Research Methods: The Monty Hall Problem

The purpose of this lab is to use an experiment to help answer a question. The lab centers on the Monty Hall problem, which is actually an old problem in a new guise. The problem appeared a few years ago in the "Ask Marilyn" column of *Parade Magazine*, a column by Marilyn vos Savant, who claims to have the "world's highest IQ." The solution given to the problem generated considerable controversy, and vos Savant noted that she received thousands of letters, some from Ph.D.'s in mathematics, insisting that she was wrong. The problem has since received attention in articles in several newspapers, magazines and journals.

The problem is basically a scenario from the game show, *Let's Make a Deal*, which was hosted by Monty Hall. Participants on the show were offered a prize behind one of three curtains. Behind one of the curtains was a valuable prize and behind the other two were junk prizes. The contestants chose one curtain; before it was opened, Monty Hall would open another curtain that was hiding a junk prize. He would then give the contestant the opportunity to change their pick. The question is, "Are you better off staying, switching, or doesn't it matter?" What do you think? Should the contestant stay, switch, or doesn't it matter?

Rather than simply being told the solution to the problem, which many people refuse to believe anyway, we will perform a simple "experiment" with cards, as was suggested by vos Savant in her column. In one condition, we will simulate staying, that is, not changing the curtain picked. In the other condition, we will simulate switching, that is, changing the curtain picked; thus, the Monty Hall problem. The next step is to design the experiment.

Method

Students will form pairs in order to play a simple game with three cards. Two of the cards are black, and represent the junk prizes, and the third card is red, and represents the car, or the valuable prize. One student will assume the role of the game show host, Monty Hall (the dealer), and the other student will be the contestant. You will then play 30 hands in each of two conditions, for a total of 60 trials. In the first condition of 30 trials, the player will stay with their original choice every time, and in the second condition of the next 30 trials, they will switch their original choice every time. Your instructor will tell you which conditions --stay or switch-- to start with.

On each turn, the dealer shuffles the three cards and places them face down on the table. The dealer should look at each card before placing it on the table, so that he or she knows where the red card is. The player will then use one of two strategies, stay or switch, depending on the condition. For the stay condition, the player simply chooses a card, and then the dealer turns over one of the black cards, and then reveals the player's choice. The dealer then records the outcome of each trial on the data sheet: a win (player chooses the red card) or a loss (player chooses a black card). For the switch condition, the player chooses a card, the dealer turns over one of the black cards, and then the player switches to the other card, which the dealer then reveals. Again, record the outcome on the data sheet.

Results

At the end of the experiment, the raw data consists of the outcome of each trial, a win or a loss. For each condition, stay or switch, you should add up the number of wins and the number of losses separately; this allows a check of your work, because if the wins and losses do not add up to the total number of trials (30), then you have made an error. You should record all of your frequencies in the table below.

		Outcome		
		# Wins	# Losses	
Strategy	Stay	a	b	n_1
	Switch	c	d	n_2
		c_1	c_2	

This table shows the frequency of wins and losses for the stay and switch conditions. Assuming the frequencies of wins and losses are different in the two conditions, are these differences real, or due to chance? Inferential statistics allows us to calculate the probability of whether or not you got this difference by chance. If chance is an unlikely explanation, that is, if the probability you got this outcome is less than 1 in 20, we conclude it did not occur by chance. The only other explanation is the difference between conditions, that is, staying and switching produce different frequencies of wins. To obtain the probability, calculate the Chi-Square statistic, which uses the following formula:

$$chi^2 = \frac{N * (a*d - b*c)^2}{n_1 * n_2 * c_1 * c_2}$$

N= total # of all stay and switch trials (a+b+c+d) = ________

use comput

n_1= # of trials in stay condition (a+b) = ________

n_2 = # of trials in switch condition (c+d) = ________

c_1 = # of wins in both conditions (a+c) = ________

c_2 = # of losses in both conditions (b+d) = ________

Next, calculate the proportion of wins by dividing the number of wins in each condition by the number of trials for that condition. So, the data are the proportion of wins in the stay condition, which is a/n_1, and the proportion of wins in the switch condition, which is c/n_2. When Chi^2 is equal to or greater than 3.84, that means that there is less than a 1 in 20 likelihood the proportions are due to chance. This value, 3.84, is called the critical value. So a value equal to or larger than 3.84 indicates that the proportion of wins differs across the two strategies.

Discussion

Which strategy did this experiment indicate was best? Did the results of the experiment cause you to change your mind about which was the best strategy? Why did or didn't you change your mind? What does the result of the experiment suggest regarding accepting common sense? Or a good sounding theory? The instructor will provide explanations of the problem, which can be discussed by the class.

With respect to psychological research, a variation on the problem has recently been used to examine cognitive dissonance (Gilovich, Medvec, & Chen, 1995).

References

Gilovich, T., Medvec, V., & Chen, S. (1995). Commissions, omissions, and dissonance reduction: Coping with regret in the "Monty Hall" problem. *Personality and Social Psychology Bulletin*, 21, 182-190.

vos Savant, M. (1990a). "Ask Marilyn," *Parade Magazine,* September 9, p. 15.

vos Savant, M. (1990b). "Ask Marilyn," *Parade Magazine,* December 2, p. 25.

vos Savant, M. (1990c). "Ask Marilyn," *Parade Magazine,* February 17, p.15.

Data Sheet: Monty Hall Problem

Name ______________________ Section __________

Record W for wins and L for losses

stay			shift	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
21			21	
22			22	
23			23	
24			24	
25			25	
26			26	
27			27	
28			28	
29			29	
30			30	
# right = a			# right = c	
# wrong = b			# wrong = d	

a/n_1 = ________ c/n_2 = ________ chi^2 = ________

Is your computed chi^2 equal to or greater than 3.84? _______

What does this tell us about the results of the experiment?