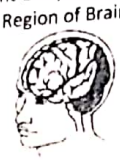
STAT 210: Statistics
Handout #3: More Examples of 2-AFC

Example 3.1: Williams-Beuren syndrome (WBS) is a rare neurodevelopmental disorder which is caused by the deletion of more than 25 genes from region q11.23 of chromosome 7. Subjects with WBS display smaller brain volumes than normal; however, they often show an excess of volume in the right occipital cortex region of the brain. There are many documented effects of WBS, e.g., increased risk of cardiac problems, higher risk of diabetes, etc. The study presented here is concerned with the left-handedness of people with WBS.

Research Question: Do males with Williams-Beuren syndrome have a greater chance of left-handedness than males in the general population?

Number of Males in Study with WBS that were Left-Handed	Left-Handedness Rate for Males in the General Population
8 out of 25	12.4%

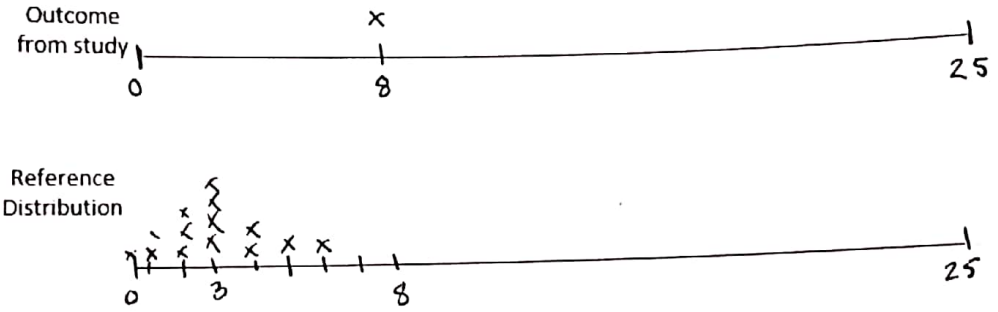
Right Occipital Cortex Region of Brain



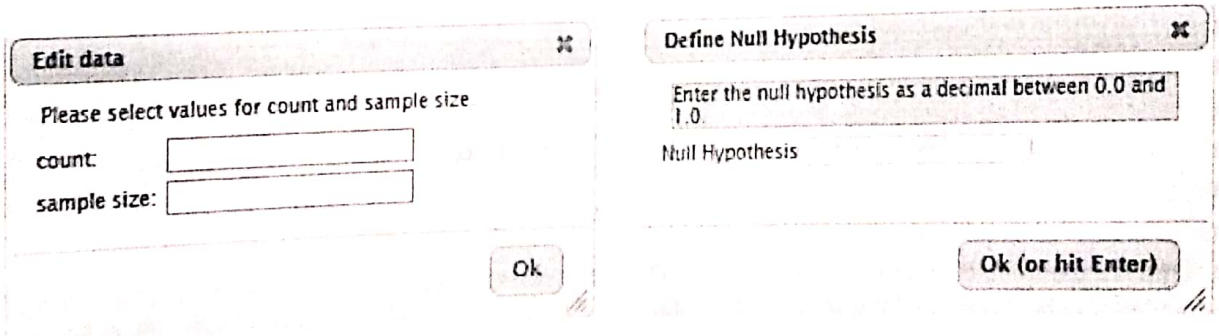
L R

Source: Van Strien, J.W., Lagers-van Haselen, G.C, van Hagen, J.M, de Coo, I.F.M, Fens, MA, van der Geest, JN. (2005). "Increased prevalences of left-handedness and left-eye sighting dominance in individuals with Williams-Beuren syndrome." *Journal of Clinical and Experimental Neuropsychology*. 2005 Nov;27(8):967-76.

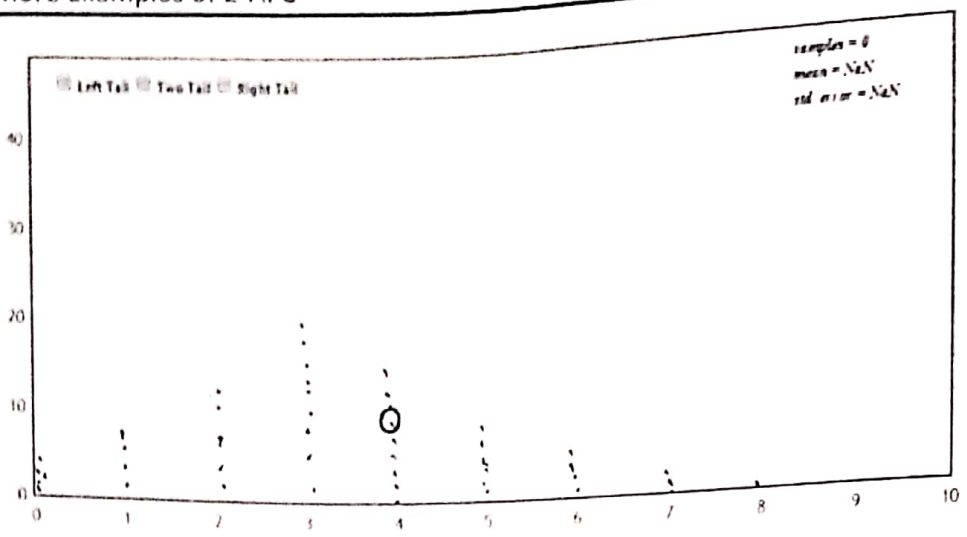
Specify the setup using the number line below for the evaluation of this research question.



Identify the following simulation parameters for your investigation.



Next, plot the outcomes from your repeated iterations.



Answer the following questions regarding this investigation.

1. Which of the following statements is most correct regarding the above reference distribution?
   a. The dots on this reference distribution were constructed under the assumption that males with WBS have a greater prevalence of left-handedness because of the excess volume of the right occipital cortex region of the brain.
   b. The dots on this reference distribution were constructed under the assumption that males with WBS have a greater prevalence of left-handedness than males in the general population.
   (c.) The dots on this reference distribution were constructed under the assumption that males with WBS have the same left-handedness rate as males in the general population.

2. Circle a single dot on the above dotplot. Complete this sentence to explain what this single dot represents. In this particular simulated outcome, there were 4 out of a possible 25 left-handed WBS male subjects. This dot was generated under the assumption that male WBU people ~~are~~ have the same left handedness rate as males in the general population.

3. Consider once again the research question for this investigation.

   Research Question: Do males with Williams-Beuren syndrome have a greater chance of left-handedness than males in the general population?

   The right-tail of this reference distribution is the tail of interest for this investigation. Why is this the case?

   It supports the research question - greater than

4. What is a reasonable cutoff for this investigation? That is, what values would indicate an increased rate of left-handedness for males with WBS?

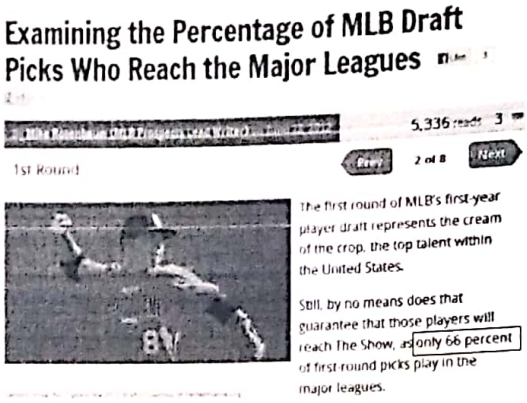
   Cutoff: 7

Example 3.2: Consider the following snip-it of an article published in Sports Illustrated. This article is about a 19 year-old pitching prospect that was drafted by the Baltimore Orioles in the 1st round. The author of this article speaks to the risk of drafting and thereby compensating pitchers taken in the 1st round.

THERE IS NO SPORTS GENUS with a greater risk-reward ratio than high school pitchers. Like supermodels, they look great, but the chances of entering into a long-term relationship with one are slim. Teams keep drafting them for their visceral gifts, but the toll of throwing so hard so young, their incomplete physical development and the few opportunities to measure them against top competition leave teams spending millions on veritable lottery tickets.

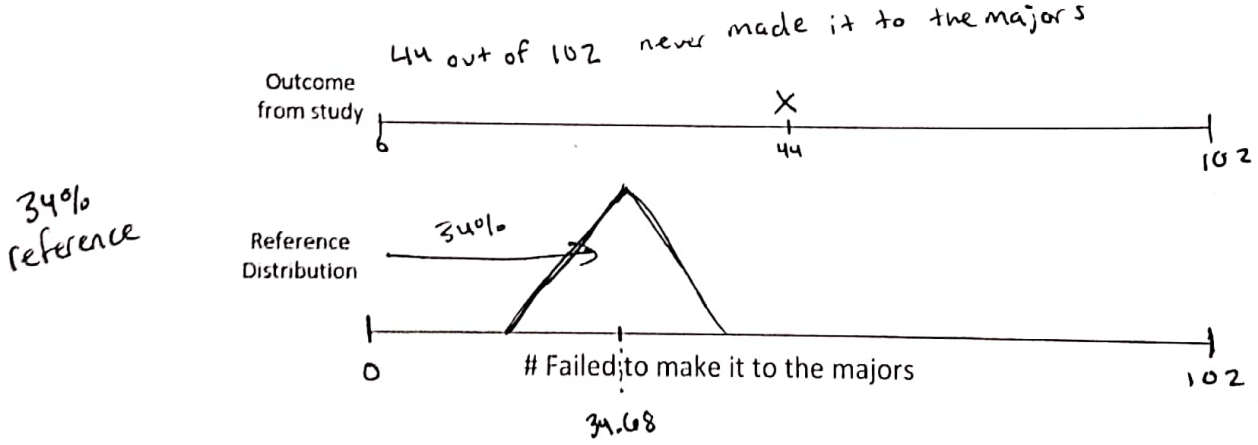
Major league teams signed 102 high school pitchers taken in the first round from 1981 through 2000 (not including supplemental first-round picks). Of those 102 high school first-rounders, 44 never reached the majors.

In an effort to determine whether or not pitchers are of a greater risk of failure, we must compare them to other position players. A quick Google® search produces the following information.
In this article, the author states than 66% of 1st round draft picks play in the major leagues and 34% end up never reaching the major leagues.



Research Question: Do pitchers taken in the 1st round of the draft have a higher risk of failure than other position players.

Specify the setup using the number line below for the evaluation of this research question.



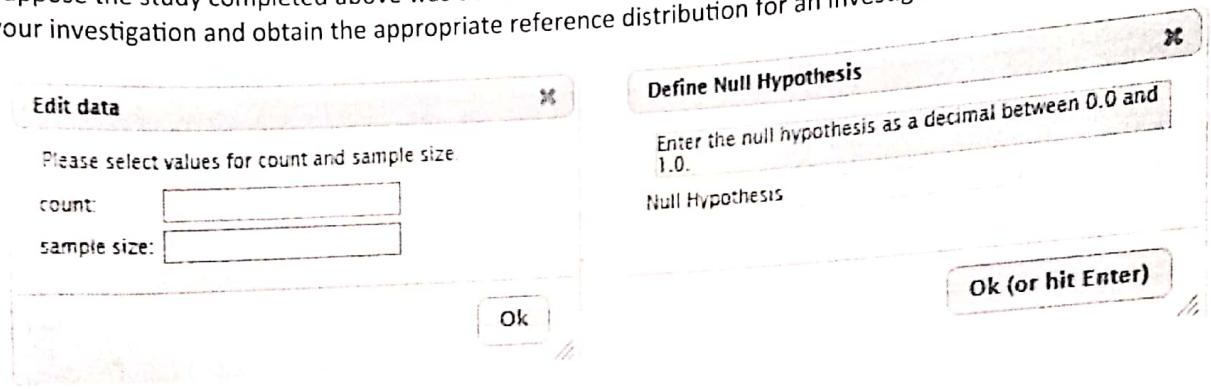
Rightsided because "have a higher risk of failure" and the right side is a higher risk of failure

5. The number of males in this study that were left-handed was 8. Using your reference distribution, do you believe 8 provides enough evidence to support the research question? Explain.

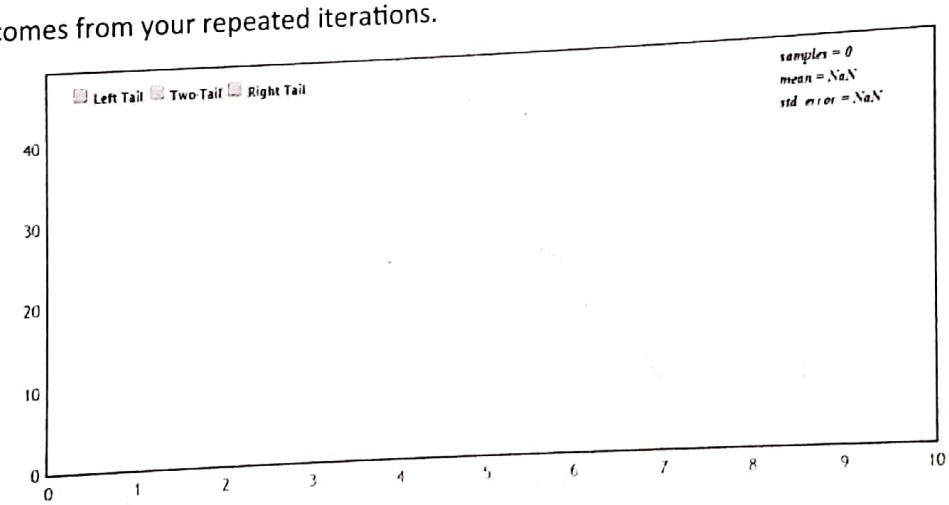
In the general population, the rate of left-handedness rate for females is slightly lower than males. Conduct a Google search to determine a reasonable rate of left-handedness for females.

Google

Suppose the study completed above was done on Females. Identify the following simulation parameters for your investigation and obtain the appropriate reference distribution for an investigation of females.



Plot the outcomes from your repeated iterations.

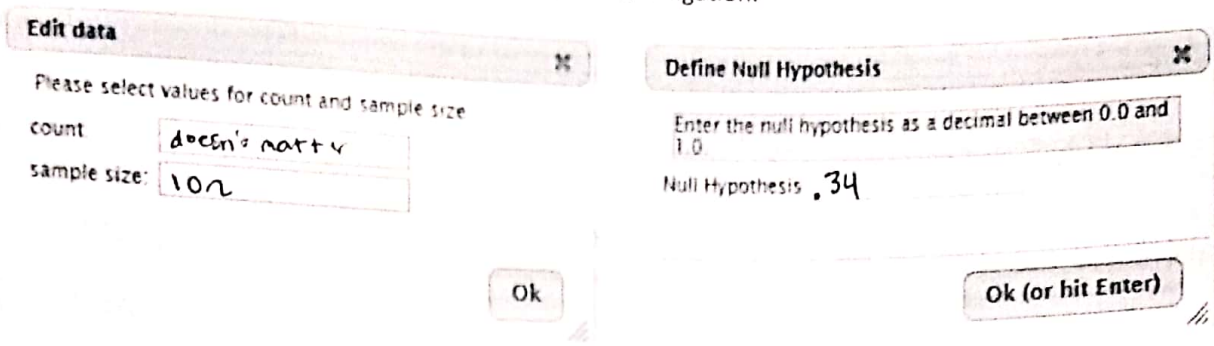


Questions

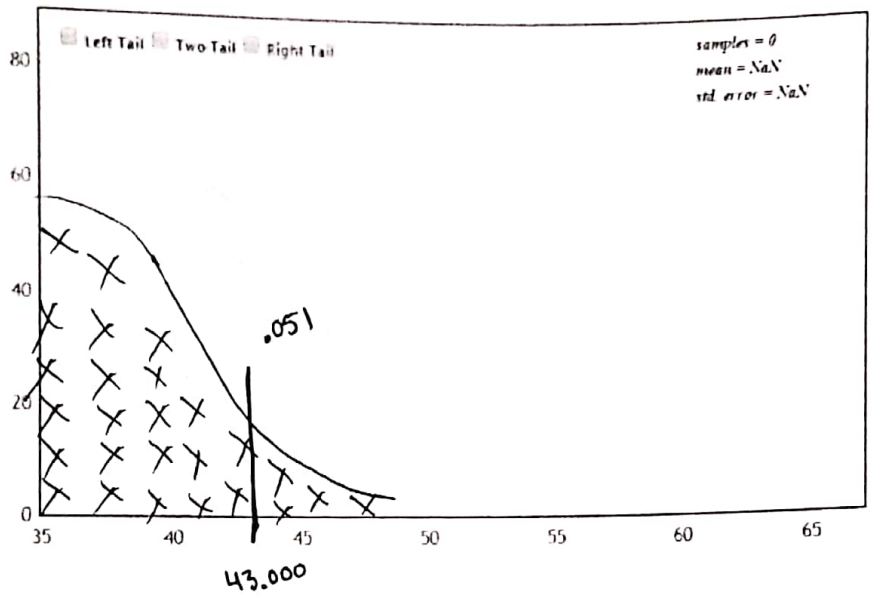
6. How is the reference distribution for females different than the reference distribution for males?

7. Should we expect the cutoff value for females to be higher or lower than the cutoff value for males? Explain.

Identify the following simulation parameters for your investigation.



Next, plot the outcomes from your repeated iterations.



Questions:

8. Which of the following statements is most correct regarding the above reference distribution?
   a. The dots on this reference distribution were constructed under the assumption that pitchers had the higher risk of failure as other position players.
   b. The dots on this reference distribution were constructed under the assumption that pitchers had the same rate as failure as other position players.
   c. The dots on the reference distribution were constructed under no assumptions as this would bias our decisions regarding the pitchers.

9. Consider once again the research question for this investigation.

   Research Question: Do pitchers taken in the 1st round of the draft have a higher risk of failure than other position players.

   Which tail of the distribution is of interest for this investigation. Explain your answer.

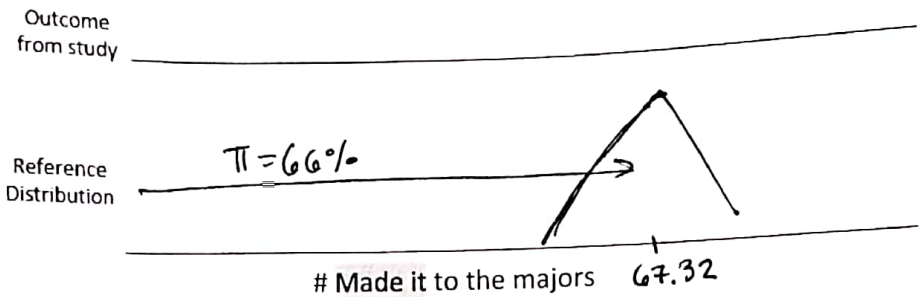
   Right "Higher Risk?" → right tail is higher risk

10. What is a reasonable cutoff for this investigation? That is, what values would indicate that pitchers have an increased risk of failure?

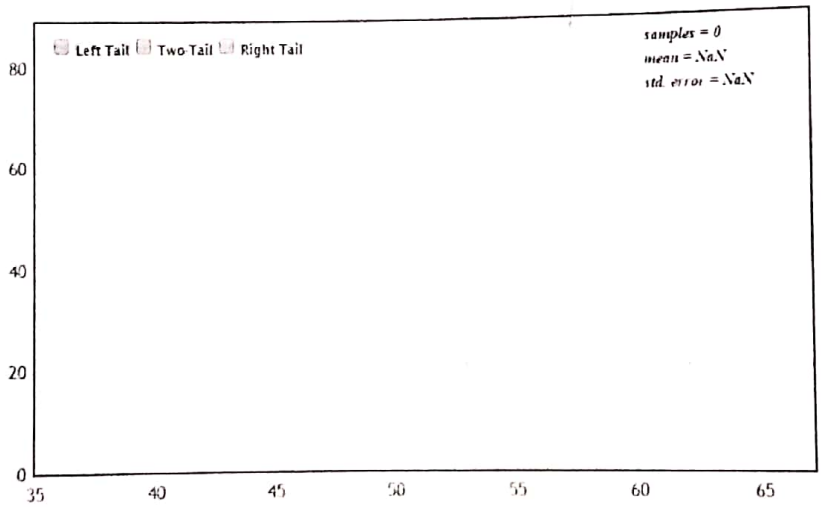
Cutoff: 43.0

11. The number of first-round high school pitchers that never reached the majors is 44. Using your reference distribution, do you believe provides enough evidence to support the research question? Discuss.

Suppose your friend decided to analyze the number that made it to the majors instead of the number that failed to make it.



Construct a reference distribution for this investigation.



Questions

12. Do you reach the same conclusion as above when analyzing # Made it to the majors? Briefly discuss.

Yes. The answer you find one direction must meet the same as the other direction. Otherwise it was done wrong

Invariance

Example 3.3: Ear Infections (Source: Rosner)
A common symptom of otitis media (ear infection) in young children is the prolonged presence of fluid in the middle ear. The hypothesis has been proposed that babies who are breast-fed for at least 1 month may build up some immunity against the effects of the condition. A small study of 24 pairs of babies is set up, where the babies are **matched** on a one-to-one basis according to

- age
- Sex
- socioeconomic status, and
- and type of medications taken.

One member of each matched pair is a breast-fed baby and the other was bottle-fed.

Definitions

- Response Variable: The primary outcome or measurement of interest in an analysis. Also known as: Dependent Variable or Y-Variable
- Confounding Variable: A variable that cannot be delineated from another variable when attempting to establish a relationship with the response variable.

Question: Suppose Age is known to influence the occurrence of ear infections. Explain why the differences in the ages between the two groups hinders our ability to compare these two groups.

The primary outcome measurement recorded in this study was the duration (in days) of fluid in the middle ear after the first episode of otitis media. The results from the 24 pairs are below. Of interest is to make comparisons between the breast-fed and bottle-fed babies. These comparisons should be done within each pair of babies because of the auxiliary factors that were considered in this study.

Who did better in head-to-head comparisons?

	A	B	C
1	Pair	Breast-Fed	Bottle-Fed
2	1	20	18
3	2	11	35
4	3	3	7
5	4	24	182
6	5	7	6
7	6	28	33
8	7	58	223
9	8	7	7
10	9	39	57
11	10	17	76
12	11	17	186
13	12	12	29
14	13	52	39
15	14	14	15
16	15	12	21
17	16	30	28
18	17	7	8
19	18	15	27
20	19	65	77
21	20	10	12
22	21	7	8
23	22	19	16
24	23	34	28
25	24	25	20

Count the number of times breast-fed and bottle-fed babies did better and complete the following table.

Outcome	Number of Pairs
Bottle-fed did better	7
Breast-fed did better	16
Tie	1
Total	24

In all our analyses thus far, we have been restricted to only two outcomes. Recall, for this example we have three outcomes: 1) breast-fed better, bottle-fed better, and one tie; as a result, when we construct our spinner in StatKey, we will not include the outcome from the tie.

Questions

1. Does Pair #8 provide evidence for bottle-fed doing better, breast-fed doing better, or neither? Explain.

   Neither. The tie is not definitive of either outcome and we can only have 2 outcomes in this binomial ...

2. If the tie is removed, how many pairs do we have for our analysis?

   23 pairs

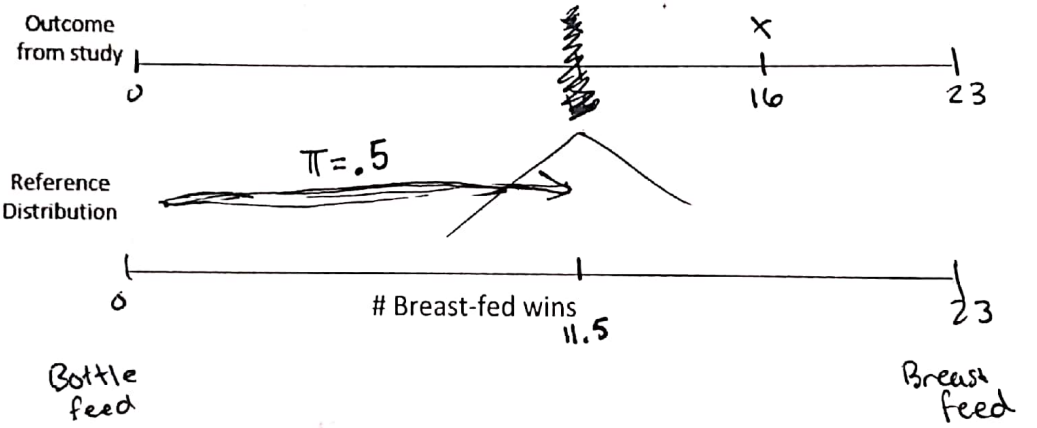
3. If there is no difference in the duration of ear infection between breast-fed and bottle-fed, for how many pairs should the bottle-fed babies do better than the breast-fed babies?

   23/2 (half of them) ($\pi = .5$)

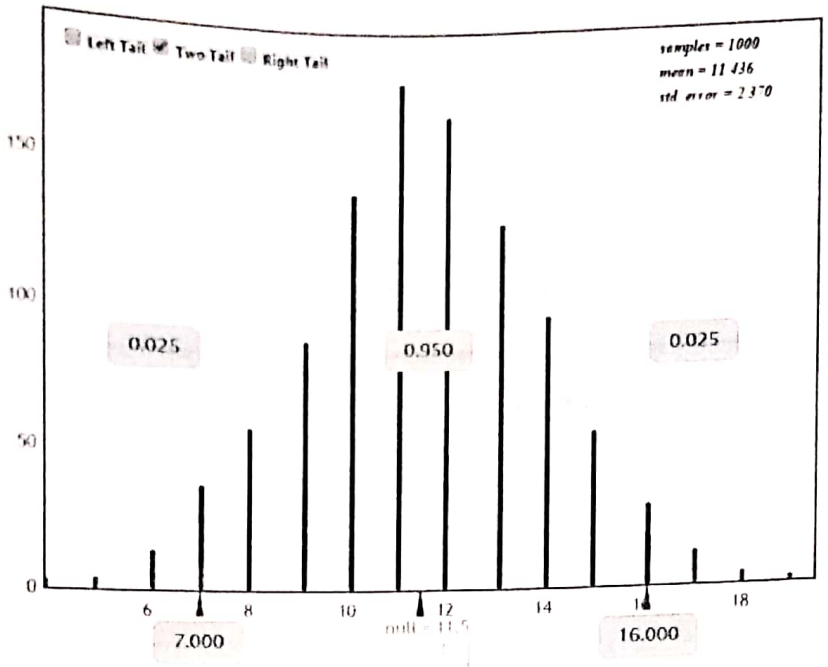
Research Question: Does type of feeding (i.e. breast or bottle) affect the presence of fluid in the middle ear?

Does it matter → Both sides matter (2 sided analysis)

Set up a simulation study to investigate the situation for which there is no difference between the bottle-fed and breast-fed babies. In your simulation, you should track the number of breast-fed pairs. Specify the setup using the number line below for the evaluation of this research question.

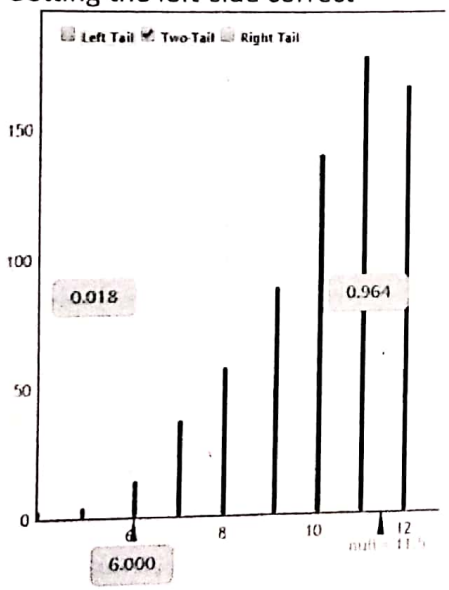


The outcomes of the simulation study in StatKey is provided here.

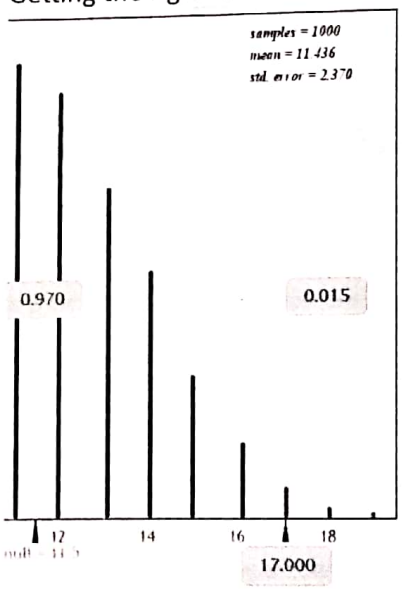


Getting a cutoff value on the left and right side using StatKey.

Getting the left-side correct



Getting the right-side correct



Questions

4. What would it mean in the context of this problem, if the outcome from our sample was at the smallest possible value on our graph?

   Bottle fed had shorter ear infections

5. What would it mean in the context of this problem, if the outcome from our sample was at the largest possible value on our graph?

   Breast fed had shorter ear infections

6. Is the outcome from our sample (i.e. 16 pairs for which breast-fed doing better) an outlier? Discuss.

   No. 17 and above, or 6 and below are outliers.

7. For this example, we will have two cutoff values. The reason we have two cutoff values is because the original question asked if there was a simply a difference (i.e. no preference to bottle-fed or breast-fed was given).

   - Upper cutoff value: 17
   - Lower cutoff value: 6

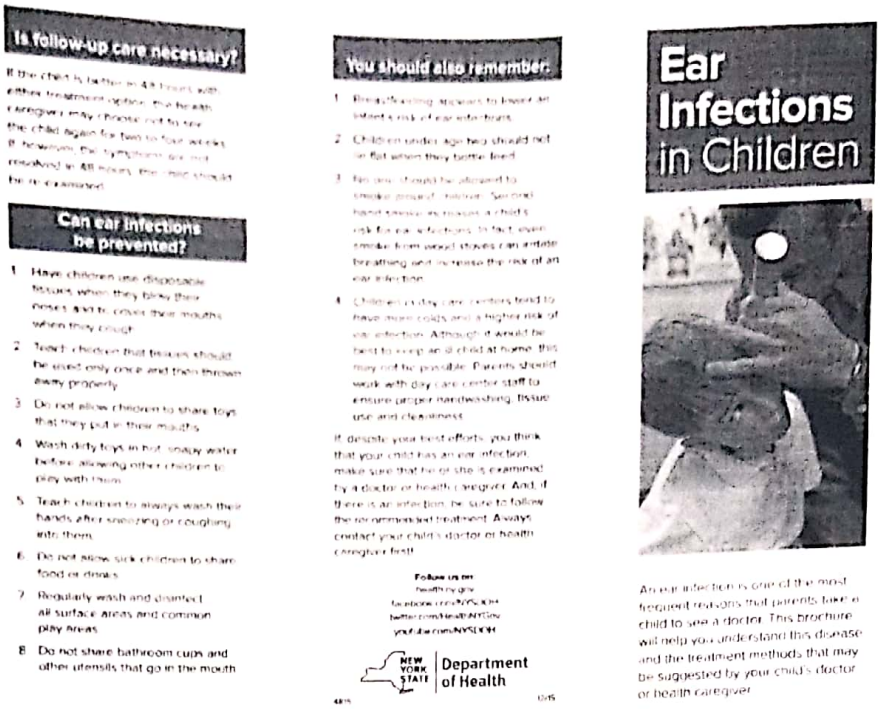
8. Does the observed outcome from our sample provide enough *statistical* evidence to suggest breast or bottle fed babies have a lower duration of fluid in their inner ear? Explain.

   Nope.

Handout #3: More Examples of 2-AFC

Consider the following pamphlet on Ear Infections in Children from the Department of Health from the State of New York.

Link to Pamphlet: https://www.health.ny.gov/publications/4815.pdf



Is follow-up care necessary?

If the child is better in 48 hours with either treatment option, the health caregiver may choose not to see the child again for two to four weeks. If, however, the symptoms are not resolved in 48 hours, the child should be re-examined.

Can ear infections be prevented?

1. Have children use disposable tissues when they blow their noses and to cover their mouths when they cough.
2. Teach children that tissues should be used only once and then thrown away properly.
3. Do not allow children to share toys that they put in their mouths.
4. Wash dirty toys in hot, soapy water before allowing other children to play with them.
5. Teach children to always wash their hands after sneezing or coughing into them.
6. Do not allow sick children to share food or drinks.
7. Regularly wash and disinfect all surface areas and common play areas.
8. Do not share bathroom cups and other utensils that go in the mouth.

You should also remember:

1. Breastfeeding appears to lower an infant's risk of ear infections.
2. Children under age two should not be fed when they bottle-feed.
3. No one should be allowed to smoke around children. Second-hand smoke is known to increase a child's risk for ear infections. In fact, even smoke from wood stoves can irritate breathing and increase the risk of an ear infection.
4. Children in day care centers tend to have more colds and a higher risk of ear infection. Although it would be best to keep an ill child at home, this may not be possible. Parents should work with day care center staff to ensure proper handwashing, tissue use and cleanliness.

If, despite your best efforts, you think that your child has an ear infection, make sure that he or she is examined by a doctor or health caregiver. And, if there is an infection, be sure to follow the recommended treatment. Always contact your child's doctor or health caregiver first!

Follow us on:
healthy.ny.gov
facebook.com/NYSDOH
twitter.com/HealthNYGov
youtube.com/NYSDOH

NEW YORK STATE | Department of Health

4815 0/15

Ear Infections in Children

An ear infection is one of the most frequent reasons that parents take a child to see a doctor. This brochure will help you understand this disease and the treatment methods that may be suggested by your child's doctor or health caregiver.

Consider the following information provided under the You should also remember: section of this pamphlet.

You should also remember:

1. Breastfeeding appears to lower an infant's risk of ear infections.

Questions

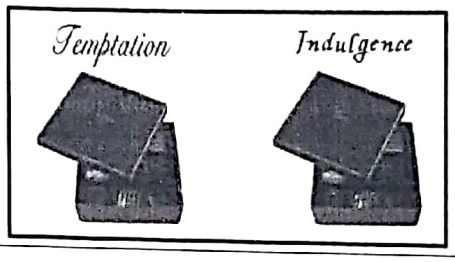
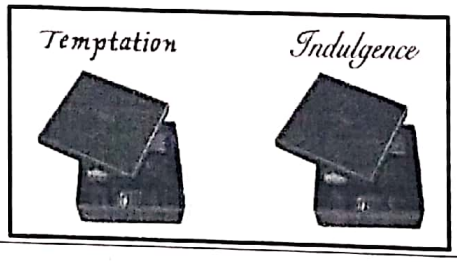
9. Does the analysis completed here agree with this statement?

10. Would the following statement be appropriate, "Breastfeeding lowers an infant's risk of ear infection." Why or why not?

Example 3.4: Doyle (2002) studied the effect of font type on a brand's identity and its ability to build the market share of a product. Past research has established the importance of font type in consumer choice. Doyle conducted a small field study involving 40 people in which individuals were asked to select between two boxes of chocolates that were presented to them on a blue tray. To alleviate the potential effect of name recognition on consumer choice, fictitious names were used to identify the two brands – Temptation and Indulgence. Two different font types were compared in this study – Signet and Salem. A total of 30 people (out of the 40) selected the chocolate associated with the Signet font type.

Name of Chocolates	Font Style	
	Signet	Salem
Temptation	*Temptation*	Temptation
Indulgence	*Indulgence*	Indulgence

To alleviate the possible effect of name on the selection, one-half of the people were presented the Temptation brand using Signet font and the other half were presented the Temptation brand using the Salem font.

½ of the people were presented a tray like this	
The other ½ were presented a tray like this	

Source: Doyle, J.R. and Bottomley, P.A (2002). "*Font Appropriateness and Brand Choice*", Journal of Business Research. Vol. 57, Issue 8, pp873-880.

Questions:

1. In the above pictures, the Temptation brand is shown on always shown on the left side of the tray. A statistician might argue that such a setup might introduce bias in this study. Explain why this might be the case?

People may have a left/right inclination that may cause confounding

2. How could the potential bias due to the placement (left vs. right) be overcome in this study? Explain.

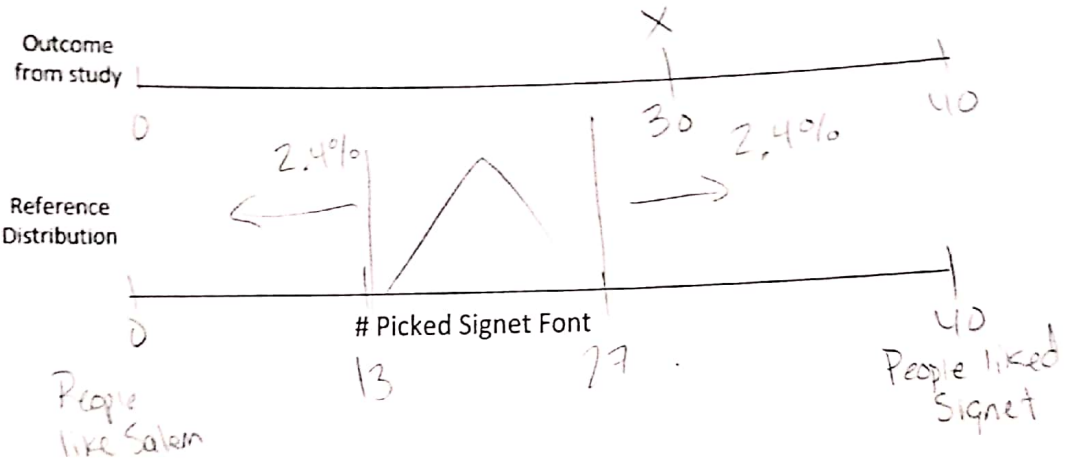
Include additional trays that switch the left/right order such that all 4 types of trays are equally offered.

3. Why did the researchers present ½ the people with Temptation using Signet font type and the other half with the Salem font type? In particular, what issues might arise if all participants were presented the Temptation brand using the Signet font type and the Indulgence brand using the Salem font type? Explain.

To prevent confounding. Mix up the font word/combo so that we know whether it was the font or the word that influenced the choice

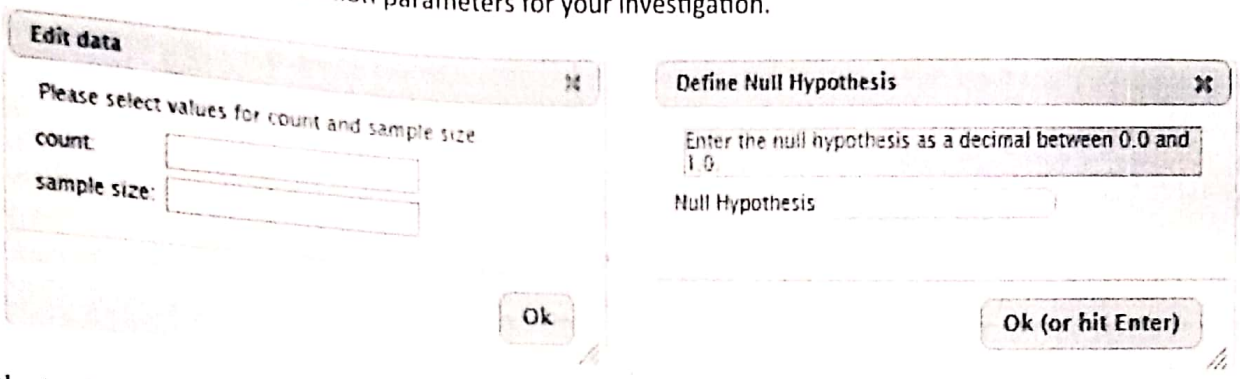
Research Question: Is there a difference in the preference of the Signet font type and the Salem font type in consumer choice of chocolates?

Specify the setup using the number line below for the evaluation of this research question.

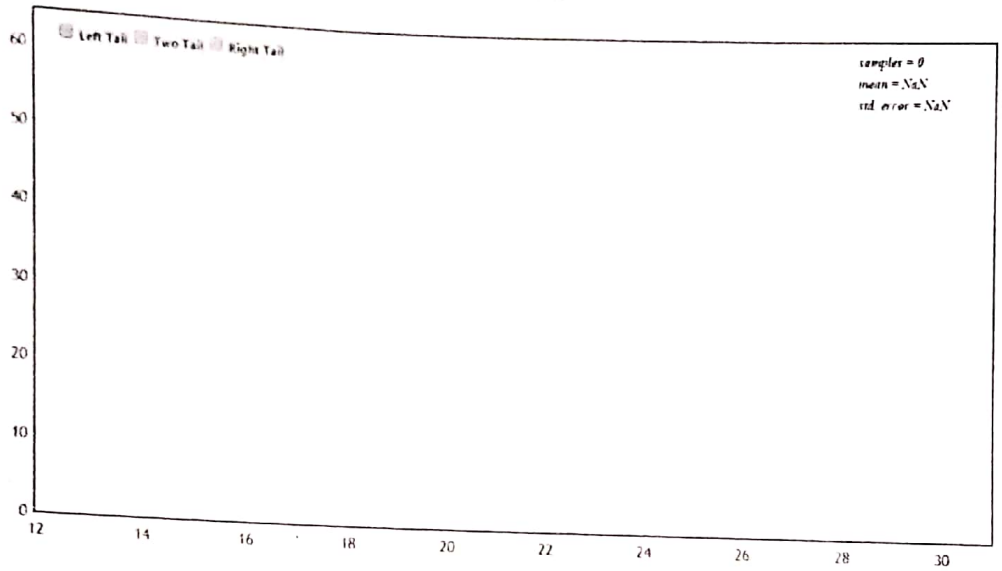


30 is an outlier so yes the font matters

Identify the following simulation parameters for your investigation.



Next, plot the outcomes from your repeated iterations.



13. What are the reasonable cutoffs for this investigation? That is, what values would indicate a preference for one font over the other?

Lower Cutoff: 13

Upper Cutoff: 27

14. The number of people that picked the Signet font was 30. Is this enough statistical evidence to support the research question?

Yes

STAT 210: Statistics
Handout #3: More Examples of 2-AFC

A little something extra...

Doyle (2002) makes the following statement in his paper.

> "One interesting finding is that, in both the main experiments and the pretests, we consistently found no interaction of gender with font. In particular, women do not prefer lighter, more scripted, scrolled (i.e. so-called "feminine") fonts (such as Signet). This equality between the sexes certainly should make life easier for the company that would use a font to project its brand(s) in mixed-gender markets."

Doyle does mention in this paper that 21 of the 40 participants were women and 19 were men. From above we know 30 of the 40 choose the Signet font and the remaining 10 choose the Salem font. The following table gives some structure to such outcomes. This is referred to as a **2-by-2 contingency table** or a 2x2 cross-tab table.

	Font Type		
Gender	Signet	Salem	Total
Female			21
Male			19
Total	30	10	40

Unfortunately, the authors did not present the actual numbers required to complete this table (e.g. we just know 30 people selected Signet, 21 were female, 19 were male). Below, I have created two fictitious tables – Table A and B.

Table A			
	Font Type		
Gender	Signet	Salem	Total
Female	16	5	21
Male	14	5	19
Total	30	10	40

Table B			
	Font Type		
Gender	Signet	Salem	Total
Female	21	0	21
Male	9	10	19
Total	30	10	40

Questions

1. In Table A, what proportion of the Females selected the Signet font?

   16/21

2. In Table, A, what proportion of the Males selected the Signet font?

   14/19

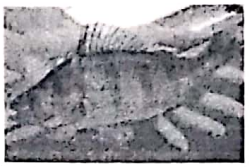
3. What proportion of Females selected the Signet font in Table B? What proportion of Males selected the Signet font in Table B? 21/21 , 9/19

4. Consider the following statement presented in their paper, "..., we consistently found no interaction of gender with font." Which table, A or B, most likely represents the outcomes from this study? Explain your reasoning?

   Table A. If gender truely had no influence over the choices I would expect the proportions mentioned above to be the same between genders. Table A has closer proportions than table B.

Example 3.5 Delwiche and Liggett (2004) conducted a study regarding potential differences and preference for wild-caught vs. cultured yellow perch. Judges (n=52) completed 2 replications each of both a paired preference and a triangle test. A **triangle test** is a type of discrimination test that is commonly used in sensory analysis (e.g. taste test) to determine whether or not there is a detectable difference among two or more items.

Source: Delwiche, J.F. and Liggett, R.E. (2004). "Sensory Preference and Discrimination of Wild-caught and Cultured Yellow Perch". Journal of Food Science, Vol. 69, Nr. 4.

Type	Can you tell the difference?
Wild-caught	
Cultured	

In a triangle test, a judge is presented with three plates and they need to identify the two that "match".

Plate 1 
Plate 2 
Plate 3 

1, 2
1, 3
2, 3

For example, suppose Plate 1 was Wild-caught, Plate 2 was Cultured, and Plate 3 was Cultured. If the judge correctly identifies Plate 2 and 3 as a "match", then the outcome from this judge would be correct. The triangle test was preformed twice on each of the 52 judges. Below is a snip-it of a mock-up of the data from this study.

	A	B	C
1	Judge	Replicate 1	Replicate 2
2	1	Correct	Correct
3	2	Incorrect	Incorrect
4	3	Correct	Correct
5	4	Correct	Incorrect
6	5	Incorrect	Incorrect
7	6	Incorrect	Incorrect
8	7	Correct	Correct
9	8	Incorrect	Incorrect
10	9	Correct	Correct
11	10	Correct	Correct
12	11	Correct	Correct
13	12	Correct	Incorrect
14	13	Correct	Correct

Handout #3: More Examples of 2-AFC

Research Question: Is there enough evidence to say there is a difference in taste between the wild-caught and cultured perch when a triangle discrimination test is used?

The following table includes a summary of the study outcomes presented above. There were a total of 52 judges and each completed two replicates of the triangle test.

Study Outcome	Replicate 1	Replicate 2	Total
Correct	26	27	53
Incorrect	26	25	51
Total	52	52	104

1,2
1,3
2,3
Chance of correct when no taste difference is 33.3%

Questions

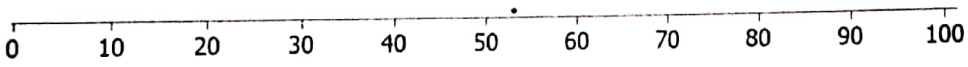
1. How many judges correctly identified the "match" on the first replicate? How about the 2nd replicate?

   26 1st time 27 2nd time

2. Your friend makes the following statement, "Your data is wrong, you cannot have 53 correct "matches" when there are only 52 judges." Why is this statement incorrect? Explain.

   Because each judge did it twice giving us a total of 104 sample done by 52 judges. "53 correct" meant $\frac{53}{104}$ correct

3. Your friend makes the following false statement, "When information from both replicates is combined (i.e. 104 total), we can see that only about half (i.e. 53) of the judges correctly identified the "match"; thus, we lack evidence to say these judges can tell a difference." This statement is false because a triangle test is *not* a 50/50 scenario. What value should your friend be comparing 53 against? Explain.



Identify the parameters for a simulation that would allow you to answer the above research question.