Science Education Collection

Measuring Verbal Working Memory Span

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Overview

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Why is it relatively hard to remember everything on a shopping list if it includes more than just a handful of items? Why is it possible to remember a phone number that one just heard, but not two or three phone numbers at once? Why is it difficult to remember names when several new people are introduced at the same time?

The answer has to do with the fact that over short-durations people rely on a specialized memory system called working memory. Unlike long-term memory, working memory has a very limited capacity. It is there so that information can be kept in mind, studied, manipulated, and then transferred to other memory and cognitive systems. But in order to serve in this active role, it needs to be selective, admitting only limited amounts of information at a time.

Experimental psychologists tend to think that people possess independent working memory systems for different kinds of information, with a major division between verbal and visual information. Each of these systems has an independent capacity limit.

To measure a person's verbal working memory capacity limit—often called, his or her memory span—experimental psychologists often use a verbal list paradigm.

This video will demonstrate the measurement of verbal working memory span using a verbal list paradigm.

Procedure

1. Make a set of word lists.

1. To make stimuli for this experiment, gather 40 index cards and a pen.
2. Generate a random list of 210 common nouns, words like, car, dog, pen, boat, chair, and hammer.
3. Each index card will include three, four, five, six, seven, eight, or nine common nouns on it. Make five cards with each number. Don't repeat nouns from list to list, and try not to have them group together by category. For example, avoid lists with only animals or tools or foods. Instead, try to make sure the lists are mixed, with a variety of content types on each. A sample list of three words might include bowl, table, and saw and a sample list for five might include: shelf, deer, jelly, book, and flame.

2. Test a participant.

1. Place your index cards face down on a table between you and the participant, organized into piles for each number of words.
2. Explain the instructions: On each trial, the experimenter will pick up one of the cards, slowly read the words on the card in order from top to bottom, and as soon as the experimenter finishes the participant will need to repeat the list, in the same order.
3. Start with the top card on the three-word pile, complete that pile, and work your way up.
4. As the participant responds note on the relevant card whether a word was repeated back correctly by placing a check mark next to a word when the participant says it, or an 'X' if she fails to, or says something else in its place. The words need to be reported back in the right order.
5. The experiment is done when you get through all the lists.

3. Perform the analysis.

1. If you go back the index cards, you have a record of whether each word in a list was recalled correctly or not.
2. The most informative way to analyze these results is in terms of the number of words in a list, and a given word's position in a list. For all the cards with three words, for example, you can compute the probability that the first word was recalled correctly, and the same for the second and third words. Do this for all the lists, and input the results into a spreadsheet (**Table 1**).
3. For graphing purposes, translate Table 1 into a more compact summary of accuracy as a function of word position and list length (**Table 2**).

List Length	Word Position	Number correct	Percent Correct
3	1	5	100
3	2	5	100
3	3	5	100
4	1	5	100
4	2	4	80

4	3	5	100
4	4	5	100
5	1	5	100
5	2	4	80
5	3	4	80
5	4	5	100
5	5	5	100
6	1	4	80
6	2	4	80
6	3	3	60
6	4	3	60
6	5	3	60
6	6	5	100
7	1	4	80
7	2	2	40
7	3	3	60
7	4	2	40
7	5	2	40
7	6	3	60
7	7	4	80
8	1	5	100
8	2	3	60
8	3	3	60
8	4	1	20
8	5	3	60
8	6	2	40
8	7	3	60
8	8	4	80
9	1	4	80
9	2	3	60
9	3	1	20
9	4	3	60
9	5	2	40
9	6	1	20
9	7	3	60
9	8	3	60
9	9	4	80

Table 1. List learning results. Example data from one participant. Recall that there were five cards for each list length. For a given word position and given list length, the participant had five opportunities. Percentage correct is thus the number of correct responses out of five.

	Position								
Length	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
3	100	100	100						
4	100	80	100	100					
5	100	80	80	100	100				
6	80	80	60	60	60	100			
7	80	40	60	40	40	60	80		
8	100	60	60	20	60	40	60	80	
9	80	60	20	60	40	20	60	60	80

Table 2. Summary of list learning results. The data are summarized in terms of response accuracy as a function of a word's position in a list and the length of the list.

Results

In terms of verbal memory span, one way to classify a person's ability is as the longest list for which he/she performs better than 75% correct for all word positions. For this participant, that seems to be a list with five words (**Figure 1**), which makes the verbal working memory span five.

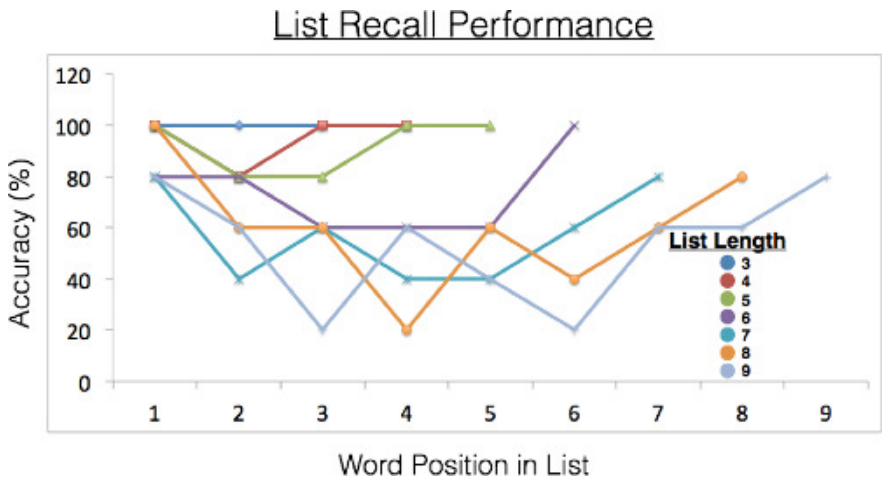

Figure 1. List learning accuracy as a function of word position and list length. Each line represents a list of a given length, and each point is the percent of occasions in which a word in a given position was recalled.

One feature of performance here and in general in list learning experiments is that accuracy is much better at the beginning and end of a list, compared to words in the middle. As shown in **Figure 1**, for the seven-word performance (colored in teal), the first word was recalled with 80% accuracy (one mistake out of five trials), and the last word too. But in the middle, performance was 40% or 60%.

Such results are typical, and experimental psychologists have used results like this to draw several conclusions about verbal working memory. The first is that it involves an active rehearsal process. This is why words in the beginning of the list are remembered better—sometimes called a primacy effect. They are rehearsed more than other words over the duration of maintenance. The second conclusion is that the contents of verbal working memory interfere with one another; this is why words in the middle of the list are recalled with greater difficulty. They have more neighbors to compete with and interfere with. And this is also why the very end of a list is often spared—called a recency effect. The words there were heard most recently, and with no interfering neighbors afterwards.

Applications and Summary

Measures of verbal working memory, including list learning, are used in a variety of contexts as a quickly and easily obtainable measure of an individual's cognitive ability. This is because memory span is known to correlate very reliably with IQ. In fact, memory span is a sub-test on many IQ tests. In clinical settings, verbal span can thus be used to determine whether illness or brain damage has had an effect on cognitive functioning in general, and as indicator of degenerative diseases such as Alzheimer's.