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Measuring Verbal Working Memory Span

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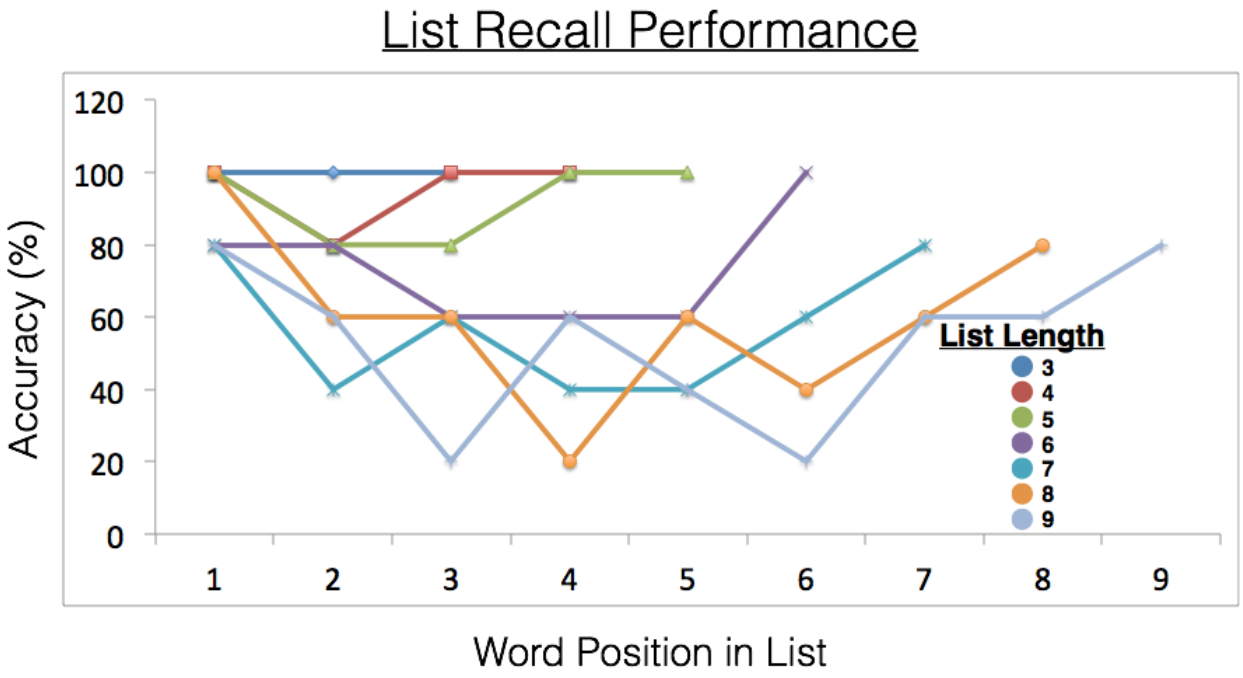

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	Position								
Length	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
3	100	100	100						
4	100	80	100	100					
5	100	80	80	100	100				
6	80	80	60	60	60	100			
7	80	40	60	40	40	60	80		
8	100	60	60	20	60	40	60	80	
9	80	60	20	60	40	20	60	60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

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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

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Psychology Education Title

Measuring Verbal Working Memory Span

Overview: 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 simultaneously? 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. In order to serve in this active role, working memory needs to be selective, admitting only limited amounts of information at a time.

Experimental psychologists often posit 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 a memory span— experimental psychologists often use a verbal list paradigm.

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

Procedure

1. Make a set of word lists

1.1. Generate (either by hand or on a computer) a random list of 150 or so common nouns, words like, CAR, DOG, PEN, BOAT, CHAIR, and HAMMER.

1.2. Take an index card and write three of the previously generated nouns on it. Do this five times total, so that you have five cards, each with three nouns on them.

1.3. Take another index card and write four of the previously generated nouns on it. Do this five times total so that you have five cards, each with four nouns on them.

1.4. Repeat steps 1.2 and 1.3 for five, six, seven, eight, and nine of the common nouns. Be sure not to repeat nouns from list to list, and avoid having nouns grouped 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, Saw", and a sample list for five might include "Shelf, Deer, Jelly, Book, Flame". When you are done you should have five cards with three nouns, five cards with four nouns, five cards with five nouns, and so on, up to nine nouns.

2. Testing a participant

2.1 Participant pool includes healthy adults between the ages of 15 and 50.

2.2. Place your index cards face down on a table between you and the participant. The cards should be stacked into piles for each number of words.

2.3 Explain the instructions to the participant: "On each trial, you will pick up one of the cards, slowly read the words on the card in order from top to bottom, and as soon as you finish you will need to repeat the list, in the same order."

2.4 Start with the top card on the three-word pile, complete that pile, and work your way up.

2.5 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 he or she fails to, or says something else in its place. The words need to be reported back in the right order.

2.6 The experiment is done when you get through all the lists.

3. Analysis

3.1 If you go back to the index cards, you have a record of whether each word in a list was recalled correctly or not.

3.2 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 that will look like this:

Table 1. *Sample results from list learning. Recall that there were five cards for each list length. That means that 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.*

This table can in turn be translated into a more compact summary of accuracy as a function of word position and list length:

Table 2*. Sample results from list learning summarized in terms of response accuracy as a function of a word's position in a list and the length of the list.*

Representative Result

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.*

The figure plots the results in Table 2. In terms of verbal memory span, one way to classify people's ability is to identify the longest list for which they perform better than 75% correct for all word positions. For this participant, that seems to be a list with five words. So their verbal working memory span is five.

One feature of performance here and generally in list learning experiments is that accuracy is much better at the beginning and end of a list, compared to words in the middle. Look at the seven word performance for example (colored in teal). The first word was recalled with 80% accuracy (that's just one mistake out of five trials), and the last word too. But in the middle performance was 40% or 60%.

This is 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. This is 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 and interfere with. This is also why the very end of a list is often spared, often referred to as a recency effect. The words there were heard most recently, and with no interfering neighbors afterwards.

Applications

Measures of verbal working memory, including list learning, are used in a variety of contexts as a quick and easily obtained 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.

Possible additional images

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Legend:

Table 1. *Sample results from list learning. Recall that there were five cards for each list length. That means that 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.*

Table 2*. Sample results from list learning summarized in terms of response accuracy as a function of a word's position in a list and the length of the list.*

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.*