

Teaching by Design

KEYWORDS

Experiment;
Factor.:

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Summary

Some teaching material which invites a group of students to design and carry out a small experiment to investigate the working of short term memory is described. No equipment of any kind is required. These ideas have been found to be very helpful in making students think about some very basic and practical issues in designing and carrying out an experiment. The simple nature of the material makes it accessible to all levels of students

◆INTRODUCTION◆

PRACTICAL work is an essential part of statistical teaching and it is desirable to build this in even at the most elementary levels, although considerations of space, time and equipment can make this difficult. Sometimes practical work takes the form of describing an experiment which someone else has performed and giving students the opportunity to explore and analyse the resulting data. It is, however, important that students are given some practical experience of the design of experiments and the collection of data. There are substantial psychological benefits to be gained from this because students then feel that they own the data and have greatly increased motivation to analyse it. They are also able to see the whole process, from problem through experiment to conclusion. This puts statistics within the context of scientific method and counteracts the perception that it is simply a collection of techniques of analysis. Students can also learn a great deal about the elementary practical issues associated with experiments.

The aim of this article is to describe an experiment whose design and analysis can be carried out in less than two hours. It concerns an investigation of the workings of short-term memory and requires no equipment. The idea for this material grew out of an M.Sc. course in Data Analysis given at the University of Manchester some years ago. A brief outline of this project is given in Anderson & Loynes (1987). The experiment described below was greatly improved and developed through conversations with Prof. Keith Millar of the Behavioural Sciences Group

at the University of Glasgow. It was carried out by sixteen students studying for an Honours degree in Statistics. However, the simplicity of the material would make it useful with students of levels.

◆THE EXPERIMENT◆ AND ITS DESIGN

The students were told that it was their task to design and carry out an experiment which would investigate the operation of short term (known by psychologists as “working”) memory. More specifically, the students were asked to study the way in which a list of items is recalled from memory. The role of the teacher was not to lead, but to act as chairman for the ensuing discussion and to steer the proceedings clear of major difficulties if disaster loomed.

After some discussion, the idea of asking each person to recall a list of words emerged. The class would work in pairs, one person would construct a list of words, read these aloud and then ask his partner to recall as many as possible. Further discussion of potential difficulties led to the following protocol.

1. The list of words should be read to the subject rather than displayed in written form, so that the recall of words in particular positions of the original list could be noted.
2. All words should have two syllables so that results are comparable across members of the class.
3. Each reader should say the word “elephant” silently after each word in the list, so that the list is read at an even pace.

4. The words should all be nouns so that there is less chance of the hearer constructing a helpful sentence linking the words.
6. The list should contain 12 words.
7. Alphabetical order should be avoided.
8. Unusual words should be avoided so that the results are comparable across the class.
9. The list should be read once only so that the effect of order is identifiable.
10. Subjects should be given a period of 30 seconds within which to recall as many words as possible.
11. Before the period of recall begins, there should be a silent gap of 10 seconds, so that the subject is not simply immediately repeating the last few words heard.
12. In order to identify positions, the recorder should note a list of 1's and 0's corresponding to whether the words in the list were recalled or not.

There may be aspects of this experiment which are open to improvement but the list makes clear that the students were very willing to participate and that a large number of important practical issues were rapidly identified. Almost all of these were contributed by the students themselves.

In further discussion, some points for later investigation were noted. These included:

- (i) the effect of using related rather than unrelated

- words,
- (ii) the effect of altering what happens in the period between reading and recall,
- (iii) whether it would be better if one person read a single list to the whole class.

◆RESULTS, INTERPRETATION AND FURTHER EXPERIMENTA- TION

The experiment was performed and the data collected without difficulty. The data were collated, added up and plotted on the blackboard. Analysis consisted simply of counting up the number of people who correctly recalled items from each position in the list of twelve words. In view of the small number in the class these data were further amalgamated into totals corresponding to the six adjacent pairs of words across the list. These totals are plotted in Figure 1 using the code A. We see that early and late words in the list are recalled better than those in the middle. Psychologists interpret this as evidence that the early words find their way into long term memory whereas the words in the middle of the list are overwritten in short term memory by those at the end.

A second experiment was then performed to investigate the effect of using words which are related. It was thought better to use a single reader for the whole class and some regret was expressed that this had not happened in the first experiment. This also had the effect of streamlining the conduct of the experiment. All the words chosen by the reader had connections with the then current events of leadership election in

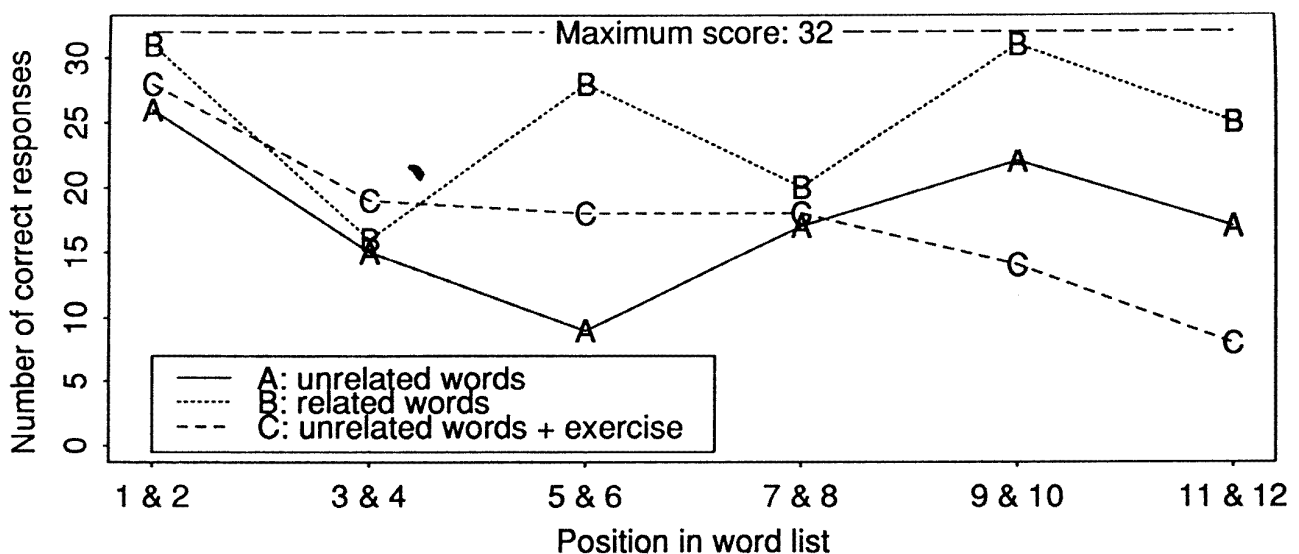


Fig. 1. Frequencies of correct responses.

the Conservative party. The results of this experiment are displayed in the figure as code B and it is clear that related words produce higher scores at all positions in the list. Psychologists interpret this as evidence that memory operates in a conceptual way, rather than consisting of a set of pigeonholes for arbitrary items.

A third experiment was conducted, using an unrelated word list, to assess the effect of changing the conditions in the period between reading and recall. The hearer was asked to count backwards in 7's from 256 as an exercise which required appreciable thought and so prevented the rehearsal of the word list. The results are presented in the figure as code C. It is clear that the recall of later words is poorer and this is interpreted as indicating that the contents of working memory have been obliterated by the arithmetic exercise.

◆CONCLUSIONS◆

There is clearly plenty of scope for tailoring this kind of experiment to the time available and to the experience of the students. In the second year of this lab the students used a factorial design on the two factors related or unrelated words and presence or absence of disturbance before the recall period. In the first year of the lab, the last half hour of the lab was devoted to a related exercise described by Ley et

al (1973). Here, a consultation of a patient with a GP is simulated in two ways, one where the information and advice was given to the patient in conversational form and another where the statements were organised into connected groups in a very coherent way. Given the background of these students it was possible to split the class into two groups and organise a simple crossover trial.

It was clear from the students' reactions that they enjoyed the lab. In my opinion they also learnt a great deal. The lessons learnt were simple and practical but important. The results of the experiments were not profound but, in a small way, they allowed the students to gain the satisfaction of carrying out an investigation from beginning to end.

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