Source	SS	df	MS	F
(A)	SS_a	$(a-1)$	SS_a/df_a	MS_a/MS_E
(B)	SS_b	$(b-1)$	SS_b/df_b	MS_b/MS_E
A x B	SS_{ab}	$(a-1)(b-1)$	SS_{ab}/df_{ab}	MS_{ab}/MS_E
Error (res; w/in)	SS_E	$ab(n-1)$	SS_E/df_E	
Total	SS_T	$N-1$		

Source	SS	df	MS	F
Sex (A)				
SES (B)				
A x B				
Error (res; w/in)				
Total				

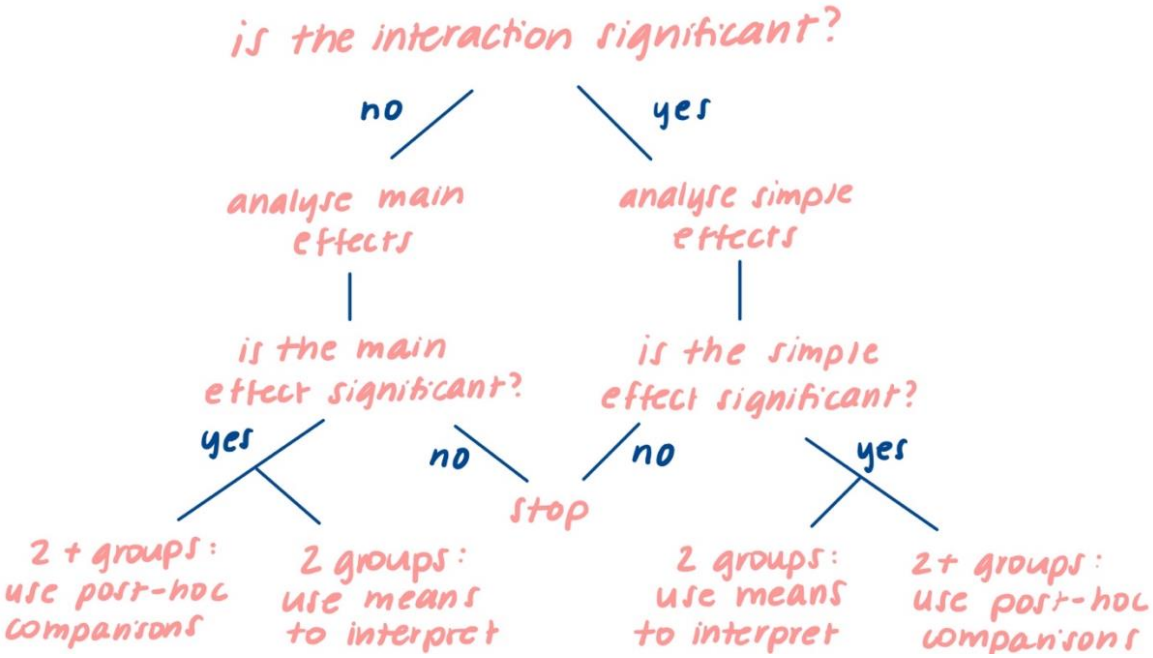
Factorial ANOVA assumptions:

1. DV measured on interval/ratio scale (**numeric**)
2. IV's are **categorical** and consist of 2 or more levels
3. **Independence of observations** (usually met by design) – no relationship between observations w/in or between groups (levels)
    a. Randomness and representativeness
4. **Normality** – observations of DV normally distributed for each level of IVs
5. **Homoscedasticity** – use "egen cell = group(IV IV)" then "robvar DV, by (cell)"

Factorial ANOVA steps

1. Understand RQ and hypotheses, sampling pop., and how variables are measured/manipulated (type and scale)
    a. H0: mean 1 = mean 2 = mean 3
    b. HA= at least one mean is different from the others
2. Univariate statistics and graphical summaries.
    a. By IV IV, sort: summarize DV, detail OR table IV IV, contents(n DV mean DV sd DV) row col format (%6.2f)
3. Check assumptions – swilk and robvar
    a. Egen cell= group(IV IV), then Robvar DV, by (cell) to check homogeneity
    b. Bysort IV IV: swilk DV to check normality of each group
4. Run AVOVA – look at interaction first. Does at least one of the groups differ significantly from the rest? Anova DV IV##IV. margins IV#IV, post then marginsplot (must follow anova command)
    a. If the interaction is significant -> do simple effects (step 5). Simple effects = cell means
        i. If there are 3+ levels to the IV, must do post hoc to determine nature of difference
    b. If interaction is not significant -> look at simple main effects
5. Secondary analyses
    a. Simple effects for significant interactions and run post hoc as needed – Bonferroni/Scheffe and pairwise comparisons
    b. Post hoc for main effects if more than 2 means and main effect significant

6. Interpret



Factorial ANOVA calculation steps by hand

1. Calculate SS for each factor, interaction(s), total, and error
    a. If using computational formula, also calculate SS for each cell.
    b. Then calculate df
2. Calculate MS for each factor, interaction(s) and error
3. Calculate F for each factor and interaction(s).

(shouldn't be asked to calculate by hand, but just in case)

Definitional formula:

1. $SS_a = bn\sum(\bar{X}_{ai} - \bar{X})^2$
2. $SS_b = an\sum(\bar{X}_{bi} - \bar{X})^2$
3. $SS_{ab} = n\sum(\bar{X}_{ij} - \bar{X}_{bi} - \bar{X}_{ai} + \bar{X})^2$
4. $SS_{res} = \sum(X_{ijk} - \bar{X}_{ij})^2$

$\bar{X}_{ij}$ = cell mean $\bar{X}_{ai}$ = column marginal mean $\bar{X}_{bi}$ = row marginal mean

Computational formula:

1. Calculate SS_T= Sum $X^2 - G^2/N$
2. Calculate SS_{cells}= $T^2/n - G^2/N$ (overall model)
3. Calculate SS_a= Sum $T_a^2/nb - G^2/N$
4. Calculate SS_b= sum $T^2_b/na - G^2/N$
5. Calculate SS_{ab}= $SS_{cells} - SS_a - SS_b$
6. Calculate SS_E= $SS_T - SS_{cells}$

Simple effects

Follows a significant interaction – how does one IV and its levels behave at one level of the other IV?