

9.63 Laboratory in Cognitive Science

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Course 3-
Single Factor Design

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Independent / Dependant Variable ?

Duration of an image?	skin conductance ?
Number of errors?	anxiety level ?
Reaction time?	attractiveness?
Number of images recognized? (old)	brightness/contrast?
Number of items in an image? (set size)	object domain
Orientation of a face? (e.g. 0, 45, 90, 135)	(animal/artifact)?
Number of objects in a picture?	distance to an image?
D-prime?	field of study?
Types of advertising pictures?	income level?
Types of movies?	political party?
Age?	

Confounded Experiment in Advertising

In the ad., people were asked to choose between two cola drinks. In one series Pepsi was in a cup labeled **S** and Coke in a cup labeled **L**.

Most people choose the drinks in the S cup (Pepsi)

Conclusion was Cola drinkers prefer Pepsi.

Is this a legitimate conclusion?

Confounded Experiment in Advertising

- Control experiment

What do we know ...

- An experiment needs independent variable(s) (manipulated factors: e.g. age) and a dependent variable (measurement, e.g. score at a memory test), and often controls (control group, control condition)
- A common dependent variable in a variety of cognitive science domain is the d-prime (measure of sensitivity). When there are errors and d', there is a response bias (criterion, C)

	Old	New
Say "Old"	Hit	False Alarm
Say "New"	Miss	Correct Rejection

Project 1: Single design experiment

- One independent variable (2 or 3 levels)
- 1 Control group (if the design is between-subjects) or 1 Control condition (if the design is within-subject)
- One dependent variable (response)

- One simple question, one simple hypothesis

Single Factor design

- An experiment concerns with 1 independent variable (factor), and N levels.
- Abuse of language: “condition” is used for factor and level.
- “Condition” is more often used in a within-subject experiment
- In a between-subject experiment, use the word “group”.

Experimental design

- The two most important part of a design:
- (1) the existence of a control group or a control condition
- (2) the random allocation of participants to groups or condition

- Two types of design, for a single factor:
- Within-subjects design
- Between-subjects design

Within-subject design: order

- Take care of order effects between your conditions (or levels of a factor):
counterbalancing

If 3 conditions

S1 ABC
S2 CAB
S3 BCA

If 4 conditions

A B C D
?

S4 ACB
S5 BAC
S6 CBA

If 5 conditions

A B C D E
?

Latin Square

Subject	Rank order
	1 2 3 4
1	A B C D
2	D A B C
3	C D A B
4	B C D A

Here sequence is not controlled for. B always follows A.

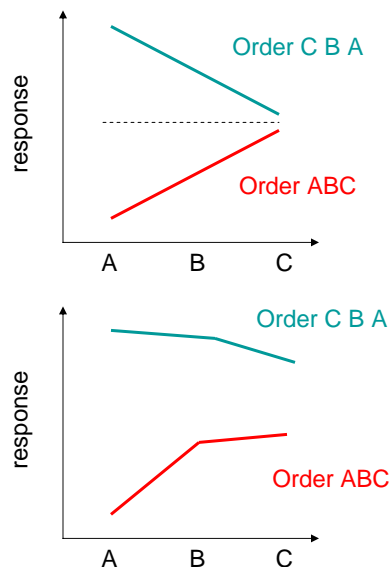
Subject	Rank order
	1 2 3 4
1	A B C D
2	B D A C
3	C A D B
4	D C B A

Each condition is preceded once by every other condition

- Randomization between conditions can be used when each condition is given several time to the subject, or when a sufficient number of subjects will be tested.

Reverse counterbalancing

- Reverse counterbalancing: when each condition can only be presented a few times:
- e.g. if 3 conditions:
A B C C B A
- **Reverse counterbalancing used in design in cognitive neuroscience (fMRI)**
- **Reverse counterbalancing only acceptable if the 3 conditions act in a linear manner**
- Effect of non linearity between the order effects of the 3 conditions arise, when a variable has a large effect in the early part of the experiment and less later (e.g. practice effect, "warm-up" effect).
- How can we correct the initial "warm-up" effect?



Within subject: multiple conditions

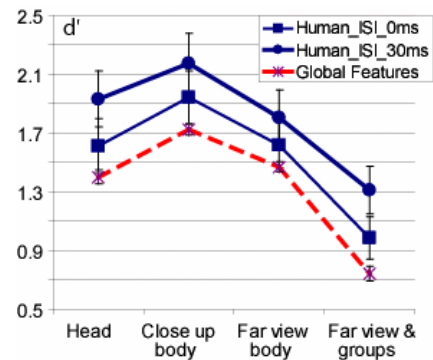
- Multiple conditions (3 or more levels of a variable) are often used to determine the shape of the function that determines the dependent and independent variables.
- Multiple conditions also used when 2 or more levels of the independent variable (factor) are considered “controls”.

Levels of Independent Variable

- Question: how will detection performance vary with the distance of viewing the object – animal - ?
Target:
Images removed due to copyright reasons.
- First factor: Presence of an animal.
Distractor:
- Principal factor: distance of the animal from the camera with 4 levels (or 4 conditions)
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Levels of Independent Variable

- Question: how will detection performance vary with the distance of viewing the object – animal - ?
- First factor: Presence of an animal.
- Principal factor: distance of the animal from the camera with 4 levels (or 4 conditions)
- Dependant variable: d'



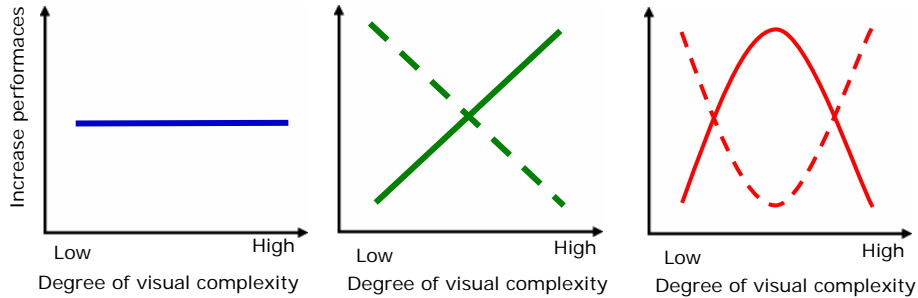
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Levels of Independent Variable

- When you choose the levels of a factor, you may need to take into account the full range of variations along that factor

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Hypotheses



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One independent variable: level of complexity (or clutter or quantity of objects)
How many levels/conditions do I need?

Experiment : Short-term memory

- Method: Participants (N=33) were asked if a target image was identical to a prime image, after a delay allowing a consolidation in short-term memory. The target could be the same image, a different image that looks alike (peer) or a very different image.

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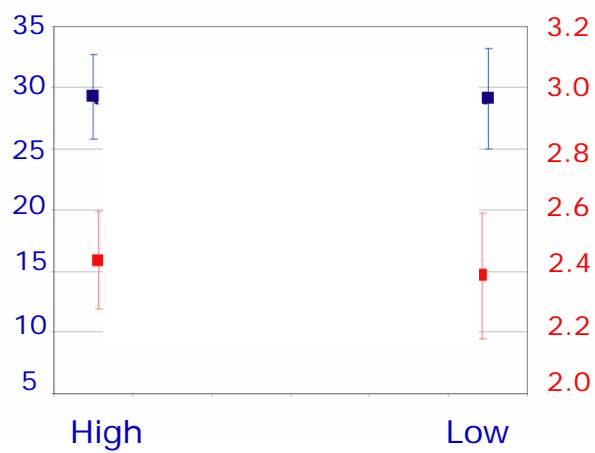
Which Dependent Variable can I use?

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Results

Dependant Variable 1

Dependant Variable 2



Levels of Independent Variable:
When the experiment calls for several conditions

- 1) the stimuli should cover as much as the range of the independent variable as practicable
- 2) the stimuli should be closed enough together that overlooking any interesting relationship between the stimuli is unlikely.
- 3) the spacing of stimuli: interval between the stimuli should be the same

Between-subject design

- When different groups of subjects (within-design are not possible because of the possibility of carry-over effects: practice, expertise, learning, memory).

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Leading question:
“About how fast were the cars going
When they *smashed* into each other?”

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Change blindness phenomena

- Change blindness is a phenomenon in visual perception where 'visible' changes occurring in a scene go unnoticed. This failure to detect change occurs even when changes in the visual scene are very large and when observers are explicitly instructed to look for changes.

Change Blindness's paradigm

- **"Flicker paradigm"**

Images removed due to copyright reasons.

Sequence is repeated 60s or until participant detects change

Single Factor, Between-subject design

The observation: People are not good at detecting changes in the visual environment.

The hypothesis: People will be slower to detect a change in two successive scenes if some visual event briefly intervenes between those two scenes (e.g. simulating a blink of the eye)

The method: Experiment using the Flicker Paradigm. In one condition, subjects' reaction time is measured to a changing object in one of two identical scenes that flicker back and forth with a gray screen presented between the scenes for 80 msec. In another condition, subjects' reaction time is measured to a changing object in one of two identical scenes that flicker back and forth without a gray screen.

The result: Subjects are significantly slower in the condition with the intervening gray screen.

Ron Rensink- Visual Cognition (2000)

How many subjects per level (condition) do you need ?

- How many subjects to use depend on how much variability you expect in your data
- The more subjects you have, the less the means of the data will deviate from their true value
- The usual way of representing this error of measurement is called the **standard error of the mean (s.e.m)**
- Increasing the number of subjects does not decrease the error of measurement in a linear way.
- **Nb subjects ? ~ 10 / condition, from 16-20, results should be stable**

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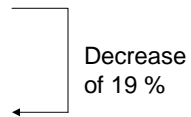
How many subjects should you test?

- Doubling the number of subjects (from 10 to 20) reduces the s.e.m by only 30 % (theoretical case)

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D-prime for the detection animal data:

N	s.e.m
6	0.24
10	0.23
16	0.18
20	0.18
30	0.16



Decrease of 19 %