

1a. First of all, imagine a repeated measures design with seven levels. Can you tell me *why* you'd need to counterbalance such a design and what kind of counterbalancing you'd use? What is the impact of counterbalancing on order and carry-over effects? [3 pts]

**You would need to counterbalance because otherwise any position effect (for instance, a practice effect) would put one condition at an advantage over other conditions just because it occurred later. There could also be carry-over effects, such that one condition always followed a particular condition that placed it at an advantage. To ensure that these position and carry-over effects fell equally on all conditions, you should counterbalance. With seven conditions, you probably would use incomplete counterbalancing. Thus, you'd need 14 orders, which means that you'd need to run multiples of 14 participants (14, 28, etc.). As a result of the counterbalancing, you would distribute the position and carry-over effects equally over the seven conditions. (But, note, you will not have eliminated the position or carry-over effects.)**

1b. OK, now let's assume that there is a particular order effect — a practice effect. That means that scores on the DV will improve over time as a result of practice. What is the impact on your error term ( $MS_{Error}$ ) of counterbalancing? [2 pts]

**If position or carry-over effects are present in your data, counterbalancing will increase your  $MS_{Error}$ .**

2. When a stimulus is presented continuously and it does not vary in intensity, the individual will eventually perceive the stimulus as less intense or not perceive it at all. This phenomenon is known as sensory adaptation. Years ago, Zigler (1932) studied adaptation for skin (cutaneous) sensation by placing a small weight on part of the body and measuring how much time elapsed until participants reported that they felt nothing at all. Suppose that a researcher does a similar study, comparing adaptation for 4 regions of the body. A 500-mg weight is placed on the region, and the latency (in seconds) for a report that it is no longer felt is recorded for each participant. Complete the following source table and analyze the results from this experiment as completely as you can. [15 pts]

**ANOVA Table for Area of Stimulation**

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Subject	6	13.915	2.319				
Category for Area of Stimulation	3	225.967	75.322	214.841	<.0001	644.523	1.000
Category for Area of Stimulation * Subject	18	6.311	.351				

**Means Table for Area of Stimulation**

**Effect: Category for Area of Stimulation**

	Count	Mean	Std. Dev.	Std. Err.
Back of Hand	7	5.986	1.022	.386
Lower Back	7	4.129	.588	.222
Middle of Palm	7	9.371	1.083	.409
Chin	7	11.414	.899	.340

**There is a significant effect of area of stimulation,  $F(3,18) = 214.841$ ,  $MSE = .351$ ,  $p < .001$ . In order to determine which specific conditions differed, you need to compute a post hoc analysis (e.g., Tukey's HSD).**

$$HSD = 4.0 \sqrt{\frac{.351}{7}} = .895$$

Thus, adaptation took significantly longer on the Chin compared to all other areas, Middle of the Palm took significantly longer than Back of Hand or Lower Back, and Back of Hand took significantly longer than Lower Back. The effect size would be:

$$\eta^2 = \frac{225.967}{232.278} = .97$$

You should certainly note that the study could not have been appropriately counterbalanced with only seven participants. With complete counterbalancing, you'd need at least 24 participants.

3. Dr. Nomar Gassé was interested in the impact of varying levels of depression on a person's ability to work effectively on a task, especially when tired. He selected people who were not clinically depressed, but who received high scores on the Beck Depression Inventory, as well as people who were diagnosed as clinically depressed and separated them into three groups (Low, Moderate, and Severe Depression). He then kept all participants awake for 48 hours. At the end of the 48-hour period, each participant was given a set of 10 problems to solve. The DV was the number of problems solved correctly in a 30-minute period. Complete the source table below and interpret the results of this study as completely as you can. [10 pts]

**ANOVA Table for Prob Solved**

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Depression	2	221.911	110.956	131.891	<.0001	263.781	1.000
Residual	42	35.333	.841				

**Means Table for Prob Solved**

**Effect: Depression**

	Count	Mean	Std. Dev.	Std. Err.
Low	15	6.600	.986	.254
Moderate	15	3.333	.976	.252
Severe	15	1.200	.775	.200

**First of all, you'd need to test for homogeneity of variance:**

$F_{Max} = .972 / .6 = 1.62$ , and with  $F_{Max Crit} = 3.6$  you'd have no concern about heterogeneity of variance and you'd use  $\alpha = .05$ . Thus, you could conclude that there was a significant effect of depression level,  $F(2,42) = 131.891$ ,  $MSE = .841$ ,  $p < .001$ . The next step, of course, would be to conduct a post hoc test to determine which levels differed.

$$HSD = 3.44 \sqrt{\frac{.841}{15}} = .815$$

Thus, Low levels of depression led to significantly more problems solved compared to the other two levels. Moderate levels of depression led to significantly more problems solved compared to Severe depression. Effect size would be:

$$\eta^2 = \frac{221.911}{257.244} = .86$$

4. In order to study the power of reverse speech (back masking), Dr. Bob Reder had participants listen to music into which backward messages had been explicitly placed. Participants were asked to refrain from drinking any liquids for two hours prior to participating in the study. In the laboratory, each participant listened to four songs. In one song, the backward message was “Coke is heavenly.” In the second song, the backward message was “Drink more Coke.” In the third song, the backward message was “Don’t drink Coke.” And in the fourth song, the backward message was “Coke will kill you.” As they listened to each song, participants had a large container of Coke in front of them and were told that they could drink as much Coke as they wanted. The DV was the number of ounces of Coke consumed during each of the four songs.

First, tell me very explicitly how many participants Dr. Reder should run in his study and how they should be exposed to the songs.

**He’d need to run at least 24 participants, and he’d use complete counterbalancing. Thus, if you think of the four messages as A, B, C, and D, the orders would be ABCD, ABDC, ACBD, ACDB, ADBC, ADCB, BACD, BADC, BCAD, BCDA, BDAC, BDCA, etc.**

Given the number of participants you propose, complete the following source table and tell me what Dr. Reder could conclude from his study. (You don’t really need to know  $F_{crit}$ ...right?) [10 pts]

Source	df	SS	MS	F
Subject	23	40.0	1.74	
Treatment	3	3.0	1.0	1.0
Error	69	69.0	1.0	

Even though the means for each condition are not provided to you here, what can you tell me about the means of the four conditions?

**The means must be very close to one another, because the  $F$  is so small.**