Tuesday AM

- Presentation of yesterday's results
- Factorial design concepts
- Factorial analyses
  - Two-way between-subjects ANOVA
  - Two-way mixed-model ANOVA
  - Multi-way ANOVA

Factorial designs

- A factorial design measures a variable at different levels of two or more "factors" (categorical independent variables).
- For example, one might measure the efficacy of a drug given in two different forms and at three different dosages.

Factorial designs

- Factors: drug form, drug dosage
- Levels of drug form: oral, inhaled
- Levels of drug dosage: low, medium, high
- Dependent variable: time to pain relief

	low	medium	high
oral	$\mu_{t,l\text{-}o}$	$\mu_{t,m\text{-}o}$	$\mu_{t,h\text{-}o}$
inhaled	$\mu_{t,l\text{-}i}$	$\mu_{t,m\text{-}i}$	$\mu_{t,h\text{-}i}$

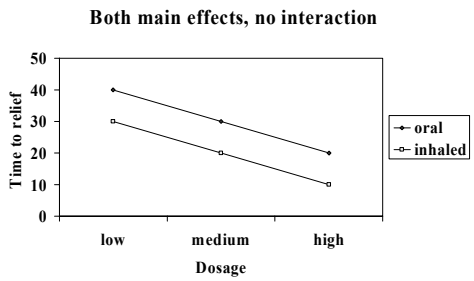
Factorial analyses

- Overall analyses of factorial designs are broken down into main effects and interactions
  - Main effect of dosage
  - Main effect of form
  - Interaction between dosage and form
- When there is no interaction, the main effects are easily interpreted as the independent effects of each factor, as if you'd done t-tests or one-way ANOVAs on the factors.

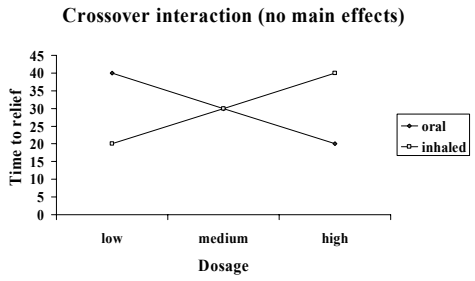
Interactions

- When an interaction is present, the effect of one variable depends on the level of another (for example, inhaled drugs might only be effective at high doses).
- Main effects may or may not be meaningful.
- Graphing the means can show the nature of the interaction.

Interaction graphs



Interaction graphs



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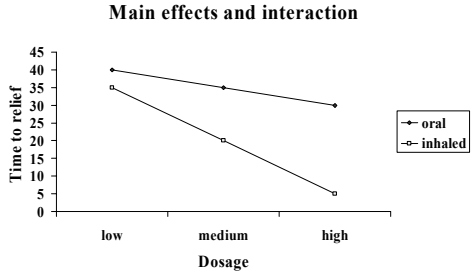

Simple effects and contrasts

- Simple effects are the effects of one variable at a fixed level of another (like doing a one-way ANOVA on dosage for only the oral form).
- Just as you might use contrasts in a one-way ANOVA to identify specific significant differences, you can do the same in factorial analyses

Two-way between-subject ANOVA

- Goal: Determine effects of two different between-subject factors on the mean value of a variable.
- Each cell of the table of means is a different group of subjects.
- Example: Do mean exam scores of students taking PBL or nonPBL versions of physiology taught in Spring, Fall, or Summer differ?
- Each main effect (instruction method, semester) and the interaction has its own null hypothesis

Two-way ANOVA in SPSS

- Analyze…General Linear Model…Univariate
- Enter dependent variable, and fixed factors, and optionally ask for contrasts, plots, tables of means, post-hoc tests, etc.

Tests of Between-Subjects Effects: Occupational Prestige

Source	SS	df	Mean Square	F	Sig.
SEX	54.460	1	54.460	.330	.566
RACE	7632.679	2	3816.340	23.119	.000
SEX * RACE	1255.778	2	627.889	3.804	.023
Error	233079.627	1412	165.071		

- There was a significant interaction between race and sex ($F(2,1412) = 3.8$, $p < .05$) and a main effect of race ($F(2,1412) = 23.1$, $p < .05$)…. Explain the effects...

Two-way mixed-model ANOVA

- Goal: Determine effects of a b/s and a w/s factor on the mean value of a variable.
- Each row of the table of means is a different group of subjects; each column are the same subjects

	Traditional test	Computer test
Spring	$\mu_{test,traditional\text{-}spring}$	$\mu_{test,computer\text{-}spring}$
Summer	$\mu_{test,traditional\text{-}summer}$	$\mu_{test,traditional\text{-}summer}$
Fall	$\mu_{test,traditional\text{-}fall}$	$\mu_{test,computer\text{-}fall}$

Two-way mixed-model ANOVA

- In standard data format, each of the levels of the within-subject factor is a separate variable (column).
- Analyze…General Linear Model…Repeated Measures
- Name the within subject factor, and give the number of levels, then click Define
- Assign a variable to each level of the within-subject factor
- Assign a variable to code the between-subject factor
- Optionally select contrasts, post-hoc tests, plots, etc.

Two-way mixed-model ANOVA

- Effects of sex (within-country) and predominant religion (between-country) on country's life expectancy

Tests of Within-Subjects Effects

Source	SS	df	Mean Square	F	Sig.
SEX	263.354	1	263.354	143.32	.000
SEX*RELIGION	97.529	9	10.837	5.897	.000
Error(SEX)	180.077	98	1.838		

Tests of Between-Subjects Effects

Source	SS	df	Mean Square	F	Sig.
Intercept	215459.270	1	215459.270	1260.5	.000
RELIGION	4313.969	9	479.330	2.804	.006
Error	16751.749	98	170.936		

Multi-way ANOVA

- Of course, you are not limited to two factors. You can do an ANOVA with any number of factors, between- or within-subjects, and any number of levels per factor, if you have enough data.
- In larger and more complex ANOVAs, however, planned contrasts are often more important than overall interaction effects, etc.

Multivariate ANOVA

- Sometimes you have measurements of multiple different variables (not repeats of the same variable) for the same subjects. You could do a set of ANOVAs on each, or a single multivariate ANOVA (aka MANOVA).
- Sometimes you have repeated measurements of multiple variables for the same subjects. This is called *doubly multivariate* data.
- SPSS can do either with the GLM procedure.

Tuesday AM assignment

- Using the osce data set, test for effects of rater and of patient on the ratings of each of these:
  1. Reasoning
  2. Knowledge
  3. Communication
- If you find any significant effects, plot or table the cell means to illustrate the effects.
- What kind of analyses are these?