A Classroom Activity Using a Virtual Memory Tray: Does Walking Through a Doorway Lead to Memory Loss?

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Abstract

Participants in a common party game view a tray of items for a brief amount of time. Then the tray is covered and participants try to recall as many of the items as they can. In the classroom, we have used a virtual memory tray to investigate whether the act of walking through a doorway may lead to memory loss, as has been claimed by some actual studies. The activity has been used in many different classes, ranging from freshman Stats classes to a graduate course in Experimental Design. The basic form of the activity can be used to illustrate comparative box plots and either the two-sample t-test or one-way ANOVA. An additional factor may be added in order to illustrate two-way ANOVA and the concept of interaction. In this paper a virtual memory tray will be presented, along with suggestions for its use and some summaries of classroom data.

Key words: classroom activity, memory, two-way ANOVA

1. Introduction

For the past 10 years I have been doing variations on the activity described here in various courses ranging from freshman level introductory statistics to a graduate course in Experimental Design. The idea for the activity came from a combination of discussions with a colleague who had tried using a memory tray in class and a news report claiming that walking through a doorway leads to memory loss.

My colleague, Justin Kimmel, had previously tried using an actual physical memory tray as a simple and entertaining data-gathering activity. This is a common party game where a number of items are placed on a tray. Participants are given a limited amount of time to study the tray in an attempt to remember as many of the items as possible. After the time limit is reached the tray is covered up or removed from sight and each participant compiles a list of a many items that he or she can remember. Whoever recalls the most items is the winner. However, a limitation to the use of an actual physical memory tray in the classroom is that it is difficult for all students in a large class to see the items. We agreed that a better approach would be to create a virtual memory tray by putting pictures of items on a slide and projecting the virtual tray to the class.

Around that time, many news outlets presented summaries of the paper, "Walking through doorways causes forgetting," by Radvansky and Copeland (2006). A subsequent article by Radvansky, Krawietz, and Tamplin (2011) supported the prior research results and generated another round of reports in the news media. Although Radvansky et al, used more sophisticated methods to assess memory loss, the memory tray approach has proven to be an effective way to both engage the students and obtain a meaningful response variable. The basic idea is to have the students view a virtual tray containing 30 items for 30 seconds and then remove the tray. Students are either assigned to remain in the classroom or to leave through the doorway and then return to their seats. At this time all

students attempt to recall as many of the items as they can. Their score – the number of items correctly recalled – is used as the response variable.

In this paper, I will first provide details for a basic implementation of the activity. Different variations on the activity will then be presented, along with some of the results. The variations that have been tried in the classroom include three-group designs, block designs, and designs with two treatment factors. Results have consistently been that those who walk through the doorway average slightly fewer recalled items than those who remain in the room.

2. Implementation of the Basic Activity

The simplest version of this activity is to form two groups, with students assigned at random to the groups. Random assignment can be done using computer software such as Minitab or StatCrunch, or by dealing cards. To do this in Minitab Version 17, list the names of the students present in class in one column. In a second column, labeled "Group", assign the value "Door" to the first half of the class and "Stay" to the remaining students. Then go to Calc > Random Data > Sample from Columns. In the Number of Rows box, put the number of students in the class. In the both the "From Columns" and "Store Samples" boxes insert "Group". This will result in shuffling the Group assignments randomly among the students. To accomplish this in StatCrunch, go to Data > Sample Columns. Enter "Group" in the select columns box, type in the sample size, and select Compute.

Alternatively, the instructor can deal one card to each student from a deck (or decks) with cards removed so that the number of cards equals the class size and that half of the cards are red. Students who get a red card are assigned to walk through the doorway; those with a black card remain in the room. (Do not randomize by flipping coins or the equivalent, as this will not necessarily result in equal-sized groups.) After the students have been assigned to groups, the virtual memory tray can be shown to the class for a set amount of time. I generally allow 30 seconds for viewing the tray. The tray I use consists of 30 drawings and pictures gleaned from the internet. Many of the items are things that I typically have in my office (Figure 1).

During and immediately after viewing, students are not permitted to write anything down. All students must wait until those who have walked out the door have returned. Those who are assigned to walk through the door are asked to stay outside for about a minute. Once those students are back in their seats, I give the class one minute to write down as many of the tray items as they can remember. The students then tally up the number of items they got correct and report their scores. To facilitate this process, I usually provide a scoring sheet, as shown in Figure 2. To be counted as correct, just the basic genre needs to be listed, not specific details. For example, for the cup of Starbucks coffee, "coffee" would suffice. Also, we just ignore any items on the students' lists which were not actually on the tray.

Once the scores have been determined, the next step depends on what material has been covered thus far in the class. For example, if an introductory stats class is currently in the descriptive statistics portion of the course, the class could compute descriptive statistics for each group and make appropriate graphs. The raw scores for each group could be given to the students, who then determine each group's five-number summary and construct

comparative box plots. If the class has covered the two-sample t-test, then, in addition to the box plots, the test can be performed. Students can analyze the data themselves using software or hand-calculators, depending on the course. I find that the students are keenly interested in the results, so, unless the class is really large, I usually enter the data into software immediately and show the results. For large classes, this would take too much class time, so I enter the data after class and show results at the next class meeting.

Figure 1: Virtual Memory Tray

3. Results

Every time I have done the activity, which is about 20 times in 10 years, those who went through the doorway averaged fewer recalled tray items than those who stayed in the room. In each case the difference was small, ranging from around .5 to 3 items fewer. For the data in any given class, the difference was not found to be statistically significant with a two-tailed two-sample t-test. (The data tend to be roughly symmetric for each treatment group with no severe outliers, so the t-test would seem to be valid.)

The last four times I did the activity in our most elementary level stats classes we used the same basic implementation protocol described previously. Three of these classes were conducted in recent summer sessions and one was an evening class. (The enrollments were considerably smaller than our usual daytime classes, which are mostly in the 60-80 student range.) Figure 3 shows Minitab output using the combined data for these four classes. Those who walked through the door averaged 2.0 fewer recalled items than those who remained in the room. The difference was found to be statistically significant with the 2-tailed 2-sample t-test. So the results support the existence of the "Doorway Effect."

MEMORY TRAY SCORE SHEET

Check each of the items that are on your list, and total the number you got correct.

Name _____   Group _____   Score _____

1	Band-aid	
2	Paper clip	
3	Keys	
4	Zippy bobblehead	
5	Starbucks coffee	
6	Exp Design book	
7	Spider	
8	Coke can	
9	Flashlight	
10	Cookie	
11	Tennis ball	
12	Sticky notes	
13	Socks	
14	Flash drive	
15	Ball hat	

16	Toothpaste	
17	Dog treat	
18	Pencil	
19	Orchid	
20	Pizza slice	
21	Umbrella	
22	iPhone	
23	Dice	
24	Sunglasses	
25	Deodorant	
26	Penny	
27	Advil	
28	Banana	
29	Screwdriver	
30	Speakers	

Figure 2: Scoring sheet

Using Combined Data from Four Classes
C = Control Group (stay in room)
E = Experimental Group (exits through door)

Two-sample T for Score

Group	N	Mean	StDev	SE Mean
C	24	13.88	3.31	0.68
E	26	11.88	3.41	0.67

Difference = $\mu(C) - \mu(E)$
Estimate for difference: 1.990
95% CI for difference: (0.077, 3.904)
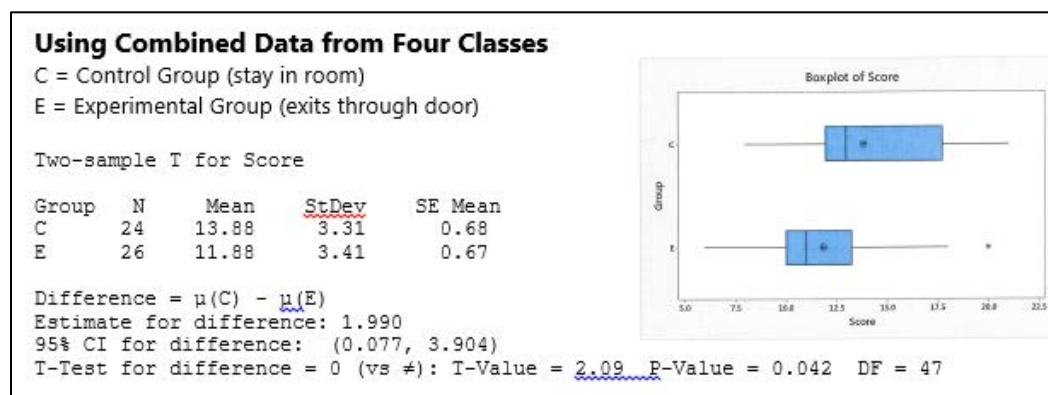T-Test for difference = 0 (vs ≠): T-Value = 2.09 P-Value = 0.042 DF = 47

Figure 3: Combined results from four elementary statistics classes

4. Variations

4.1 One-way ANOVA

One variation that I have tried several times has been to add a third group to the experiment. Students assigned to this third treatment group leave their seats and walk around, but

remain inside the room. In this way, we can resolve a potential confounding issue associated with the basic version of the activity. Specifically, the factor "door vs. no door" is confounded with the factor "sitting vs. walking." Thus, an apparent memory loss for those who walk through the door could possibly be attributed to walking as opposed to sitting. This problem is avoided by adding a group of "walker-stayers." Comparative box plots can be made to summarize the results of the three groups, and a one-way ANOVA can be carried out. Of course, the latter makes sense only if ANOVA has been covered in class. Thus, I have not implemented this variation in our most basic introductory courses. We do have two 4-credit undergraduate courses (one geared toward Engineering majors and the other by biology/pre-med majors) where ANOVA is covered and where this activity has fit very well.

4.2 Two-way ANOVA

Another variation, and the one which I have most often used in upper level and graduate classes, is to include a second treatment factor. For the second factor I initially varied the amount of time the students were given to view the tray – 20 seconds or 30 seconds. More recently, the second factor has been to have the students either close their eyes after viewing the tray or to keep their eyes open. The idea from this came from a study which purported to show that closing one's eyes improves the memory ability of witnesses to crimes (Nash, Nash, Morris, and Smith, 2015). By adding this second factor we now have a 2x2 factorial experiment with four treatment groups. Software can be used to randomize the students to these four groups (Door/Closed Eyes, Door/Open Eyes, Stay/Closed Eyes, Stay/Open Eyes). Alternatively, a card can be dealt to each student, with each suit corresponding to one of the four treatment groups. The resulting data are analyzed using 2-way ANOVA. I have done the experiment in this way with an upper level 4-credit course in applied stats geared toward engineering majors and with a graduate course in Experimental Design.

Figure 4 shows StatCrunch output for a recent 2-factor experiment conducted in an upper level course geared toward Engineering students. For this class the main effect for the door/stay factor was statistically significant, with those going through the doorway averaging 3 fewer items recalled than those who stayed in the room (12.7 items vs. 15.7 items). Those who closed their eyes recalled on average almost one more item than students who kept their eyes open, but the main effect for this factor was not significant. The interaction between the eyes open/closed factor and the door/stay factor is nearly zero and not statistically significant. This is observed by the virtually parallel pattern seen in the interaction plot.

4.3 Blocking

The final variation that I have tried thus far is to use a generalized randomized block design (Addelman, 1969). One semester the makeup of my Experimental Design class was 50% Engineering majors and 50% Statistics majors. So we randomly assigned half of the Engineers to the Door treatment and half to Stay; likewise for the Stats majors. (The students voted to include this factor so as to make it a contest between the Stats and Engineering majors. The resulting data were analyzed using a 2-way ANOVA, but as usual, neither of the main effects nor the interaction were statistically significant.

A more appropriate use of blocking for this situation would be to attempt to account for variation in the individual memory capabilities of the students. By not accounting for this

and using a completely randomized design, the within-group variation will be inflated, lowering the power of the test to compare the treatments. In my Experimental Design class we have used this as an example of the need for blocking and have had discussions of ways to block for individual memory differences. One possibility would be to have all students do a pre-test with a different memory tray. Then the four students with the highest pre-scores can be one block, those with the next four highest pre-scores would be another block, etc. The four students in any given block would be randomly assigned to the four treatment combinations: Door/Eyes closed, Door/Eyes open, Stay/Eyes closed, Stay/Eyes open. To date I haven't implemented this approach in class, but plan to do so the next time I teach the Experimental Design course.
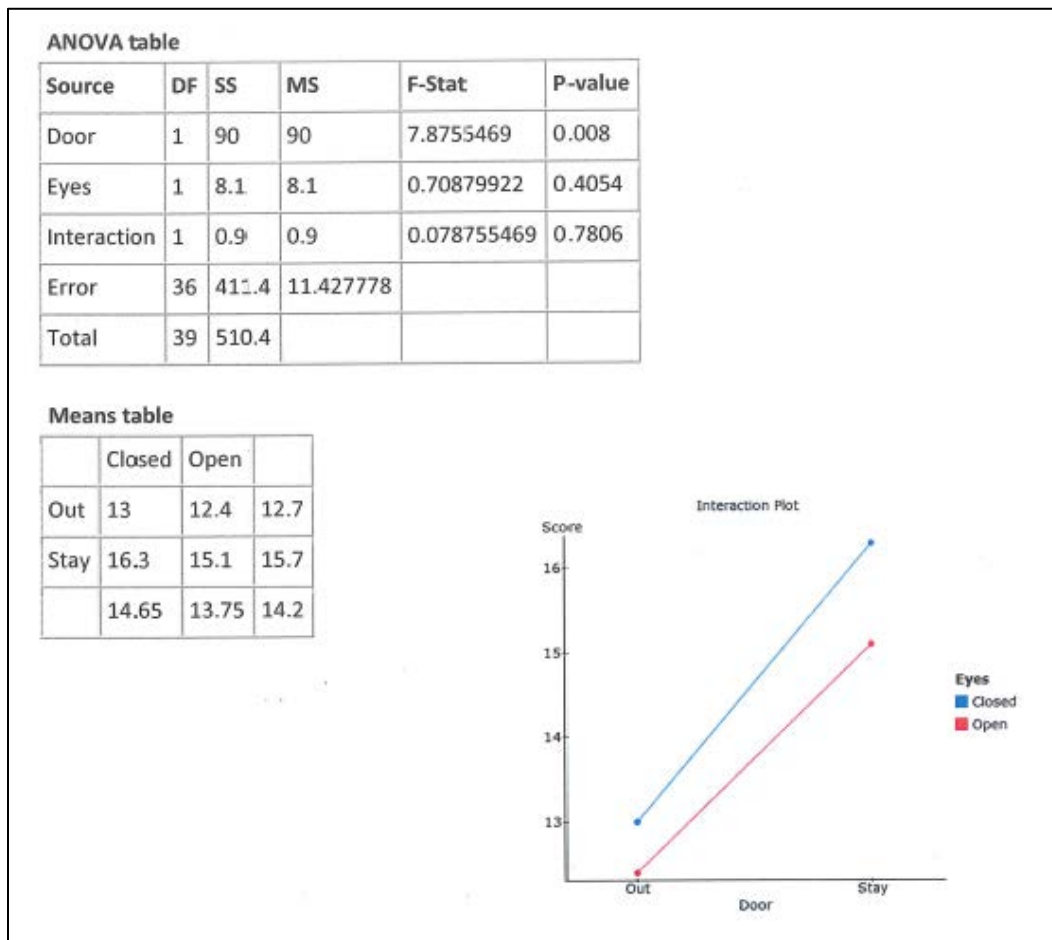
ANOVA table

Source	DF	SS	MS	F-Stat	P-value
Door	1	90	90	7.8755469	0.008
Eyes	1	8.1	8.1	0.70879922	0.4054
Interaction	1	0.9	0.9	0.078755469	0.7806
Error	36	411.4	11.427778		
Total	39	510.4			

Means table

	Closed	Open	
Out	13	12.4	12.7
Stay	16.3	15.1	15.7
	14.65	13.75	14.2

Figure 4: Results of an implementation of a 2-factor memory experiment

5. Summary

The virtual memory tray has been a fun activity for both my students and myself. It can be tailored to a variety of classroom settings, from introductory to graduate classes. An instructor can create his or her own tray fairly easily. Putting 30 items on the tray and allowing 30 seconds of viewing time seems about right. Scores tend to fall in the 10-20

range, so this is neither too easy nor too hard. (The data would not be very interesting if it is so easy that everyone scores 100%.)

Most stats courses have at least a small unit related to experimental studies, so this activity provides an example of this, as well as a break from focusing on survey data. Finally, Sowey (1995) issued a call to teachers of statistics to "make it memorable." This memory tray activity is one which literally achieves that goal.

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