1. What is sampling error? What is sampling error due to? How can we represent the amount of sampling error that is present in a statistic?

2. What is an unbiased estimator? What is a biased estimator? Which sample statistics are unbiased and which are biased?

3. Why is the sample mean the “best estimate” of a population mean?

4. Why is the sum of squares divided by n - 1 rather than by n when computing the variance estimate?

5. What are degrees of freedom?

6. What is the sampling distribution of the mean?

7. What characteristics of a sampling distribution of the mean are addressed by the central limit theorem?

8. What will the mean of a sampling distribution of the mean always equal? Why?

9. What is the standard error of the mean? What information does it convey? How is it calculated?

10. What is the difference between the standard error of the mean and a standard deviation of a set of raw scores?

11. In cases where the population standard deviation is unknown, or does not exist, the standard of the mean cannot be calculated. What is used in its place, and how is it calculated?

12. What are the two factors that influence the size of the standard error of the mean, and how do they do so?

13. Say that a sampling distribution of the mean has a standard error of the mean that is equal to 0. What does this indicate about the means of the samples drawn from the population?

14. Say that a sampling distribution of the mean has a standard error of the mean that is equal to 0. What does this say about the variability of scores in the population (σ)?

15. Say that the population standard deviation for working memory capacity scores is $\sigma = 8$. Calculate the standard error of the mean based on a sample size of 15.

16. Assume the mean working memory score in the sample from #15 is $M = 66$.Calculate the 95% margin of error and the upper and lower boundaries for the 95% confidence interval around this sample mean, using the standard error of the mean from #15.

17. Calculate the 99% margin of error and the upper and lower boundaries for the 99% confidence interval around the sample mean in exercise #16, using the standard error of the mean from #15.

18. *Use the following to answer the questions below*. The "attentional control scale" is a device used for measuring individual differences in a person's ability to control and maintain their focus of attention and thinking. Scores on the attentional control scale range from 15 to 60, with higher scores reflecting better control over attention. Assume that scores on the attentional control scale are normally distributed with $\mu = 37.5$ and $\sigma = 10$. You administer the attentional control scale to a random sample of twelve psychology majors and obtain the scores listed below. Use them to answer the following questions:

26	28	47	21	38	27	38	18	36	22	26	45

a. Calculate the sample mean.
b. Calculate the sum of squares.
c. Calculate the sample variance.
d. Calculate the sample standard deviation.
e. Calculate the standard error of the mean, based on the population standard deviation above.
f. Calculate the upper and lower limits of the 95% confidence interval around the sample mean.
g. Calculate the estimated standard error of the mean, based on the sample standard deviation.
h. Using the estimated standard error of the mean, calculate the upper and lower limits of the 95% confidence interval around the sample mean.

19. *Use the following to answer the questions below*. Short term memory is the storage area of memory that maintains information in an active state just long enough for that information to be moved and stored in long term memory. The capacity of short term memory is generally $\mu = 7$ pieces of information and $\sigma = 2$. A short researcher tests the short term memory for a sample of five neuroscience majors and obtains the following short term memory scores. Use this information to answer the questions below:

6	8	9	8	9

a. Calculate the sample mean.
b. Calculate the sum of squares.
c. Calculate the estimated population variance.
d. Calculate the estimated population standard deviation.
e. Calculate the standard error of the mean, based on the population standard deviation.
f. Calculate the upper and lower limits of the 95% confidence interval around the sample mean.
g. Calculate the estimated standard error of the mean, based on the estimated standard deviation.
h. Using the estimated standard error of the mean, calculate the upper and lower limits of the 95% confidence interval around the sample mean.

20. What two things does the size of the confidence interval reflect?

21. A sample of $n = 20$ is drawn from each of two populations. For population A, $\mu = 8.00$ and $\sigma = 4.00$; and for population B, $\mu = 9.00$ and $\sigma = 6.00$. Which sample mean is likely a better estimate of its population mean? Why?

22. A population has the following parameters: $\mu = 500$ and $\sigma = 100$. A sample of $n = 100$ subjects is randomly selected, and has $\overline{X} = 520$. Calculate the 95% confidence interval around the sample mean.

23. Calculate the 99% confidence interval based on the information in #22.

24. Say that the sample size from #22 and 23 was increased to n = 1000. Recalculate the 99% confidence interval based on the information in #22 and 23.

ANSWERS

1. Sampling error is a difference between a sample statistic and a population parameter. It results from the fact that a sample is based on only a portion of a population. The amount of sampling error can be represented as the difference between a sample statistic and its corresponding population parameter.

2. An unbiased estimator is a statistic whose average over all possible samples of a given size is equal to the value of the population parameter. The sample mean is an unbiased estimator. A biased estimator is a statistic whose average over all possible samples of a given size does <u>not</u> equal the value of the population parameter. The sample variance and standard deviation are biased estimators.

3. Because the sample mean is an unbiased estimator of the population mean.

4. This is because sample variance is a biased estimator of population variance. Specifically, sample variance underestimates population variance, so dividing by n - 1 instead of by n makes the variance estimate slightly larger and corrects for this underestimation.

5. Degrees of freedom are the number of pieces of information that can vary independently of one another. Specifically, in a sample, there are exactly n - 1 scores that can vary independently of one another, but the last score is determined by the other N - 1 scores

6. It is a distribution of all the means for all possible random samples of a given sample size that are drawn from a population.

7. The mean, the standard deviation, and the shape of the sampling distribution of the mean.
8. The mean of the sampling distribution of the mean will always equal the population mean, because the sample mean is an unbiased estimator of the value of the population mean.

9. The standard error of the mean is the standard deviation of a sampling distribution of the mean. Its value is the average deviation of a sample mean of a given size n from the population mean. The standard error of the mean is calculated by dividing the population standard deviation by the square root of the sample size.

10. A standard deviation of a distribution of raw scores is the average deviation of a raw score and the mean of that distribution. The standard error of the mean is the average deviation between a sample mean of a given size and the population mean.

11. The estimated standard error of the mean is used, which is calculated from dividing the estimated standard deviation by the square root of the sample size.

12. The sample size (n) and population standard deviation (σ), which is the variability among the scores in the population. As sample size increases, the standard error gets smaller, and as the standard deviation gets smaller, the standard error gets smaller.

13. This indicates that the means of all samples drawn from the population are equal to the population mean.

14. This indicates that there is no variability among the scores in the population; that is, all scores are the same and σ is equal to 0.

15. 2.066

16. MOE = +/- 4.049; CI = {61.951, 70.049}

17. MOE = +/- 5.33; CI = {60.67, 71.33}

18. a. 31 b. 1000 c. 90.909 d. 9.535 e. 2.877
f. {25.342, 36.658} g. 2.752 h. {24.946, 37.054}

19. a. 8 b. 6 c. 1.5 d. 1.225 e. 0.894
f. {6.248, 9.752} g. 0.548 h. {6.477, 9.523}

20. The size of the confidence interval is an area of the normal distribution that is covered by that range, which is centered on the sample mean. It also indicates how confident we can be that the population mean is contained within that range.

21. The sample drawn from population A will have a mean that is a better estimate of the population mean. This is because the population standard deviation is smaller in population A (4.000) than population B (6.000). Consequently, the standard error of the mean will be smaller for the sample drawn from population A (0.894) than population B (1.342).

22. {500.4, 539.6}

23. {494.2, 445.8}

24. {511.842, 528.158}