psyc3010 lecture 1

introduction to course and housekeeping
introduction to factorial designs

next week: factorial anova

lecturer

Winnifred Louis
- email: w.louis@psy.uq.edu.au
- phone: 3346 9515
- office: McElwain 407
- contact hours:
  - Before class at the lecture
  - After class at the lecture
  - Mondays 4-6pm
    - During my weekly office hours I can be reached by phone or Skype (winnifred.louis) as well as by dropping in. If there is a queue, I will call you back when your place in the line is reached
  - Appointments are welcome.
Tutors

- Jo Brown, Lead Tutor
  - j.brown@psy.uq.edu.au
  - Tutes open for sign up on SINET Friday at 7:30pm. E-mail Jo with concerns and ?s from Saturday morning please.
- Sarah Forbes, s.forbes@psy.uq.edu.au
- Katie Greenaway, k.greenaway@psy.uq.edu.au
- Matthew Land, matthew.land@uqconnect.edu.au
- Ted Thengtrirat, wichanart.thengtrirat@uqconnect.edu.au
- Nonie Finlayson, nonie.j@gmail.com

What will we do? Learn how to:

1. Generate research designs for questions involving multiple IVs / predictors, based on methodological and practical considerations.
2. Identify the statistical analyses that are appropriate for research designs involving multiple IVs / predictors.
3. Identify the key terms and conceptual principles relevant to statistical techniques involving multiple IVs / predictors.
4. Plan and execute (omnibus and follow-up) tests in statistical analyses involving multiple IVs / predictors.
5. Interpret results from these statistical analyses, identifying the implications of the results for hypotheses and research questions.
6. Report and discuss the results of these analyses, following standard conventions in Psychology.
7. Use your statistics knowledge to develop and enrich your work as a psychologist.
Oh and by the way ...

- Finally be able to engage professionally with published research
- Fundamentally change how we understand the nature of reality

A note about the value of attendance

- I post detailed slides before every lecture
- I also keep track of attendance. There is no penalty for skipping, but keep this in mind ->
- The data show that tutes also valuable, esp. for higher assignment marks

<table>
<thead>
<tr>
<th>Absent Fails among finisher's (8%)</th>
<th>Always/Often</th>
<th>Sometimes</th>
<th>Rarely/Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fails among finisher's (8%)</td>
<td>29%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>1sts (9%)</td>
<td>0%</td>
<td>13%</td>
<td>23%</td>
</tr>
</tbody>
</table>
Why is attendance so important?

Strange because detailed class notes available every week online

2006 (44% chronic skippers failed) & 2005 (39% chronic skippers failed);

controlling for second year grades (and, in ’06, anxiety), attendance delivered a 15-20% boost in final 3rd year grades.

- **explanation #1**: 3rd factor hurts attendance & marks
  - sickness
  - family and/or work obligations
- **explanation #2**: added value to regular attendance
  - immediate clarification of confusing material
  - rehearsal of knowledge over multiple classes
  - rate of knowledge absorption spread over term (rather than over the 2 weeks before the exam)

2009 tchg award APS talk

The correlation between lecture attendance (tertiles) and final mark, after controlling for previous year’s mark, among only those who completed all assessment

<table>
<thead>
<tr>
<th></th>
<th>Stats</th>
<th>r</th>
<th>N</th>
<th>Social</th>
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<th>N</th>
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</thead>
<tbody>
<tr>
<td>Yr 1</td>
<td>.33</td>
<td>113</td>
<td></td>
<td>Yr 1</td>
<td>.53</td>
<td>17</td>
</tr>
<tr>
<td>Yr 2</td>
<td>.26</td>
<td>106</td>
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<td>Yr 2</td>
<td>.40</td>
<td>12</td>
</tr>
<tr>
<td>Yr 3</td>
<td>.26</td>
<td>82</td>
<td></td>
<td>Yr 3</td>
<td>.29</td>
<td>51</td>
</tr>
<tr>
<td>Yr 4</td>
<td>.30</td>
<td>92</td>
<td></td>
<td>Yr 4</td>
<td>.16</td>
<td>72</td>
</tr>
<tr>
<td>Meta-analysis</td>
<td>.30</td>
<td>--</td>
<td></td>
<td>Meta-analysis</td>
<td>.29</td>
<td>--</td>
</tr>
</tbody>
</table>
Managing anxiety & motivation

- Do the work regularly
- Find small attainable goals along the way
- Be methodical: organise
- Do not avoid!
- Take heart – anxiety early in the course is unrelated to outcomes (controlling for 2nd year grades & attendance, you get just as good marks no matter how anxious you are)

course structure

- one 2 hour lecture per week
  - Tuesday 10-12 in this room
  - Covering theory, examples and applications
  - Slides available from the web before each lecture
- one 2 hour tutorial per week
  - Mostly covering examples to work through and interpret
  - Some tutes will consist of computer-based analyses using SPSS: Not to be missed!
  - Lecture and tutorial materials do not overlap perfectly
  - Sign-up via my-SINET (details later)
- Ongoing Blackboard web site
  - Need to monitor web site regularly for announcements and files
  - Should also check out and ideally post to web forum
    - Warning: NEVER post answers to assignment
    - NEVER post or answer any question with specific numbers or quotations from the assignment in it on the forum
    - will end up penalised for plagiarism or collusion even if meant to be helpful (argh!)
materials and resources

- **textbooks**
  - Page refs will be provided for both
  - Field’s better for struggling students, has SPSS. Uses slightly different equations sometimes.
  - Howell’s a more gifted mathematician but can be difficult reading. Lectures this year use Howell equations mostly.

- **tutorial workbooks**
  - 1 hardcopy of main workbook and formatting guidelines available in the first tute.
  - Additional exercises workbook available online.
  - PDFs of these posted online.

- **lecture notes**
  - PPT/PDF on web as noted – useful to bring to each lecture
  - Review questions also posted online

online resources

- **Blackboard is your friend**

  - **week-to-week resources:**
    - lecture slides and notes (weekend before lecture)
    - lecture recordings (week after lecture – but not guaranteed!)
    - tutorial slides (week after tutorial)
    - announcements

  - **semester-long resources:**
    - review of general arithmetic and terminology
    - reading list from 2nd year statistics
    - tips for completing assignments
    - practice questions for quizzes and exam
Psyc3010 – factorial designs, multivariate analyses

<table>
<thead>
<tr>
<th>Factorial ANOVA</th>
<th>Multiple Regression</th>
<th>Log-linear analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>between/within &amp; mixed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANOVA &amp; t-tests</th>
<th>Bivariate (simple) correlation</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>between/within</td>
<td>Assumed Knowledge!!!</td>
<td></td>
</tr>
</tbody>
</table>

assessment

- **two written assignments**
  - approximately 1500 words, each comprising 20% of the final grade
  - due dates are:
    - assignment 1 → 11 April at 12 noon
    - assignment 2 → 23 May at 12 noon

- **two online quizzes**
  - 5 multiple choice questions each, worth 5% of the final grade each
  - Open book, but you must work alone
  - Quiz dates are:
    - Quiz 1 → 27 March 9am – 28 March 9pm
    - Quiz 2 → 15 May 9am – 16 May 9pm

- **final exam**
  - comprising 50% – 50 multiple-choice questions
  - closed book, during exam period

- **you must complete both assignments and the final exam in order to pass the course**
make-up quiz policy

- Application form available on Blackboard
- Application form must be received by the course coordinator within 1 week of the original quiz dates
- Applications considered only for reasons prohibiting student from taking the quiz on all days it was active

→ Application does not guarantee approval

extensions

- Extensions for assignments must be sought through the appropriate channels before the assignment due date
  - Application forms are available online
- Penalties apply for late submissions without approved extensions
- Late assignments must be e-mailed to your tutor
  (one mark per day, including weekends or public holidays)

For medical conditions, medical certificates must be provided
Applications for extension may be made after the deadline on medical grounds if you have certification you were sick on the day & up to the day you handed in your application.
appeals

- what if you are not satisfied with the mark your tutor has given you, or you believe there is an error in marking?
  - Firstly, wait 1 week after your assignment has been returned (your tutor most likely will have late assignments to mark, and the extra week will give you time to consider the matter fully)
  - Secondly, approach your tutor and ask for further feedback. Explain why you disagree with the mark given.
  - Finally, if an agreement is not reached, you are entitled to have the assignment remarked. To do this:
    • Use the School of Psychology request for remark form available on BB
    • Be aware that the decision of the second marker is final and your amended mark may be lower

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tute nominations

Many time slot options (14 tutes will (most likely) be offered):
- Tuesday 12-2; 2-4; 4-6; 6-8
- Wednesday 10-12; 12-2; 2-4; 4-6.
- Thursday 10-12, 12-2, 2-4

- Sign-up will be via My SI-NET as of Friday March 4 at 7:30pm

- Self-identification as needy:
  - we cannot accommodate everyone
  - part time students with full time work, care giving responsibilities or similar will receive preference for late available/conflicting spots
  - If you fall into this category, complete and submit an index card with your student #, Name, and 3 tute slots in order of preference (#1 = first choice)
  - Indicate the reason for your neediness on your card

- Questions about tute sign-up? See me after class or e-mail Lead Tutor (Jo j.brown@psy.uq.edu.au) from Saturday March 5
simple (one-way) designs

- **experiment 1** – “what effect does the kind of stats examples I use have on your stats recall (in the exam)?”
  - $N = 18$ in 2 conditions
  - I give *silly* examples OR *serious* examples, then test your recall (pop quiz)
  - IV $\rightarrow$ example type (2 levels)
  - DV $\rightarrow$ quiz performance
  - analysed with an independent samples t-test or one-way anova
simple (one-way) designs

- **experiment 2** – “what is the effect of my lecture preparation on your stats recall (in the exam)?”
  - $N = 18$ in 3 conditions
  - I give lecture after 1 full day of preparation, 1 hour of preparation, OR no preparation, then test your recall (in exam)
  - IV $\rightarrow$ lecturer preparation (3 levels)
  - DV $\rightarrow$ exam performance
  - analysed with one-way anova
  - Then follow-up tests to find differences among the means

factorial designs

- we can combine these two one-way experiments using a factorial design
  - a factorial experiment has at least two factors (IVs), each with at least two levels
  - then the two IVs can be examined simultaneously – example type and lecturer preparation can be crossed
### data table for one-way design

<table>
<thead>
<tr>
<th>Lecturer Preparation</th>
<th>None</th>
<th>Some</th>
<th>Heaps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>7</td>
<td>16</td>
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<td>7</td>
<td>8</td>
<td>8</td>
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<td>3</td>
<td>6</td>
<td>12</td>
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<td>7</td>
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<td></td>
<td>8</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Mean</td>
<td>6.5</td>
<td>7.5</td>
<td>10</td>
</tr>
</tbody>
</table>

Participants are randomly assigned to one level of Factor 1.

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### a data table for a one-way design

<table>
<thead>
<tr>
<th>Lecturer Preparation</th>
<th>None</th>
<th>Some heaps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>7</td>
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<td></td>
<td>7</td>
<td>8</td>
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<td>7</td>
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<tr>
<td></td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Mean</td>
<td>6.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

We have “a” or “j” groups (Factor A has a levels or Factor X has j levels).

We compare group means to each other / to the grand mean.
One-way ANOVA

- One IV
- Group means compared to each other & to the grand mean
- If they are different, there is an effect of the IV

Data table for two-way design

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Lecturer Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Silly</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Serious</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>8</td>
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<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>6.5</td>
</tr>
</tbody>
</table>

Participants are randomly assigned to one level of Factor 1 and one level of Factor 2
factorial vs one-way designs – research questions

- **a one-way design asks one question**
  - are the mean dependent variable scores of the populations for each level of the factor different from the grand mean (from each other)?

- **a factorial design asks more questions**
- **In a two-way factorial design:**
  - are the means of the populations corresponding to the levels of the first factor different - *is there a main effect of factor 1?*
  - are the means of the populations corresponding to the levels of the second factor different - *is there a main effect of factor 2?*
  - Does the effect of one factor on scores on the dependent variable depend on the level of the other factor - *is there a factor 1 X factor 2 interaction?*

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a data table and some notational standards

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Lecturer Preparation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**the grand mean**

the mean of all observations – not as important for inferential purposes but forms part of the structural model of ANOVA

|           | 8     | 8    |
|           | 6.5   | 7.5  |
|           | 10    | 8    |
### a data table and some notational standards

<table>
<thead>
<tr>
<th>Lecturer Preparation</th>
<th>Silly</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>marginal means</strong> of lecturer preparation</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>a significant <strong>main effect</strong> of lecturer preparation tells us there is a difference somewhere in these three marginal means (but not exactly where – follow-up comparisons would be necessary)</td>
<td>6.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

### a data table and some notational standards

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Silly</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>marginal means</strong> of example type</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>a significant <strong>main effect</strong> of example type tells us these marginal means are different</td>
<td>57</td>
<td>1</td>
</tr>
<tr>
<td>788</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>57</td>
<td>1</td>
<td>2</td>
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<tr>
<td>1068</td>
<td>677</td>
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</tr>
<tr>
<td>81</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>888</td>
<td>6.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>
**cell means**

the effect of one factor at one level of the other factor is called a **simple effect**

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Lecturer Preparation</th>
<th>None</th>
<th>Some</th>
<th>All</th>
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<tbody>
<tr>
<td>Silly</td>
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<td>5</td>
<td>7</td>
<td>16</td>
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<tr>
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<td><strong>5</strong></td>
<td><strong>7</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td>Serious</td>
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<td><strong>8</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecturer Preparation</th>
<th>None</th>
<th>Some</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silly</td>
<td>6.5</td>
<td>7.5</td>
<td>10</td>
</tr>
<tr>
<td>Serious</td>
<td>6.5</td>
<td>7.5</td>
<td>10</td>
</tr>
</tbody>
</table>
cell means

when the effect of one factor is conditional upon the levels of the other factor we have an **interaction** (the simple effects are used to interpret an interaction)

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Lecturer Preparation</th>
<th>None</th>
<th>Some</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silly</td>
<td>5</td>
<td>7</td>
<td>16</td>
<td>8</td>
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<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<td>2</td>
<td>6</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Serious</td>
<td>5</td>
<td>7</td>
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<td>8</td>
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<tr>
<td></td>
<td>6.5</td>
<td>7.5</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

advantages of factorial designs

- **more economical in terms of participants**
  - a two-way factorial design requires fewer participants than two one-way designs for the same level of power, because we **average** over the levels of the other factor
- **allows us to examine the interaction of independent variables**
  - does the effect of example type on recall **depend** on lecturer preparation?
  - the **generalisability** of results can be assessed – is the difference described by a main effect the same across levels of the other factor?
  - One independent variable interacts with another independent variable when the effects of one variable are different depending on which level of the other variable you are considering
  - One independent variable interacts with another variable when it changes ("moderates" or "qualifies") the impact of a second independent variable on the dependent variable
notation in factorial designs

- **by the number of factors involved (general)**
  - two-way between-subjects factorial design

- **by the number of levels of each factor involved (specific)**
  - 2x3 between-subjects factorial design
  - Factor A = example type \((a=2 \text{ levels})\)
  - Factor B = lecturer preparation \((b=3 \text{ levels})\)
  - therefore, design is \(2 \times 3\) between-subjects
  - in \(2 \times 3\) design there are 6 cells = 6 treatments with \(n\) observations

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**a data table and some notational standards**

<table>
<thead>
<tr>
<th>e.g. Type</th>
<th>Lecturer Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor A</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Silly</strong></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>3</td>
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<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Serious</strong></td>
<td>10</td>
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<td></td>
<td>8</td>
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<td>8</td>
</tr>
</tbody>
</table>

|          | 6.5 | 7.5 | 10 | 8 |
plotting main effects & interactions

- y-axis is for the dependent variable
- x-axis is for the factor with the most levels or for the factor which is most theoretically important
- other factor (with fewer levels or which is less interesting) represented by separate lines on the graph
- all cell means in the design must be represented on the graph

- Parallel lines indicate that there is no interaction
- non parallel lines indicate an interaction
  - disordinal interaction (lines cross – signs reverse)
  - ordinal interaction (lines do not cross – signs do not reverse)
  - range of measurement affects whether an interaction is ord or disord
- evidence for main effects is a bit harder
  - differences in the average height of the levels of the factor
possible outcome – 2 main effects and no interaction

No Interaction

Lines are parallel: effect of lecturer preparation does not depend upon example type
Main effect of lecturer preparation
When we average across example type:
Exam marks vary over lecturer preparation
(We average across the line factor by imagining columns halfway between the 2 lines)

Main effect of example type
When we average across lecturer preparation, exam mark after silly examples is higher than exam mark after serious examples
(We average across the x-axis factor by imagining Xs at the average height of each line)
data from previous table – one main effect and a (disordinal) interaction

![Graph showing exam marks against lecturer preparation]

- Exam mark
- Lecturer Preparation
- None
- Some
- All

Silly examples
Serious examples
Interaction (disordinal)
Effect of lecturer preparation depends upon example type

Main effect of lecturer preparation
When we average across example type, exam marks vary over lecturer preparation
No main effect of example type

When we average across lecturer preparation, exams mark after silly examples are same as exam marks after serious examples.

Exam mark

Silly examples
Serious examples

Lecturer Preparation

None Some All

0 2 4 6 8 10 12 14
another possible outcome – 2 main effects and a (ordinal) interaction

![Graph showing exam marks for different levels of lecturer preparation]

Main effect of lecturer preparation
another possible outcome – 2 main effects and an (ordinal) interaction

Effect of lecturer preparation depends upon example type

Real example of outcomes of a 2-way interaction of Family history and Impulsivity on alcohol abuse

![Graph showing alcohol abuse vs. impulsivity levels](image)

**key points about factorial designs**

- A factorial experiment has at least 2 factors, each with at least 2 levels.
- For each pair of factors, there are two main effects and one interaction.
- Interactions and main effects can occur in any combination, they are **independent**.
- A significant interaction may **qualify** significant main effects: the simple effects of one IV depend on the level of the other IV under consideration. Then, the main effects may need to be **reinterpreted**.
- Interactions may be **ordinal** (lines don't cross, within the range of data meaningful to the study) or **disordinal** (lines do cross within that range).
A bit more detail in comparison

- **One-way ANOVA**
  - One IV
  - Group means compared to each other & to the grand mean
  - If they are different, there is an effect of the IV

- **Factorial ANOVA**
  - Two or more IVs ("factors")
  - Effect of each factor examined at each level of the other factor ("factors are crossed")
  - Group means too vague now – you need to learn the difference between marginal and cell means
  - "marginal means" averaging across levels of other factors are compared to each other / grand mean to detect main effects of each IV
  - "cell means" within the levels of other factors are compared to each other to detect simple effects of an IV
  - Simple effects are compared to each other – if they are the same, no interaction
    - Lines on a graph are parallel, difference of the differences = 0
    - Interaction means that one variable changes the effect of another on the DV
      - Lines on a graph are not parallel
      - Difference of the differences is not 0

Don't worry, we're going over this again slowly next week!!!

- **next week:** logic and computations of factorial anova

  - Revise Field Chapter 8 (don’t worry too much about the SPSS part- i.e. 8.3 onwards)
  - Skim chapter 10.1 and 10.2 of Field

  - Optional Howell - revise chapter 11 and 12; skim chapter 13

  - tutes start next week – sign-up online via my-SINET after Friday at 7:30pm