**Solutions to Exploration 5.2**

1. a. A control group is necessary because this helps us account for the fact that some people will yawn even without the "yawn seed"

   b. To control for confounding variables; to be able to conclude that the yawn seed is what "caused" the different in yawning percent

   c. Randomized experiment. The researchers randomly assigned the treatment (yawn seed or no yawn seed)

   d. No, this is not a paired study design.

   e. No, probably just got volunteers. To do a random sample they would have to, for example, make a list of all the people at the flea market and randomly choose some.

2. Explanatory (yawn seed=yes/no), Response (patron yawned=yes/no); both variables are categorical

3. Yawning is not contagious (null), Yawning is contagious (alt)

4.

	Yawn seed planted	Yawn seed not planted	Total
Subject yawned	11	3	14
Subject did not yawn	23	13	36
Total	34	16	50

5. Proportion who yawned in treatment group: 11/34=32.4%; proportion who yawned in control group: 3/16=18.8%. Difference is 32.4%-18.8%=13.6%

6.
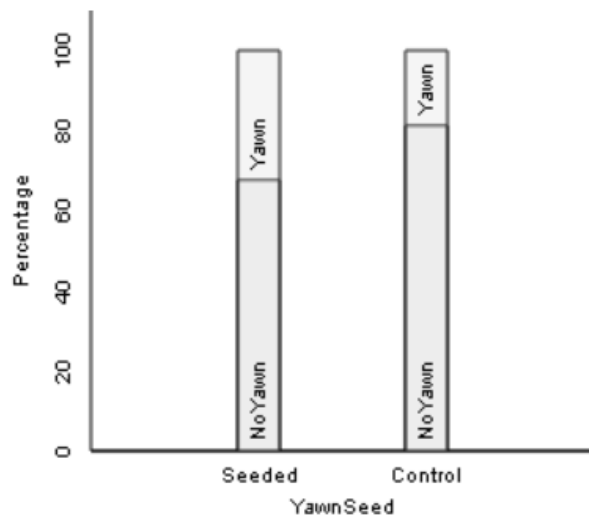
7. a. Yes. b. Possibly, but the difference in proportions is not very large

8. The difference occurred by chance (yawn seed doesn't matter), or the difference did not occur by chance (yawn seed does matter)

9. (NOTE: ANSWERS WILL VARY)

	Yawn seed planted	Yawn seed not planted	Total
Subject yawned	10	4	14
Subject did not yawn	24	12	36
Total	34	16	50

b. 10/34=29.4%, 4/16=25%, differences is 29.4%-25%=4.4%

c. No, it's smaller

10. We would like to get a general sense of common and not so common occurrences ---we cannot get a sense of the long-run distribution with only one repetition of the simulation.

11. a. (answer similar to 9b)

    b. (answer similar to 9b). No, most likely you got a different statistic this time.

    c. Same pattern, spacing changes a bit.

12. a. Each dot is coming from one of the 1000 simulations. The word "Simulation" is a good one to fill in the blank . Could also fill in with a difference in simulated proportions

13. a. Yes. The null hypothesis suggests that the difference in proportions will be zero.

    b. No, 0.136 is not out in the tail of the distribution. 0.136 is a typical result.

    c. 0.136 or more (larger)

    d. 0.254 is the approximate p-value (answers will vary)

    e. Under the assumption that yawning is not contagious, if we repeated the shuffling/dealing many, many times, the probability we would obtain results as or more extreme than 0.136 is 0.254.

    f. No, the Mythbusters' result does not provide much evidence that yawning is contagious.

14. 10/34=29.4%, 4/16=25%, differences is 29.4%-25%=4.4%

15. Smaller, larger, weaker. A smaller difference in proportions is closer to zero, the center of the null distribution, so the p-value (proportion of simulated statistics as extreme) will be larger, larger p-values offer weaker evidence against the null.

16. Approximate p-value= 0.5192, this p-value provides very weak evidence against the null and we can conclude it is plausible that yawning is not contagious.

17. No, while it is true that a higher proportion (29%) of people yawned when viewing the yawn "seed" than compared to the proportion of yawners without a yawn seed (25%), the difference (4.4%) is very small and happens quite easily just by random chance. The simulation we conducted helped to quantify that a difference like 4.4% (or larger0 happens about 50% of the time just by chance (even when yawning is NOT contagious)

18. Yes, because it is a randomized experiment

19. It's not a random sample, so, generalizing the result very much is not a great idea. We're not even sure if the people in the study are a good representation of people at the flea market since the participants in the study may be systematically different than the people not in the study.

20. The two conclusions are not the same because (i) suggests that we've proven yawning is not contagious while (ii) suggests that our study didn't prove yawning was contagious. (ii) is the more appropriate conclusion

21. Connecting a random sample of people (for example, randomly choosing people and going door to door) would improve our ability to generalize to a larger population. A bigger sample size is likely needed. Plus, we need to be sure that the yawn seed is both realistic (not obviously fake), noticed by the respondents and that adequate time is given to see if the person yawns. Asking participants if they "felt like they had to yawn" (if they didn't yawn) might also be interesting, since many people might be stifling the yawn to be polite.

22. a. same, b. smaller, c. stronger, d. Fail to Reject null

23. p-value=0.187. Weak evidence against the null at the 0.05 significance level.

24. We now have stronger evidence that yawning is contagious but the evidence is not very strong at all.

25. a. The difference in the long-run probability of yawning based on whether or not someone observed a yawn 'seed' b. 0.044.

26. a. 0.136, b. 0.044 ± 0.272, (-0.228,0.316), c. both positive and negative values, d. Since 0 is in the interval, 0 is a plausible value for the difference in proportions, which does not provide evidence of a difference in the proportions