To determine the effectiveness of delay and distraction on free recall rate in order to verify two

Shreya Jain

Table of Contents

Introduction

The subject of memory has been an area of interest for psychologists for some time. Many theories and ideas suggesting the process of recalling information have been proposed over the years. Atkinson and Shiffrin studied short-term and long-term memory to develop the Multi Store Model (MSM), which defined memory as a cognitive process that helps encode, store, retain and later retrieve information. Their theory emphasised the individual stores of memory acclaimed as the sensory register, short-term memory (STM) and long-term memory (LTM). Short-term memory is the capacity to store limited information and keep it readily available for a brief period. In contrast, long-term memory refers to the unlimited storage of information maintained for an indefinite period of time.

MSM suggested a linear fashion in which information flowed through these three stores. Information is first inherited from the five senses such as sight, touch, sound etc. The sensory register stores this information for a brief period of time. The information that is attended to is encoded and then transferred to the Short term memory store, whereas the rest of the information is lost and thereby forgotten. The short term memory store can only hold a limited amount of information (7 ± 2 chunks) for a specific duration of under 30 seconds. If information is rehearsed, it is then transferred to the long-term memory store, whereas unrehearsed information decays. The long-term memory store is said to retain unlimited amount of information for indefinite periods of time.

Their theory received a lot of recognition and criticism. Over the years, many theories opposing the multi-store model have also been proposed.

One of the strongest evidence for the MSM is the serial position effect. It is a cognitive phenomenon theorising that the first few and last few words of a sequence are recalled more frequently than the words in the middle, suggesting that it is a product of human short-term and long-term memory processes and hence supporting the multi-store model. The tendency to remember the first few words is due to a cognitive bias called the primary effect, whereas the tendency to remember the last few words is due to the primacy effect.

An experiment by Cunitz and Glanzer in 1966 aimed to understand the effect of short-term and long-term memory mechanisms in the beginning and end peaks of the serial position curve. By identifying and categorising the findings of the study depending on the primacy effect and/or recency effect, the researchers explored the serial positioning effect under three different conditions.

In experiment II, 46 army enlisted men participated in a lab experiment. The experiment conducted a free recall task after being presented with a list of 15 monosyllabic words. The researchers used a repeated measures design by testing subjects individually and randomly assigning the word lists to one of the three conditions. The three conditions were immediate free recall(IFR) and delayed free recall of 10 (DFR10) and 30 (DFR30) seconds, respectively. Participants had a distraction task during the delay to prevent further rehearsal. The number of words recalled was their dependent variable, and the delay in time was their independent

variable. Through the findings, the researchers observed that in the free recall condition, both the primacy and recency effects were present. However, as the delay in free recall increases, the presence of the recency effect shrinks. This can be explained through the finds of the DFR 10 and 30 condition.

Cunitz and Glanzer's experiment is significant to cognitive psychology in understanding memory as a complex cognitive process that encompasses multiple mechanisms. Memory is vital for the operation of various human functions like thinking and decision-making. Hence, it allows us to understand human rationale that influences our behaviour, decisions and thought process. Cognitive biases such as the serial positioning effect are systemic errors in thinking and decision-making that explain the influences on the processing and interpretation of information. Especially as students, memory serves as an important trait that we utilise in and beyond academics.

Students' memories serve as a record of what they have learned. Understanding how memory works and functions may enable us to make better use of it. Taking inspiration from the study of Glanzer and Cunitz, we decided to replicate the experiment to test the claims presented in the serial positioning effect, particularly the recency effect.

Our experiment was a variant modification of the aforementioned one. Instead of using a repeated measures design like the experiment, an independent measures design was used to avoid participant acculturation, fatigue, and the possibility that the true purpose of the experiment would be guessed by the participants. The participants were divided into two conditions:

immediate free recall (IFR) and delayed free recall (DFR). An audio file including a list of 30 words was played to the participants, they were then instructed to recall and note the words mentioned in the audio file. The participants in the DFR condition had to engage in a distraction activity for 60 seconds before filling out their data slips, which was the only distinction between the two groups.

Investigation: To investigate how the placement of words in a list affects recall and how changes in variables influence the recency effect.

Research hypothesis: The bimodal serial positioning curve and U test statistics produced would depict the influences of variables on the recency effect.

Null hypothesis: The bimodal serial positioning curve and U test statistics produced do not represent two distinct storage mechanisms. Changes in variables have no effect on the recency effect curve.

Exploration

Design

Independent measures design was used for this experiment to compare and contrast the findings of the study, participants were randomly allocated to either the control or the experimental group. However, age was taken into consideration while dividing the participants into groups. An equal number of participants from each age group were used in both conditions.

In terms of experimental controls, there were standardised instructions, methodology and debriefing. Both groups were presented with the same recording of the list of words. Furthermore, it was ensured that the experimental group participants underwent the same distraction activity. To control situational variables, all participants were tested in a quiet classroom on the school grounds, where there were no distractions and minimal noise.

The collected nominal data would be converted to ordinal data for inferences and descriptive statistics. A random word generator was used in the experiment to generate 30 monosyllabic and disyllabic nouns. To avoid confounding variables, the provided words were familiar and frequently used. The DFR condition participated in a 60 seconds distraction activity where they were instructed to count numbers aloud.

Ethical considerations were followed by ensuring adequate information was provided to all participants to make an informed decision. They were also made aware of their right to withdraw from the experiment at any given time. Consent was sought before the experiment by the participants and their parents in case they were under 16. They were debriefed at the end of the experiment regarding the aim of the experiment.

Participants

26 participants between the ages of 14 through 18 were selected from within the school through convenience sampling since it is the most timely method to procure participants. The inclusion criteria were that each participant should have sufficient proficiency in English as the words list

constituted English words. In addition, we ensured none of the participants are/were psychology students, eliminating participant expectations that may result in low credibility. To minimise the objective intellectual differences between the age group, we randomly allocated 13 students based on their ages such that both groups could have an equal number of students belonging to the same age group.

Materials

As mentioned in the experimental controls, both groups were subjected to the same voice recording of the 30 words list which consisted of randomly generated monosyllabic nouns with two seconds intervals between each word. (Appendix E)

Excluding the voice recording, the materials used were:

- Laptop for the audio recording.
- Informed consent form. (Appendix A)
- Standardised Instructions for participants to understand the procedure of the experiment. (Appendix D)
- Debriefing form provides participants with an explanation of the hypothesis being tested and their role in the experiment. (Appendix C)
- Pen and data slips (Appendix B) for the participants' responses.

Procedure

1. Ensure all participants acknowledge and approve their rights by signing the consent forms.
2. Divide the students based on their age, following which we randomly allocate an even number of participants of all ages to the control and the experimental group.
3. Assign separate classrooms for both groups of participants; ensure the classrooms is empty with no distracting materials present such as posters etc.
4. Standardised briefing instructions were read to the participants, and questions regarding the experiment were answered.
5. Participants were provided with data slips, and the voice recording with the list of words was played.
6. Participants were instructed to answer the questions on their data slips. This asked for their initials and their age.
7. Participants in the IFR conditions were requested to recall the words from the audio and list them in the data slip within five minutes
8. Participants in the DFR conditions performed a distraction activity before filling out the data slips. They were asked to call out even numbers out loud for 60 seconds.
9. Once all groups had undertaken the experiment, they were collectively debriefed about the experiment's aim: a brief about the MSM and serial positioning effect. The results of the experiment were also provided to them through an email post the experiment.

Analysis

The serial position curve was used as inferential statistics to determine the difference in the recency effect. The serial position curve is a U-shaped relationship between a word's position in a list and its recall probability. To generate the serial positioning curve for the last ten words, the percentage recall for each serial position was calculated using the formula $\left(\frac{Number\ of\ times\ the\ word\ was\ recalled}{Number\ of\ Participants}\right) \times 100$. The graph below was created by plotting the IFR and DFR serial position number against the proportion of words correctly recalled.

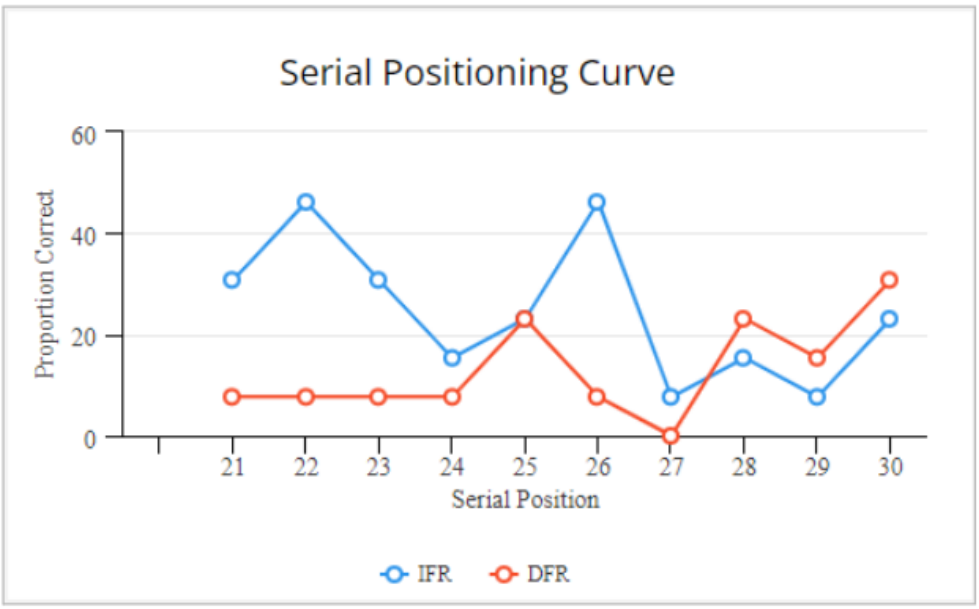

Figure 1: bimodal serial positioning graph

The proportion of recall in regards to the recency effect is higher for IFR than DFR. The variability in the data could be due to extraneous variables. Considering recall weakens for the experimental condition relative to the controlled condition, it verifies the research hypothesis.

The experiment conducted used mean recency rate and standard deviation for descriptive analysis. In order to measure the dispersion of the dataset relative to its mean, we calculated the standard deviation using the data for the recency effect in each group.

Table 1: recency mean and standard deviation of the raw data

Condition	Recency Mean	Standard Deviation
IFR	2.69	1.94
DFR	1.38	1.22

The table above shows the calculated mean and standard deviation. Through this data, we can deduce that the control group that underwent immediate free recall is more likely to recall words from the recency effect as compared to the experimental condition (DFR) due to the higher recency mean value. This shows that the recency effect disappears as a result of a delay in recall.

A U test was performed to compare the differences in the ordinal data obtained from two independent groups. It helped in determining the appropriate hypothesis. It was conducted using the raw data (Appendix F) and tested against a 0.05 significance level.

The U value obtained was 65.5, which was greater than the p-value for the critical value of 45. Hence, the null hypothesis is rejected, and the research hypothesis is accepted. Confirming that a delay in recall influences the recency effect.

Evaluation

Although there were differences between the two experiments, the findings are consistent with those of Glanzer and Cunitz experiment II. Furthermore, the bimodal serial positioning graph, the similarities between the differential and inferential data, and the large standard deviations strengthen the null hypothesis. It also proved the existence of multiple memory stores and hence, the multi-store model. As the method and procedure of the experiment are simple, replication is easier, improving reliability.

Several factors contributed to strengthening the validity and credibility of the experiment. Since it was conducted in a controlled environment, internal validity was ensured. The independent measures design helped eliminate the order effect and participant bias. It also prevented the participants from figuring out the true aim of the study, consequently eliminating demand characteristics. Researcher bias was also minimised by the random allocation of participants and standardised procedure.

However, a number of variables could've influenced the results. Considering that recollection is also dependent on an individual's ability, the variance in the data may have been due to their individual cognitive ability. To counteract this, we attempted to divide equal number of participants from each age group, nonetheless, it does not guarantee homogeneity in regard to general recall ability. Since the participants hailed from similar backgrounds, the participant variable effect could've also influenced the findings, limiting the generalisability and

cross-cultural validity. The experiment was also conducted in a highly artificial setting, causing it to lack mundane realism and ecological validity.

The methodology utilised ensured the minimisation of biases and confounding variables, however, the study could be further improved. A field experiment design could instead be employed, including a diverse set of participants from varying intellectual backgrounds. Additionally, a greater number of DFR conditions could be used like the experiment suggested to examine the extent of the influence of delay on recall.

Bibliography

Mcleod, Saul. “Serial Position Effect - Simply Psychology.” *Serial Position Effect - Simply Psychology*, www.simplypsychology.org/primacy-recency.html.

“What Is Serial Position Effect? | Definition From TechTarget.” *WhatIs.com*, 1 Feb. 2017, www.techtarget.com/whatis/definition/serial-position-effect.

“Mann-Whitney U Test in SPSS Statistics | Setup, Procedure and Interpretation | Laerd Statistics.” *Mann-Whitney U Test in SPSS Statistics | Setup, Procedure & Interpretation | Laerd Statistics*, statistics.laerd.com/spss-tutorials/mann-whitney-u-test-using-spss-statistics.php.

“Two Storage Mechanisms in Free Recall.” *Two Storage Mechanisms in Free Recall - ScienceDirect*, 14 Sept. 2005, https://doi.org/10.1016/S0022-5371(66)80044-0.

“Distance Between Related Words in Free Recall: Trace of the STS.” *Distance Between Related Words in Free Recall: Trace of the STS - ScienceDirect*, 14 Sept. 2005, https://doi.org/10.1016/S0022-5371(69)80018-6.

Appendix

Appendix A

Informed Consent Form

Greetings!

You are invited to participate in an experiment to investigate how delay and distraction influences free recall rate. This experiment is being conducted as a part of our IBDP Psychology course's Psychology Internal Assessment. Prior to agreeing to participate in the study, we request you to read and approve the following agreement so that you can make an informed choice about participating in this study.

Confidentiality: All information gathered will be kept strictly confidential. The data will be used for data analysis and to write a research paper. Only those conducting the study will have access to your responses. Also, responses will not be affiliated with your name; instead, the researchers will consider the initials of your name when archiving the information. No personal details or names will be used in any publication or presentation.

Potential Risks and Discomforts: There are no anticipated risks associated with taking part in this study, so there should be no discomfort.

Incentives to Participating: The satisfaction of adding to our knowledge of how memory functions in the brain is the benefit associated with taking part in this study.

Compensation: There is no monetary compensation for the experiment.

Participation and Withdrawal: Your participation in this research is entirely voluntary.

It won't have an impact on your relationship with Nahar International School if you decide not to participate. If you choose to take part, you are free to change your mind and discontinue your involvement at any time without facing any repercussions.

Questions: If and only if the question does not impede the true aim of the experiment, the experimenter will answer any inquiry about the research now or during the course of the experiment.

The true purpose of this research will be revealed at the end of the experiment.
If you have any further questions or concerns, please contact those responsible for conducting the experiment.

I had the opportunity to discuss the above study, and all of my questions were answered satisfactorily. I agree to participate in the study with the understanding that I can elect out at any time. I am aware that upon completion of my participation, a verbal and written explanation of

the rationale and predictions underlying this experiment will be presented. I freely agree to participate in this study. By signing this form, I declare that I am between the ages of 14 and 18.

Name: Signature:

Appendix B

Data Slips.

Please answer the following:

Initials of your name: _____

Age:____

Write down as many words as you remember from the audio recording played in any order.

Appendix C

Debriefing Instructions

Thank you for participating in the experiment!

This experiment was a near replica of a study done by Glanzer and Cunitz in 1966, known as "Two Storage Mechanisms in Free Recall".

The experiment's primary objective was to demonstrate the distinction between short-term and long-term memory. To do this, we presented the identical collection of words to two participant groups. After the presentation, one group had to recall the words. After 60 seconds, the other group had to recall the phrase. The recency effect was lost because these individuals had to count out loud the even numbers, which prohibited rehearsing. The words could be freely recalled by both groups in any sequence. The outcomes that we anticipate were: Only if the preceding words are remembered and tested right away will the words at the end of the list be remembered. The recency effect would be avoided if the recall was delayed by 60 seconds.

The multi-store model of memory, which argues that memories are stored in one of three stores, is the foundation of this study. When you initially come across information, it is temporarily stored in your sensory memory before entering your short term memory if you pay attention. Only around 7 objects may be stored in your short-term memory at a time, and recalling them takes regular practice. The information will reach long-term memory with enough repetition, where it will be permanently preserved. Primacy and recency effect, which are a part of the serial position effect, is a cognitive phenomena where people prefer to recall the first and last elements in a series. It has been discovered by researchers that reading aloud to participants a list of words improves their recollection of both the list's first and final few words (primacy and recency effects respectively). These results can be explained by the fact that the last few words are still fresh in short-term memory but the initial few words have been practised long enough to reach long-term memory.

The results for the experiment will be shared with you via email as soon as we are done analysing them. Once again, this experiment was conducted under informed consent, and you (the participants) have the right to withdraw from the experiment.

Are there any more questions you would like us to answer? Thank you for your time.

Appendix D

Standardised Briefing Instructions.

Participant, please be seated.

1. You are requested to listen to an audio recording that will be played on my computer.
2. You are now requested to fill in the data slips.
3. On these slips we require you to write down the initials of your name, your age and list down as many words as you remember in any order.

Appendix E

Words.

1. Growth
2. Weak
3. Slam
4. Risk
5. Diet

6. News
7. Book
8. Rough
9. Trunk
10. Bell
11. Tree
12. Hit
13. Sword
14. Clock
15. Meat
16. Pen
17. Lemon
18. Table
19. Sky
20. Dress
21. Car
22. Apple
23. Time
24. Phone
25. Blood
26. Airplane
27. Crown
28. Shoulder

29. Board

30. Watch

Appendix F

Raw Data.

IFR:

Participant	Interval (s)	age	words remembered position wise	Recall Rate	Ranks
P1	0	14	1,2,5,26	1	9
P2	0	14	1,2,3,10,11,15,16,18,19	0	3.5
P3	0	15	9,11,12,17,18,21,22,26	3	19.5
P4	0	15	1,3,8,14,17,20,23	2	14.5
P5	0	15	3,7,14,16,21,23,30	3	19.5
P6	0	16	1,2,4,7,14,15,16,18,22,28	2	14.5
P7	0	16	1,4,5,7,11,13,16,17,18,19,22,23,25,26,27,28,29	7	26
P8	0	17	1,2,3,4,14,19	0	3.5
P9	0	17	3,5,8,11,14,21,24,26,30	4	23
P10	0	17	1,6,11,22,25	3	19.5
P11	0	17	1,2,14,17,22,23,30	4	23

P12	0	18	1,2,4,5,17,18,26	1	9
P13	0	18	1,11,13,14,17,19,20,21,22,24,25,26	5	25

DFR:

Participant	Interval (s)	Age	Words remembered position wise	Recall Rate	Ranks
P14	60	15	5,13,18,24,28,30	3	19.5
P15	60	15	6,11,22,23,28,30	4	23
P16	60	15	4,11,16,18,25	1	9
P17	60	16	6,7,8,28,30	2	14.5
P18	60	16	2,3,11,13,15,30	1	9
P19	60	16	1,2,4,11,26	1	9
P20	60	17	3,4,5,7,8,13,17,18	0	3.5
P21	60	17	1,2,13,16,18	0	3.5
P22	60	17	3,5,6,7	0	3.5
P23	60	17	2,15,21,25	2	14.5

P24	60	17	1,6,7,16,18,25,29	2	14.5
P25	60	18	9,10,11,14,17	0	3.5
P26	60	18	2,13,14,16,18,29,30	2	14.5

Appendix G

Calculations.

Mean and Standard Deviation Calculations:

Condition	Recency Mean	Standard Deviation
IFR	2.69	1.94
DFR	1.38	1.22

x=xn

s=x2n-(x) 2

n=13

Calculations for Serial Positioning Graph:

	Proportion Correct	
Serial Position	IFR	DFR

21	30.77	7.69
22	46.15	7.69
23	30.77	7.69
24	15.38	7.69
25	23.08	23.08
26	46.15	7.69
27	7.69	0
28	15.38	23.08
29	7.69	15.38
30	23.08	30.77

Test Statistics for U test Calculations:

USTAT=Rank Sum - n(n+1)2

= 156.5- 13(13+1)2

= 65.5

Critical Value of the U-test Two-Tailed Chart for the utilised sample size:

n_2	α	n_1										
		3	4	5	6	7	8	9	10	11	12	13
3	.05	--	0	0	1	1	2	2	3	3	4	4
	.01	--	0	0	0	0	0	0	0	0	1	1
4	.05	--	0	1	2	3	4	4	5	6	7	8
	.01	--	--	0	0	0	1	1	2	2	3	3
5	.05	0	1	2	3	5	6	7	8	9	11	12
	.01	--	--	0	1	1	2	3	4	5	6	7
6	.05	1	2	3	5	6	8	10	11	13	14	16
	.01	--	0	1	2	3	4	5	6	7	9	10
7	.05	1	3	5	6	8	10	12	14	16	18	20
	.01	--	0	1	3	4	6	7	9	10	12	13
8	.05	2	4	6	8	10	13	15	17	19	22	24
	.01	--	1	2	4	6	7	9	11	13	15	17
9	.05	2	4	7	10	12	15	17	20	23	26	28
	.01	0	1	3	5	7	9	11	13	16	18	20
10	.05	3	5	8	11	14	17	20	23	26	29	33
	.01	0	2	4	6	9	11	13	16	18	21	24
11	.05	3	6	9	13	16	19	23	26	30	33	37
	.01	0	2	5	7	10	13	16	18	21	24	27
12	.05	4	7	11	14	18	22	26	29	33	37	41
	.01	1	3	6	9	12	15	18	21	24	27	31
13	.05	4	8	12	16	20	24	28	33	37	41	45
	.01	1	3	7	10	13	17	20	24	27	31	34

= *(significance level)* = 5 %; vcritical = 45 (critical value)