

Linguistics colloquium

Winter term 2007

Experimental Design 101:
Factorial Judgment
Experiments

Experiments: What are they?

An **experiment** is a **set of actions and observations**, performed in the context of solving a particular problem or question, to **support or falsify** a **hypothesis**

Experiments: What are they?

- An experiment should allow for a **systematic observation** of a particular **behaviour** under **controlled circumstances** such that **observed differences** must be **due to our manipulation**

Why the experiment?

We are interested in the effect(s)

some factor/variable X

has on

some factor/variable Y

Some preliminaries: What is a variable?

*“To be is to be the value of a bound **variable**”*

different (yet similar) meanings in mathematical logic,
computer science, physical sciences, engineering,
applied statistics...



W.V.O. Quine
1908 - 2000

Variables: What are they?

Variable = (a symbol for) a quantity that
can vary

Variables:

Different types

Variables can be...

continuous

(taking values from a continuum)

discrete

(taking values from a defined set)

Variables: measurement scales

Variables differ with respect to their
information content:

nominal (categorical)	<	ordinal	<	interval	<	ratio
$x \neq y \neq z$		$x > y > z$		$x = y - z$		$x = y \cdot z$
(telephone numbers)		(grades)		(temperature)		(height)

hence, **different scales of measurement** allow different
inferences and different mathematical operations
--> **different statistics**

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables
- Control Variables
- Random Variables
- Confounding variable

Variables:

Their roles in an experiment

- **Independent Variables**
 - **what you manipulate**
- Dependent Variables
- Control Variables
- Random Variables
- Confounding variable

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables**
 - **what you measure**
- Control Variables
- Random Variables
- Confounding variable

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables
- Control Variables**
 - **what you hold constant**
 - **are kept constant so as to minimize their effects on the outcome**
- Random Variables
- Confounding variable

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables
- Control Variables
- Random Variables**
 - **what you allow to vary randomly**
 - considered by some to be a misnomer: *random function*
- Confounding variable

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables
- Control Variables
- Random Variables
- Confounding variable**
 - **“hidden” variable** that **affects** the **variables** in question (correlated with independent variable)
 - **any one person's response** to any one sentence is usually **massively confounded**
 - the only way to distinguish interesting causes from the confounds is to **test multiple speakers and multiple sentences**

Variables:

Their roles in an experiment

- Independent Variables
- Dependent Variables
- Control Variables
- Random Variables
- Confounding variable

Why the experiment

We are interested in the effect(s) that
some factor X (=independent variable)
has on
something else Y (=dependent variable)

General logic

Essentially, we want to assess the
proposition

If X, then Y

to show a causal relationship, we would need to assess 'If not X,
then not Y' as well

Interactions

What is an Interaction?

If two factors do not interact, the effect of each factor stays the same even if the level of the other factor is changed. **If they do interact, the observed effect depends on the combination of both factors, so neither factor can be studied independently.**

Interactions

The consequence of an interaction is that the effect of one variable depends on the value of another

Interactions

Real world example:

Interaction between

adding sugar to coffee (independent variable 1) and stirring the coffee (independent variable 2).

Neither of the two individual variables has much effect on **sweetness (dependent variable)** but a combination of the two does

Summary

- An **experiment** is a **tool** for **testing a hypothesis** of the form "If X then Y."
- The **basic logic** is to **manipulate X** (=independent variable) and **observe Y** (=dependent variable).
- In order to **see potential interactions** between factors, we need to introduce **more than one independent variable**.

Interlude:

Useful links: Software

MiniJudge helps you to design, run, and analyze "minimalist" linguistic judgment experiments (uses R to calculate statistics for main effects, interactions)

<http://www.ccunix.ccu.edu.tw/~Ingproc/MiniJudge.htm>

GoldVarb an application for carrying out variable rule analysis

<http://www.unh.edu/linguistics/lab/goldvarb.html>

An example: Let's say...

...you are interested in finding out **what factor(s)** determine the **meaning** of the quantifier *some*

how many things?

- (1) I heard that there are **some planets** in our solar system that have not been named yet.
- (2) If I throw this brick into this ant colony, I will definitively kill **some ants**.

how many things?

- (1) I heard that there are [**some** [**planets** in our solar system that have not been named yet]].
- (2) If I throw this brick into this ant colony, I will definitively kill [**some** [**ants**]].

how many Ys?

(3) I heard that there are **some** Y

(4) If I throw this brick into this ant colony, I will
definitively kill **some** Y.

How many Ys are being talked about?

Does the meaning of *some* differ in (3) and (4)?

operationalisation

Let the **meaning** of *some* be:

the number of Ys (=numerical equivalent in a given CoU)

We now have our **dependent variable Y**

(to be elicited):

number of things referred to

hypothesis development

looking for factors...

(a) The number of Y is dependent on the size of the objects involved.

(b) The number of Y is dependent on

(a) the **size of the object** in question **(OBJ)**

(b) the **size of the reference point** **(OBJ_{ref})**

e.g. some cars [OBJ] in front of the house [OBJ_{ref}]

hypothesis: conditional form

If X assumes values (k,l), **then** Y will be (m)

e.g. **The** greater (k,l), **the** smaller Y

hypothesis: conditional form

If X assumes values (big|small), **then** Y will be (high|low)

The greater size of (OBJ, OBJ_{ref}), **the** smaller Y

keeping control

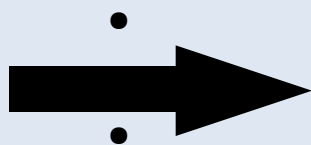
Test items should **differ only** with respect to the values they assume on **the independent variables**

Fixed SYNTACTIC FORM:

There are some...

$NP [N \text{ OBJECT } PP [P \ NP [Det \ N \text{ OBJECT}_{REF}]]]$

e.g. *cars in front of the house*



manipulate size of OBJECT

manipulate size of OBJECT_{REF}

choose task: estimation

Ask subjects:

How many things is S talking about?

(take a guess)

schematic token set

schematic token set		Reference point size	
		'small'	'big'
Object size	'small'	a (s+s)	b (s+b)
	'big'	c (b+s)	d (b+b)

building the design

switch to CALC for guide through
about here [el/Desktop/Experimen](#)

Statistical evaluation: ANalysis Of VAriance

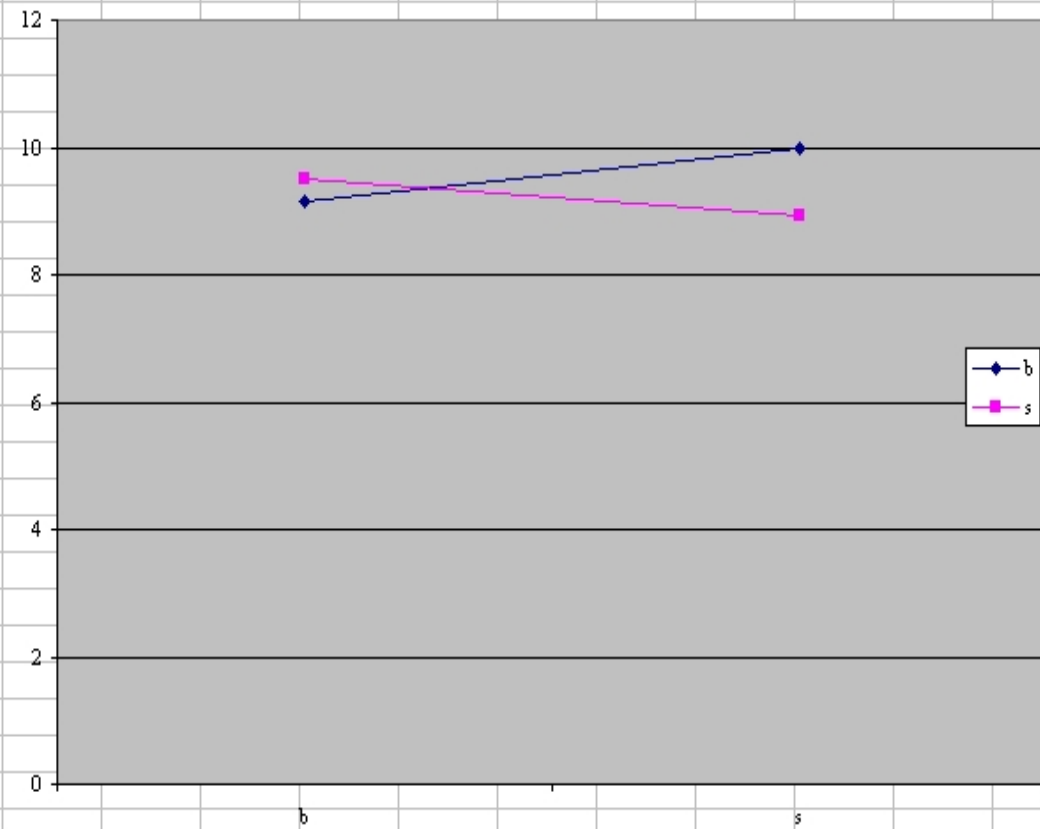
Mittelwert - estimate	reference point size		
object size	b	s	Gesamtergebnis
b	9,17	9,5	9,33
s	10	8,92	9,46
Gesamtergebnis	9,58	9,21	9,40

```
RGui - [R Console]
File Edit Misc Packages Windows Help

> anova.glm(GenLinMod, test="F")
Analysis of Deviance Table

Model: gaussian, link: identity
Response: V3
Terms added sequentially (first to last)

      Df Deviance Resid. Df Resid. Dev    F Pr(>F)
NULL    47  803.48
V1       1    0.19    46  803.29 0.0104 0.9194
V2       1    1.69    45  801.60 0.0933 0.7614
V1:V2    1    6.02    44  795.58 0.3330 0.5668
> █
```



i.e.
not significant