9.63 Laboratory in Visual Cognition

Fall 2009

Single factor design

Textbook Chapters

- Chapter 5: Types of variables
- Chapter 8: Controls
- Chapter 7: Validity
- Chapter 11: Single factor design

Single design experiment

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

Single Factor design

- An experiment concerns with 1 independent variable (factor), and N levels.
- Abuse of language: “condition” is used as factor and levels.
- “Condition” is often used in a within-subject experiment instead of “group”.
- In a between-subject experiment, use the word group.
- Experiment with 1 factor have often a very precise hypothesis.

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 (if necessary for the hypothesis)

- Two types of design, for a single factor:
- Within-subjects design (all subjects do all conditions)
- Between-subjects design (conditions done by different subjects)

Design: order or counterbalancing

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

If 3 conditions

S1	ABC
S2	CAB
S3	BCA
S4	ACB
S5	BAC
S6	CBA

If 4 conditions

A B C D ? — 24 subjects (4x3x2)

If 5 conditions

A B C D E ? — 120 subjects (5x4x3x2)

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.

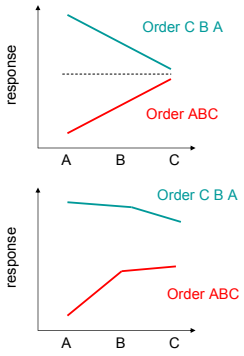
Reverse counterbalancing

- 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 onl 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).



Example I: Memory Task

Instructions: 9 photographs will be shown for half a second each. Your task is to memorize these pictures

Memory Confusion:
The scenes have the same spatial layout

You have seen these pictures

You were tested with these pictures

Factor

- Independent Variable : Type of foil manipulated at test
  Level 1: the foil image is very different image
  Level 2: the foil image resembles the original (has same spatial layout)

New image (similar foil)

Old image (seen)

New image (different foil)

Factor

- Independent Variable : Type of foil manipulated at test
  Control: the foil image is a very different image
  Level 1 : the foil image resembles the original (has same spatial layout)

New image (similar foil)

Old image (seen)

New image (different foil)

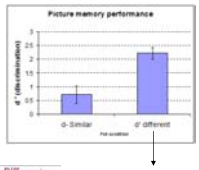
Dependant factor: A typical “d prime”

Old image (seen)

New image (similar foil)

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

Dependant factor: A typical “d prime”



“Control”

	HIT rate	FA-similar	FA-different	d' - Similar	d- Different
S1	0.49	0.82	0.1	-0.94	1.26
S2	0.67	0.6	0.05	0.19	2.08
S3	0.92	0.09	0.01	2.75	3.73
S4	0.66	0.65	0.02	0.03	2.47
S5	0.52	0.49	0.02	0.08	2.10
S6	0.77	0.46	0.04	0.84	2.49
S7	0.78	0.65	0.11	0.39	2.00
S8	0.82	0.64	0.07	0.56	2.39
S9	0.75	0.36	0.08	1.03	2.09
S10	0.69	0.55	0.01	0.37	2.82
Mean	0.707	0.531	0.051	0.53	2.34
s.e.m	0.04	0.07	0.01	0.32	0.21

Example II: Capacity of Visual Long Term Memory

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Capacity of Visual Long Term Memory?

What we know…

Standing (1973)

10,000 images

83% Recognition

… people can remember thousands of images

What we don’t know…

… what people are remembering for each item?

According to Standing

“Basically, my recollection is that we just separated the pictures into distinct thematic categories: e.g. cars, animals, single-person, 2-people, plants, etc.) Only a few slides were selected which fell into each category, and they were visually distinct.”

Figures removed due to copyright restrictions.

Massive Memory Experiment I

A stream of objects will be presented on the screen for ~ 1 second each.

Your primary task:

Remember them ALL!

afterwards you will be tested with…

Figures removed due to copyright restrictions.

Massive Memory Experiment I

Your other task: **Detect exact repeats anywhere in the stream**

Figures removed due to copyright restrictions.

Which one did you see?

(go ahead and shout out your answer)

-A-

-B-

how far can we push the fidelity of visual LTM representation ?

Same object, different states

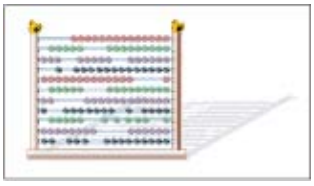


Figure by MIT OpenCourseWare.

Hypotheses

Novel condition

Exemplar condition

State condition

Figure by MIT OpenCourseWare.

- (1) As found by Standing (1973), memory capacity is excellent: we predict a very high score of percent correct (> 90%) in the *novel* condition
- (2a) According to change blindness experiments, memory fidelity (remembering the details of object) is poor: we predict recognition in the *exemplar* and *state* condition near chance level (50%).
- (2b) According to Standing (1970), memory of some visual aspects is conserved: recognition in the *exemplar* and *state* condition is superior to chance level.
- (2c) Memory fidelity is very good: we predict recognition in the *exemplar* near the level of the *novel* condition, but recognition will be lower in the *state* condition
- (2d) Memory fidelity is outstanding: we predict recognition in the *exemplar* and *state* condition at the level of the *novel* condition.

Method

Novel condition

Exemplar condition

State condition

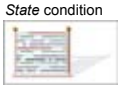
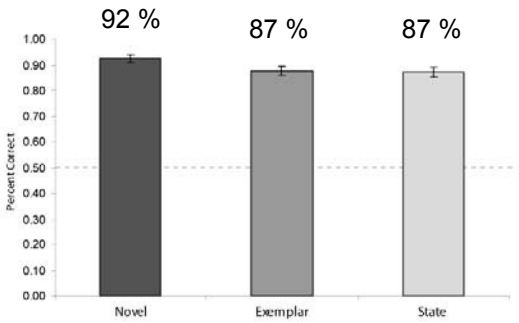


Figure by MIT OpenCourseWare.

- **Independent variable :** The level of similarity in the tested pairs, with 3 levels: (1) novel condition, (2) exemplar condition, (3) state condition.
- **Dependent variable:** the percent of correct recognition at test (chance level is 50%)
- Participants: 14 adults (18-35 years old), naïve to the object of the study
- **Stimuli**: 2500 pictures of different object classes
- **Procedure**:
- *Learning*: each object shown for 3 seconds, then a 800 blank interval (for a total of 5.5 hours). The task is to detect image repeat (response given by pressing the bar space).
- *Testing*: 300 pairs of objects shown on the screen (100 pairs per stimuli condition), one at a time, until the participant's response.

Is the *novel* condition statistically different from the *exemplar* and the *state* condition?



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Example of News Article

Example III: Multiples level of a factor

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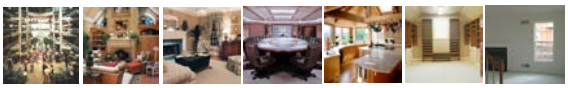
Within subject: multiple conditions

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

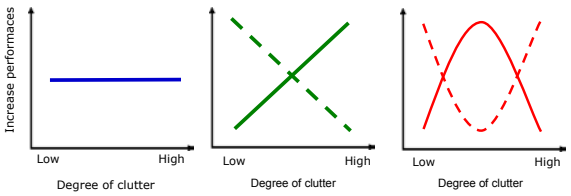
Levels of Independent Variable

- When you choose the **levels of a factor**, you may need to take into account the full range of variations along the variable
- Question: What is the effect of clutter on scene memory?

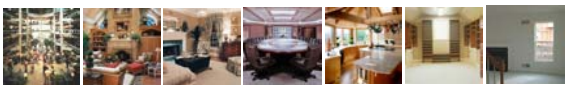


High clutter — Degree of visual clutter — Low clutter

Hypotheses

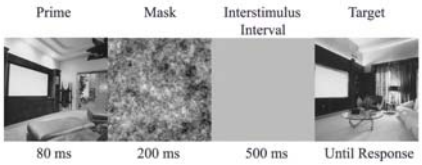


One independent variable: level of clutter (~ quantity of objects)
How many levels/conditions do I need?



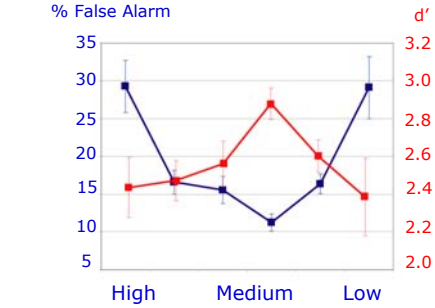
Experiment : Short-term memory

- Method: Participants 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.



Which Dependent Variable can I use?

Experiment : Results



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 (when possible)

Internal Validity

- Internal validity: cause-effect relationship between the independent and dependent variable
- **Watch out for "confounding effect"**

- Example of confounded variables which may or not have an impact on the data:
- Time of the day, year (group 1 testing morning, group 2 afternoon)
- Gender, Age, education
- Familiarity with the task
- Subject's mood - (did you run one condition right after a holiday?)
- Subjects' hobbies - video game players in one condition, gardeners in another?
- Different experimental machines?
- Familiarity with experimenter? (Were all your friends in one group/task?)

Construct Validity

- Construct validity: extend to which the results support the theory behind the research:
- **Ask the question: Would another theory predict the same experimental results?**
- You can never ensure construct validity, but you can plan your research so that it is more plausible
- Examples (textbooks ~ p. 172)
- In internal validity, you strive to rule out alternative variables
- In construct validity, you rule out other possible explanations
- In most cases, you have to run another experiment to rule out threats of validity
- For project 1 presentation, one of the exercise in class will be to think about internal and construct validity while your colleagues will present.

Statistical Validity

- Extend to which data are shown to be the result of cause-effect relationship rather than accident (chance alone)
- Did you have enough subjects? Enough stimuli? Was the variance between your groups comparable?
- Threats to validity: textbook pages ~ 173-179

Statistics Review

- Most research designs intended to provide evidence that one variable caused another
  - In a true experiment, does mean score in one experimental group differ from another group?
- "Statistical significance" assesses the probability that results could be due to chance rather than the hypothesized cause
  - E.g., could difference between 2 means be as large as it is by chance?
  - Could the outcomes be as large as it is by chance alone?

Comparing 2 Means

- Null hypothesis (H_0): Population means are equal. Any differences between sample means are due to chance (random error).
- Research hypothesis (H_1): Population means are not equal.
- T-test: Test statistic associated with a probability of obtaining sample means that differ by observed amount if population means were equal

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