School Curriculum and Standards Authority

Work Sample

Psychology | ATAR | Year 12

Performance associated with Grade A, representing excellent achievement

Assessment type

Investigation

Task title

Memory

Summary of task

Students were asked to design a reliable, valid and ethical study on memory. The task sheet set out the requirements for the task and included an abstract, introduction, method, proposed representation of results, discussion and evaluation of predicted results, conclusion and references.

The task was completed out of class over a two week period.

A grade is based on the student's **overall performance for the pair of units,** as judged by the teacher with reference to a set of pre-determined standards. These standards are defined by grade descriptions.

A study of the duration of iconic and echoic memory in children

Abstract

100 participants (50 females, 50 males) aged 8 years old were presented with a visual and an aural test. The visual test consisted of a set of 15 common nouns shown for 0.34 seconds, of which participants were asked to name the words. The number that the participant recalled was recorded, and a second set of common nouns was shown for 0.34 seconds. After a 0.5 second delay, a tone was sounded and the participant named as many words as they could recall. This process was repeated with 0.5 second increases in the delay between exposure to the words and recall, up to a maximum of 5 seconds.

Similarly, in the aural test, a set of common nouns was read aloud and the participant asked to recall as many as they could. This number was recorded, and the test repeated. The following trials included a tone which indicated the 0.5 second delay, which increased with each trial by 0.5 seconds, to a maximum of 5 seconds.

Past studies had indicated that echoic memory had a longer duration of 4-5 seconds than iconic memory, which had a duration of approximately half a second (Atkinson-Shiffrin Model, 1968) and up to 1 second (Sperling, 1960). This suggested that an auditory stimulus, and therefore use of echoic memory, would retain information for longer, and make it more likely for a participant to remember more words than when they were presented with information in a visual format that made use of iconic memory.

The aim of this investigation was to explore whether the functioning of a child's echoic memory was similar to an adult's, in that its duration was longer than the iconic memory. For this study, it was hypothesised that if the children, aged 8, were exposed to a set of words presented as visual stimuli, then the number of words they were able to recall would decrease faster over time than a set of words presented in an auditory format. The results supported this hypothesis, in that children were able to recall more from an aural stimulus than a visual stimulus, and the number of words recalled from a visual stimulus declined more quickly than the number of words recalled from an auditory stimulus. This suggested that a child's echoic memory was more developed than their iconic memory, and functioned in a similar way to adults, putting forward the idea that the duration of echoic memory is superior to that of the iconic memory in both adults and children.

– formulates an operational hypothesis

Introduction

Sensory memory is the first stage in the multi-store model of memory; it receives and stores an unlimited amount of sensory information for up to a few seconds. There are two main systems through which sensory memories are processed: the iconic memory, and the echoic memory. The iconic memory registers visual information, while the echoic memory registers auditory information. These two areas of sensory memory generally have a more significant role than memory of the other senses.

The Atkinson-Shiffrin multi-store model of memory was developed in 1968 by Richard Atkinson and Richard Shiffrin to show how information was processed and stored by the human mind. The model had three distinct parts- sensory memory, short-term memory and long term memory [see figure 1]. According to the model, all information passed through the sensory memory, and information which was attended to stayed in the short-term memory. The information was only transferred to the long-term memory through processes of rehearsal.

For copyright reasons this diagram cannot be reproduced in the online version of this document, but may be viewed at https://www.simplypsychology.org/multi-store.html

Figure 1. **DIAGRAM OF THE ATKINSON-SHRIFFIN MULTI-STORE MODEL OF MEMORY (1968)**

– provides a detailed discussion of relevant research, citing studies where the method and findings are included

Each part of the Atkinson-Shiffrin model could hold information for a different length of time, and had a different capacity for information at any one time. Long-term memory, as the name implied, could hold information the longest- it had a duration which was unlimited, as was its capacity. The capacity of the short-term memory allowed it to hold around 7 items, plus or minus 2 (Miller, 1956). Its duration was also considerably shorter than the long-term memory, with information being held for between 15 and 30 seconds (Atkinson & Shiffrin, 1971). The sensory memory, at only a few seconds, had the shortest duration of the three parts of the model. Despite this, in the Atkinson-Shiffrin model, the capacity of sensory memory was almost unlimited.

George Sperling was one of the first psychologists to suggest the existence of a type of sensory memory, specifically studying the iconic memory. In Sperling's study, adult participants were exposed to an array of letters for $^1/_{20}$ of a second and then asked to recall them. The letters were arranged in multiple ways [see figure 2], however the preferred arrays for collecting results were the 3x3 and 3x4 combinations.

For copyright reasons this diagram cannot be reproduced in the online version of this document, but may be viewed at http://www.cogsci.uci.edu/~whipl/staff/sperling/PDFs/Sperling_PsychMonogr_1960.pdf

Figure 2. **LETTER ARRAYS USED BY STERLING (1960)**

Typically, the participants could only recall 4-5 letters of the above arrays. However, Sperling introduced tones, which he played immediately after exposure to the letters, to indicate to the participants which row they should recall. A high tone indicated the top row, a medium tone indicated the middle row and a low tone indicated the bottom row. The introduction of this tone minimised the amount of time between seeing the image and recalling it, as well as directing the mind to the specific area of the momentary image which should be retained. Recall of the row indicated by the tones was consistently at or around 100%. Following this, Sperling also found that increasing the time between when the characters were shown and when he asked them to be recalled decreased the participant's ability to recall them. From this research, it was concluded that the duration of the iconic memory was approximately 1 second long (Sperling, 1960).

Other research had indicated that echoic memory lasted a significantly longer period of time than iconic memory. Using magnetoencephalography technology (MEG), researchers were able to show activity in parts of the auditory cortex of adults lasting 2-5 seconds after the stimulus (Lu, Williamson & Kaufman, 1992). In another study, segments of white noise were looped continuously and the participant asked to identify what they heard. In short fragments,

the listener recognised the repetitions of approximately 2 seconds, however the longer fragments were not recognised, suggesting that the echoic memory no longer held the previous information to be able to hear it as a pattern (Guttman & Juleiz, 1963). More recently, research conducted with 6 year olds used mismatch negativity (MMN) techniques to explore the life span of auditory tones in the brain. The study showed that auditory tones stayed in the memory for anywhere between 3-5 seconds (Glass, Sachse & von Suchodoletz, 2008). Excluding this last study, the participants in most of the studies completed previously were adults, and all conclusions had been based on the durations of both iconic and echoic memory were taken from the results of tests on adults.

The aim of this investigation was to explore whether the functioning of a child's echoic memory was similar to an adult's, in that its duration was longer than the iconic memory. For this study, it was hypothesised that if the children, aged 8, were exposed to a set of words presented as visual stimuli, then the number of words they were able to recall would decrease faster over time than a set of words presented in an auditory format.

The independent variable in this study was the type of stimuli presented to the child- either words in an aural format, or visual format. The aural stimuli was presented to the child as spoken words, while the visual stimuli was presented to the child as a 3x5 grid/table of English, written words.

The dependent variable in the study was the number of words that the participant recalled. The number of words recalled was recorded for the tests using visual stimuli, and again for the aural stimuli so that the results could be compared later in the study.

– identifies variables and describes how they will be operationalised

The controlled variables in the investigation included the age of the children (8 years old), equalising the number of each gender involved (50 females and 50 males) and the amount of time the participant was exposed to the visual stimulus (0.34 seconds). The length of time for which the visual stimulus was shown was based on research conducted where a set of 9 individual characters was exposed to the participant for 0.05 seconds (Sperling, 1960). From this, it was calculated that each character was allowed approximately 0.0056 seconds for recognition, and therefore if the nouns in the current experiment had an average of 4 characters, the approximate time the participant needed to recognise all 60 characters on the slide was 0.34 seconds. Another controlled variable was the delay between when the participant was exposed to the stimulus and when they were asked to start recalling it. The first trial began immediately after exposure, with the delay in the following trials increasing by 0.5 each time until 5 seconds.

– discusses how several variables will be controlled

Method

Participants: In this study, there were a total of 100 participants, all aged 8 years. Out of these, 50 were female and 50 were male. The population that the participants originated from were 8-year-old Australian school children, with English as their first language. The actual sample used in the experiment was chosen from this population by use of an IQ test- the sample group had an average IQ of 100, but did not score less than 95 or greater than 105. This meant that the sample represented a selection of normal/average 8-year-old students.

An experimental design of repeated measures was used, in that each participant was exposed to all conditions of the independent variable (i.e. both the visual and aural stimulus). However, the sample was split into two groups (25 girls and 25 boys in each group) to counterbalance the 'order effect' introduced by the order in which the participants were exposed to the stimulus (either visual first, or aural first). Group A recorded the results for the visual stimulus before the aural stimulus, while Group B recorded the results for the aural stimulus before the visual stimulus. This ensured that any effects on the results produced by the order in which the stimulus was presented was counterbalanced by the results of the second group.

The advantages of using repeated measures in the experimental design included the option of having a smaller sample size. To maintain reliability in the results, the sample was approximately 10% of the estimated total population of 8 year old primary school students [see figure 3]. This statistic was only calculated to an approximate value as primary school in some states comprises of grades 1-6, while in others it is grades 1-7. Disadvantages of this method included the presence of the order effect, however this was minimised through the use of counterbalancing methods which decreased its influence.

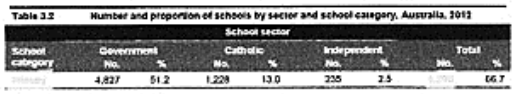

Table 3.2 Number and proportion of schools by sector and school category, Australia, 2012								
	School sector							
School category	Government		Catholic		Independent		Total	
	No.	%	No.	%	No.	%	No.	%
	4,827	51.2	1,228	13.0	235	2.5		66.7

Figure 3. **TOTAL NUMBER OF PRIMARY SCHOOL STUDENTS IN YEARS 1-6/7 IN AUSTRALIA (ABS, 2012)**

Materials: The aural stimuli utilised for this experiment was a list of simple, common nouns. In total, the list contained over 100 of these simple words [see figure 4 attached]. The visual stimuli for this experiment was a series of slideshows with 0.34 second timespans. On each slide were 15 words, arranged in a 3x5 grid form [see figure 5 attached]. A computer installed with the required software to present the slideshow was also required, as well as a sound source (e.g. bell, short 'beep' etc.) or timer which indicated when the participant could begin talking. The 10 researchers who conducted the tests, known as 'examiners' were volunteers from the researchers involved with the study.

Procedure:

- The participants were separated into two groups: Group A and Group B. The groups had an equal number of males and females (25 of each) but were otherwise chosen at random. Group A was exposed to the visual stimulus before the aural stimulus, and Group B was exposed to the aural stimulus before the visual stimulus.

- The participants exposed to the visual stimulus were told that they would be quickly shown a set of words, and were asked (before the words were shown) to recall as many words from these sets as possible immediately after it disappeared from view.
- The participant was asked to confirm that they understood the instructions, and then a practise slide (consisting of only 2 words) was shown. If the participant answered incorrectly, the examiner was required to repeat the explanation of the task, using the same example. If the answer was correct, the test was continued.
- The participant was exposed to the slide of 15 words for 0.34 seconds, and immediately after, was required to say aloud as many words as they could recall. The examiner recorded the words by circling them on the data sheet [see figure 6 attached].
- The participant was exposed to another slide with a new selection of 15 words for 0.34 seconds. They were given a 0.5 second delay before a tone sounded which indicated to the participant that they were allowed to begin. The examiner again recorded the words listed in the same way as above.
- Each participant completed a total of 11 trials (not including the practise trial, which was not recorded), which started with a delay of 0 seconds and increased by 0.5 seconds with each trial until 5 seconds (e.g. 0, 0.5, 1, 1.5... 5). Each trial used a different selection of 15 words in the same grid pattern, and the number of words that the participant recalled was recorded each time. Group A participants then completed the test using the aural stimulus, while the participation of Group B in this study ended.

– provides a detailed procedure that provides specific, accurate information which can be replicated

- The participants exposed to the aural stimulus were told that they would be read aloud a set of words, and were asked (before the words were read) to recall as many words from these sets as possible immediately after the examiner stopped.
- The participant was asked to confirm that they understood the instructions, and then a practise reading (consisting of 3 spoken words) was administered. If the participant answered correctly, the examiner was

required to repeat the explanation of the task, using the same example. If the answer was correct, the participant was informed that there would be more words in the actual trial, and the test was continued.

- The examiner read aloud a selection of 15 words to the participant, and immediately after, the participant was required to repeat as many words as they could recall. The examiner recorded the words by checking them off on a list provided on the data sheet [see figure 6 attached].
- The examiner read aloud another selection of 15 words to the participant. They were given a 0.5 second delay before a tone sounded which indicated to the participant that they were allowed to begin. The examiner again recorded the words recalled in the same way as above.
- Each participant completed a total of 11 trials (not including the practise trial, which was not recorded), which started with a delay of 0 seconds and increased by 0.5 seconds with each trial until 5 seconds (e.g. 0, 0.5, 1, 1.5... 5). Each trial used a different selection of 15 words spoken aloud by an examiner, and the number of words that the participant recalled was recorded each time. Group B participants then completed the test using the visual stimulus, while the participation of Group A in this study ended.

- This task used a split-half method to increase the internal reliability of the results. The split-half method involved the participants being split into 2 groups (Group A and Group B), with each of the groups being tested at different times to ensure that the results within the test were consistent between both groups. This method also worked to counterbalance the order effect of the independent variable- i.e. the type of test (visual or auditory) that was being administered first- and increase internal reliability in this way.
- The external reliability of this investigation is currently being tested through a replication of this study being produced by University researchers. The research is ongoing, and as such, results are unable to be provided at the time of publication of this article.
- The internal validity of this study was maintained through controlling any confounding variables that may have influenced the dependent variable and the results. For example, all the participants were of the same age, there were an equal number of males and females, and English was their first language. Variables such as intelligence were controlled within a bracketed range of 95-105 (from a standard IQ test). However, there was a confounding variable which was not identified prior to completing the test, which may have had a minor impact on the validity of the investigation: the way in which the examiner read the words aloud during the auditory test.
- Overall, the study had a high level of validity as there were minimal interferences with the dependent variable. This meant that the tests accurately measured the number of words the participants could recall after the delay (i.e. the dependent variable), and these results could then be used to form a conclusion on the duration of the iconic and echoic memory in 8-year-old children.

– describes the experimental design used to address the reliability and validity of the study

- Before the investigation went ahead, principles of ethical procedures were adhered to through the collection of a document which obtained informed consent. As the participants were under the age of 18, written parent/guardian consent was required before participation [see figure 7 attached]. This detailed the true nature and purpose of the experiment, as well as their rights as a participant, including:
  - Confidentiality: all participants had a right to privacy and anonymity in matters related to the study. Personal information was protected through the assignment of number codes rather than use of names on the data record sheets.
  - Voluntary participation: all participants decided to take part of their own free will, without coercion or fear of negative consequence. Participants were free to withdraw themselves, or their results, from the experiment at any time without coercion or fear of negative consequences.
  - Withdrawal rights: As stated above, participants were free to withdraw themselves, or their results, from the experiment at any time without coercion or fear of negative consequences. As we were dealing with children, this applied both to the parents/guardians who may wish to withdraw their child, and the child who may wish to withdraw during the tests themselves.

– identifies relevant ethical considerations, and discusses, in detail, how they are managed

- The experimenter's role within any research is to protect the physical and psychological welfare of the participants. As such, no part of this experiment was designed to cause distress or anxiety. Despite this, there was one participant who informed the examiner of the test that they had a condition known as epilepsy, sometimes triggered by quick or repetitive flashing lights, and they were removed from participation as a safety precaution, because of the fast exposure to the visual stimuli. The participant was replaced with another volunteer.
- Both the examiners and participants had access to counselling services if they encountered any unexpected stress. The examiners were also required to have provided written consent, which stated that they agreed to abide by the following:
    - To behave in a professional manner, and not act in a way which could reduce the reputability of the research or psychology as a profession
    - To behave in accordance with the Australian Psychological Society (APS)'s Code of Ethics
    - To respect the participant's rights, as detailed in the participant's statement of informed consent
    - To provide proof of a valid Working with Children Check and hold a current Senior First Aid Certificate in case of emergency

Results

See the appendix of documents attached, which contains charts which illustrate ways in which the final results were collated to be analysed, as well as some notations which further describe the data displayed.

The results from the data collection sheets [see Figure 6] were collated into the table below [see Figure 8]. This showed the changes in the scores as the delay was increased through both the visual and auditory tests. This information was then used to calculate the mean number of words that were recalled for each of the durations of delay and placed into a graph [see Figure 10]. A second graph was also created which displayed the relationship between the number of words recalled using an auditory stimulus and the number of words recalled using a visual stimulus, providing a way for future researchers to predict the number of words a participant might recall on their second test [see Figure 9].

– organises data logically and presents it in a range of forms, including tables and graphs

Discussion

This results of this study supported the hypothesis formed at the beginning of the research: if the children, aged 8, were exposed to a set of words presented as visual stimuli, then the number of words they were able to recall decreased faster over time than a set of words presented in an auditory format. The results showed that not only had the number of words recalled from a visual stimulus decreased more quickly when compared to the auditory stimulus, but also that there was a significantly lower number of words that were recalled for the visual stimulus as opposed to the auditory stimulus, regardless of the delay involved.

A strong, positive relationship was found between the number of words recalled using an auditory stimulus and the number of words recalled using a visual stimulus [see Figure 9]. The graph showed that the number of words recalled using the visual stimulus was nearly always lower than the number for the auditory stimulus, suggesting that the iconic memory, which retained the information in the visual stimulus, either had a lesser capacity than the echoic memory, or the information that it did retain left the memory faster. Past research had indicated that the iconic memory had a shorter duration than the echoic memory; the echoic memory was able to be used in conjunction with the iconic memory to indicate which part of a visual stimulus should be retained (Sperling, 1960).

– discusses using supporting evidence whether the results support or refute the hypothesis

Further findings in this study also supported Sperling's research. The decline in the average number of words recalled between 0-0.5 seconds was much larger using the visual stimulus than the auditory stimulus [see Figure 10]. The average recall of words from the visual stimulus had declined by three words after the first 0.5 seconds and five words after 1 second, whereas recall from the auditory stimulus had declined by only a single word in 0.5 seconds, or two words in 1 second. This strongly suggested that the visual information was declining faster than the auditory information, supporting claims that the iconic memory was approximately 0.5-1 second in duration (Sperling, 1960).

In addition to this, the data shown in Figure 10 indicated that while the overall decrease in words recalled from 0 to 5 seconds was equal, at an average of 9 words for both visual and auditory stimuli, when the visual stimulus was used, this decrease had occurred by 4.5 seconds. When the auditory stimulus was used, this decrease took longer- 5 seconds. This further supported previous research which suggested that echoic memory could last up to 5 seconds (Atkinson & Shiffrin, 1968).

– provides a detailed analysis of results

The data showed that recall of the words presented as auditory stimuli was still fairly good, even after a lengthy delay between observation and recall [see Figure 10]. The data for the visual stimuli indicated that participants, on average, were not able to recall at least 50% of the words after only 1 second of delay. However, the number of words recalled by the participants was, on average, still above 50% after 3 seconds of delay. These results supported research conducted using MEG testing, which measured activity present in the auditory cortex of adults for 2-5 seconds after an auditory stimulus (Lu, Williamson & Kaufman, 1992). Other research, conducted with children, suggested that auditory tones remain in the echoic memory for between 3-5 seconds [Glass, Sachse & von Suchodoletz, 2008], which is somewhat contradicted by the data from this study, which indicated a significant decline in echoic memory starting at approximately 2.5/3 seconds.

– correctly discusses the relevance of the results to psychological theory and relevant research

Furthermore, the results collected contributed further insight into data which suggested that the duration of echoic memory lasts only 1.5-2 seconds. Previous research using repetitive loops of white noise found that individuals could distinguish the loop if it lasted no longer than 2 seconds, leading to the conclusion that this was the duration of echoic memory [Guttman & Juleiz, 1963]. Results from this study indicated that there was a significant drop in the number of words recalled between 1.5 and 2 seconds using an auditory stimulus, which suggested that either the duration or the capacity (or both) of echoic memory declined more quickly after this point, hence providing a possible explanation for why the individuals in the 1963 study could no longer recognise the loop after it exceeded 2 seconds in length.

The design of this experiment was well-suited to the nature of the data to be collected and the variables being tested. A particular downfall of the design, however, was the lack of efficiency in the practical application of the test. The participants were not given a particular time limit in which they could recall the words, and it was only when they informed the examiner they could not recall any more words that they moved onto the next trial. As each participant was tested individually, this caused an unnecessary amount of time to be wasted and increased the overall length of the study. To improve this in future studies of the same nature, the researchers have suggested introducing a time limit within which the participant must recall as many words as they can, for the trials involving both auditory and visual stimuli.

– suggests improvements to the design of the investigation

The sample of participants in this study were chosen from a population of 8 year old Australian school children, chosen for this study to represent an 'average' child in this category. Although the sample represented, statistically, approximately 10% of the population, the results from this study should not necessarily be generalised to fit the entire population of 8 year old school children in Australia, as the sample was not a large portion of the population (e.g. a half, or even a quarter of the population). The population was originally chosen because of the limited research in the area of the function of iconic and echoic memory in children, with a small amount of studies being conducted in the last 2 decades (Keller 1992; Keller & Cowan, 1994; Saults & Cowan, 1996; Glass, Sachse & von Suchodoletz, 2008; Gomes et al., 2008), of which only a few specifically targeted the duration or functioning of echoic and iconic memory in the average child. In choosing this population to study, it was hoped that the research

gained from the investigation would provide another source for new insights on how children learn through memory, contributing research for designing education systems. In addition, the research from this study suggested that an 8 year old child's sensory memory worked in a similar way to an adult's sensory memory, which could lead to ideas about interchangeable learning/memorisation methods.

– correctly discusses the relevance of the results to the population from which the sample was drawn

To further investigate this topic, future research should be directed at testing adults with the same procedures, allowing for a direct comparison between the functioning of an 8 year old child's iconic/echoic memory and an adult's iconic/echoic memory. Additionally, University researchers are currently attempting to replicate the results of this experiment to confirm the reliability of the study. Future research could also be conducted using children of different ages, to investigate if the functioning of iconic and echoic memory in much younger children is still similar to an adult. Previous studies conducted by Cowan & colleagues in the 1990s have suggested that there is a developmental increase in the duration of auditory sensory memory (i.e. echoic memory), supported by a study conducted by psychologists at the Ludwig-Maximilians University in Germany in 2008, however they have not compared the function/duration to an adult's (to the knowledge of the chief researcher involved in this study).

Conclusion

The results of this investigation led researchers to suggest that the functioning of the iconic and echoic memory of an 8 year old Australian school child was similar to that of an adult. Specifically, that the echoic memory had a longer duration (approximately 3 seconds) and was more developed than the iconic memory (approximately 0.5 seconds). This conclusion was based on data which showed that over 50% of the information from a visual stimulus had been lost by 1 second after the stimulus was removed. Conversely, over 50% of the information from an aural stimulus was still remaining 3 seconds after the removal of the stimulus. Researchers concluded that if a child was exposed to information through a visual stimulus, then the amount of information that they would be able to recall would decrease faster over time than if the information was presented as an auditory stimulus.

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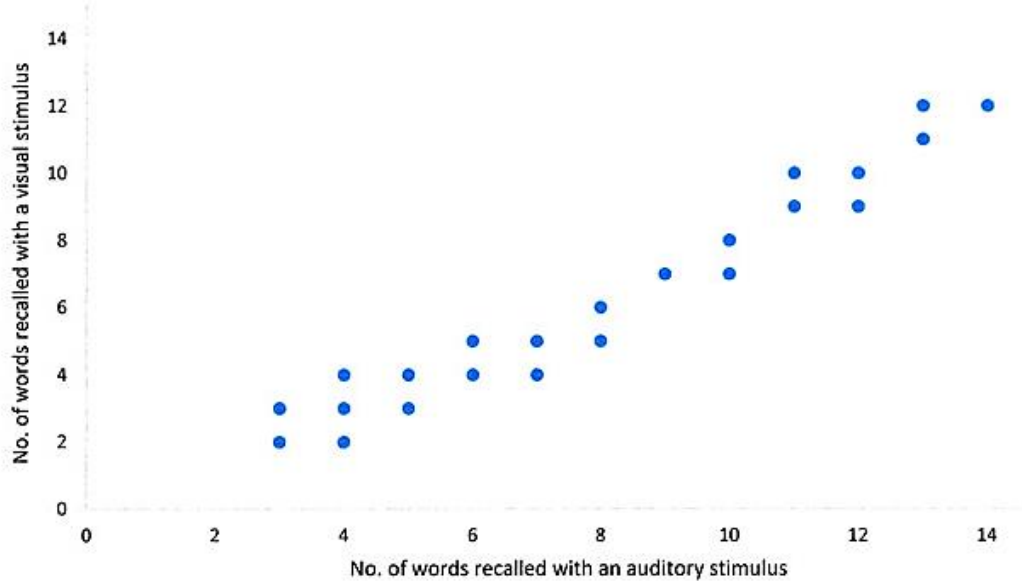
Figure 8. A table showing the number of words recalled after *x* seconds delay for visual and aural stimuli

Group	Participant No.	No. of words recalled after x seconds delay																				
		Visual Stimulus										Aural Stimulus										
		0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5

(Table continued for all 100 participants)

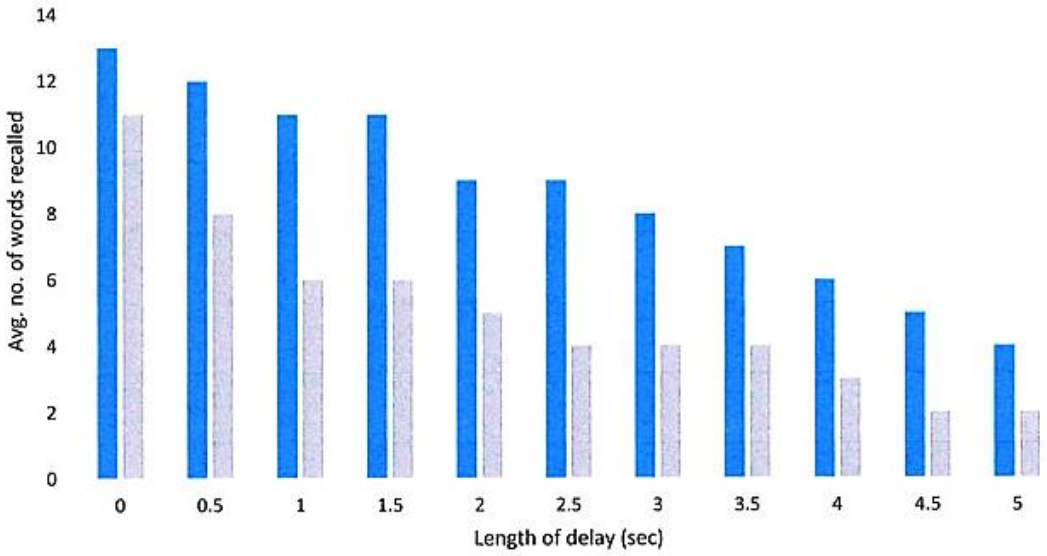
Figure 9. A scatterplot showing the relationship between the number of words recalled with an auditory stimulus and the number of words recalled with a visual stimulus



(For example: 2 participants were recorded with recalling 13 words using an auditory stimulus- one participant was then recorded with recalling 12 words using a visual stimulus, while another participant was recorded with recalling 11 using the visual stimulus.)

– presents data in appropriate, correctly labelled tables and graphs

Figure 10. A column graph showing the average number of words recalled for visual and aural stimuli with an increasing delay



Blue = auditory stimulus
Grey = visual stimulus