

<b>Title of Resource</b>	Summary steps for conducting a Factorial ANOVA: From data through follow up tests and conclusions
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<b>Brief Description:</b>	This is a 'cheat sheet' to help students work through all the steps of calculating and interpreting a factorial ANOVA from raw data. It includes follow-ups for a significant interaction effect for a 3X3 design.
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This is a nice summary of steps for a factorial ANOVA. It includes all steps from raw data, to ANOVA Summary Table, to follow up tests (up to a 3x3 design) and conclusions. It also includes key formulas along the way. The summary assumes students know the formulas for Mean Square (*MS*) and *F* for each of the effects. The follow-up test suggested, and therefore formula included, is the protected *t*-test (of course this can be modified to the instructor's personal preference). This could be provided to students at the initial introduction to factorial designs or after all of the steps have already been discussed. It is important to remember that this is just a summary of all of the steps and a nice 'cheat sheet' of sorts for the students. Students can be shown how to use the formulas in other lectures. There is also an additional resource on the Teach Psych Science website (*A 2X3 Factorial ANOVA calculation and interpretation: From data through follow-up tests and conclusions*) which carries out a 2X3 factorial ANOVA hand calculation following these steps (with reference to this resource).

## Steps for Factorial ANOVA

Step 1: Create a means table with cell and marginal means (if they aren't given to you).

Step 2: Calculate  $SS_t$  if it's not given to you.

$$SS_t = \sum X^2 - \frac{(\sum X)^2}{N} = \sum (X - \bar{X}_g)^2$$

the grand mean

Step 3: Calculate  $SS_A$        $SS_A = nb \sum (\bar{X}_A - \bar{X}_g)^2$

Step 4: Calculate  $SS_B$        $SS_B = na \sum (\bar{X}_B - \bar{X}_g)^2$

Step 5: Calculate  $SS_{btm}$        $SS_{btm} = n \sum (\bar{X}_{AB} - \bar{X}_g)^2$

Step 6: Calculate  $SS_{AB}$        $SS_{AB} = SS_{btm} - SS_A - SS_B$

Step 7: Calculate  $SS_w$        $SS_w = SS_t - SS_{btm}$

Step 8: Calculate all of the  $df$

$$df_t = N - 1$$

$$df_A = a - 1$$

$$df_B = b - 1$$

$$df_{AB} = df_A \times df_B$$

$$df_w = df_t - df_A - df_B - df_{AB}$$

Step 9: Create an ANOVA summary table.

Source	SS	df	MS	F	p
Between					
A					
B					
A X B					
Within					
Total					

Step 10: Determine the significance of each of your  $F$  values (1 for each main effect and 1 for the interaction).

Step 11: Interpret your main effects (based on significance and looking at the marginal means).

- ONLY if your Interaction is NOT SIGNIFICANT, follow up (with protected  $t$ -tests; see formula below) any significant main effects with more than 2 levels.

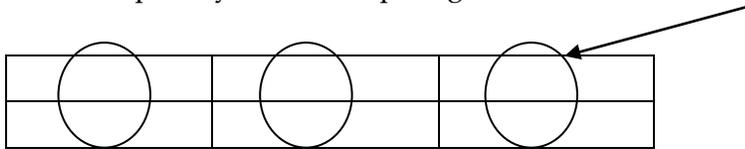
Step 12: If your interaction is significant follow it up with simple main effects, based on the hypotheses:

- you will either:

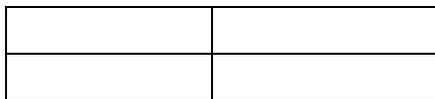
- i. go straight to doing protected  $t$ -tests (use  $df_w$  for critical  $t$ ).

$$t_{\bar{X}_1 - \bar{X}_2} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{MS_w \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

For example, if you follow up a significant interaction this way, you just do protected  $t$ -tests

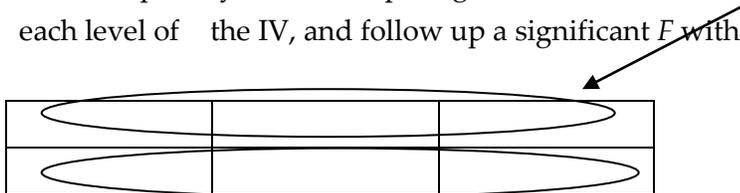


For example, with a 2X2 design (below), either way you follow-up the interaction (vertically or horizontally) you would only do protected  $t$ -tests.



- ii. OR first calculate  $F$  values (more than 2 levels; see Steps below).

For example, if you follow up a significant interaction this way, you must first calculate the overall  $F$  at each level of the IV, and follow up a significant  $F$  with protected  $t$ -tests – see calculation steps below.



For example, with this particular design (below), either way you follow-up the interaction (vertically or horizontally) you would have to first calculate  $F$ , and follow up those that are significant with protected  $t$ -tests.


Steps for simple main effects -  $F$  test (more than 2 levels):

Step A: Calculate  $SS$  for the group (1 level of the IV).

$$SS = n \sum (\bar{X}_{cell} - \bar{X}_g)^2$$

Step B: Calculate  $MS$  for the group.

$$MS = \frac{SS}{df}$$

Step C: Calculate  $F$  for the group (using  $MS_w$  from the overall ANOVA)

Step D: Determine if it is significant

Step E: If it is significant follow it up with protected  $t$ -tests (see formula above)

Step F: Do the same steps for the other level of the IV

Step 13: Interpret results and provide final conclusions. Make sure that your conclusions are based on the follow-ups that were conducted.