645,\ 1.645 = \frac{X - 100}{15}$$

d. If you administered an IQ test to a random sample of $n = 9$ people, what is the probability that their mean IQ would be greater than 109? **.0359**

$$z = \frac{\overline{X} - \mu_{\overline{X}}}{\sigma_{\overline{X}}} = \frac{109 - 100}{5} = 1.8$$

e. If you were about to take a random sample of n = 9 people and you wanted to estimate the mean IQ of the sample, you might expect that it should fall in the middle 95% of the distribution. Thus, their mean would likely fall between what two scores? **90.2 and 109.8**

$$\pm 1.96 = \frac{\overline{X} - \mu_{\overline{X}}}{\sigma_{\overline{X}}} = \frac{\overline{X} - 100}{5}$$

3. The GPAs for a sample of nine students are seen below. Using these data, estimate the mean and variance of the parent population from which the sample was drawn. [10 pts]

	GPA	GPA^2
	3.5	12.25
	2.9	8.41
	3.2	10.24
	3.0	9.0
	2.8	7.84
	3.6	12.96
	3.2	10.24
	2.9	8.41
	3.3	10.89
Sum	28.4	90.24

$$\overline{X} = \frac{\sum X}{n} = \frac{28.4}{9} = 3.16 \text{ and } s^2 = \frac{SS}{n-1} = \frac{.62}{8} = .08$$

$$SS = \sum X^2 - \frac{(\sum X)^2}{n} = 90.24 - \frac{28.4^2}{9} = .62$$

4. Educators often talk about grade inflation. Suppose that the mean GPA in 1950 was 2.4 (i.e., $\mu = 2.4$). How likely is it that the sample above (problem #3) was drawn from a population with $\mu = 2.4$? What might this evidence say about grade inflation? [10 pts]

H_0: $\mu = 2.4$ and H_1: $\mu \neq 2.4$ and with $n = 9$, $t_{Crit}(8) = 2.306$

$$t = \frac{\overline{X} - \mu_{\overline{X}}}{s_{\overline{X}}} = \frac{3.16 - 2.4}{.09} = 8.4$$

Reject H_0, because $|t| \geq t_{Crit}$. Conclude that the sample mean GPA is drawn from a population with $\mu > 2.4$ (mean GPA in 1950).

5. Miscellaneous Questions [10 pts]:

a. Suppose that you are computing a t-test with $t_{Crit} = 1.96$. What can you tell me about that t-distribution?

It is normally distributed (because of large sample size).

b. If you are looking for a small effect (low d), what would you need in order to be able to reject H_0?

A great deal of power.

c. What is the definition of the median?

50% of scores above and 50% of scores below

d. If you were to add a constant to all the scores in a sample, what would happen to the sample variance?

It would stay the same.

e. Why is the *SS* not a good measure of variability?

It will typically increase with increasing n. (The only time it won't increase is when the additional scores are all at the mean.)

f. Interpret the SPSS output below as completely as you can. (In other words, what is the statistic, what are the scores, how would you interpret the results, etc.)

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
GPA	9	3.1556	.27889	.09296

One-Sample Test

	Test Value = 2.9					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
GPA	2.749	8	.025	.25556	.0412	.4699

The output is for a single-sample (one-sample) *t*-test of H_0: $\mu = 2.9$.
With $t = 2.749$, the probability is .025 (i.e., < .05), so you would reject H_0.
You could then conclude that the sample is likely drawn from a population with $\mu > 2.9$.

Extra credit: [From memory lab] What is the name of the first psychologist to study memory systematically?

Ebbinghaus