The Memory Test

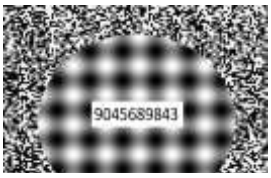
The Relationship between Short-Term Memory and Distraction

Aim: To find the relationship between the short-term memory capacity and (auditory and visual) distraction.

Hypothesis and Prediction: Auditory distraction would cause a lower short-term memory capacity than visual, which are both worse than having no distraction. Based on Miller's Law, the ten-digit string of numbers would be least likely to be correct. The experiment would have some kind of trend in its conclusion but there may be various random errors every so often due to humans not being able to be consistent with results.

Method:

All of the repetitions are in the one test. For all thirty people they are tested on three parts: no distraction, visual distraction and auditory distraction. Each part is tested five times (five questions for each part). All the participants would be of the same gender, age, mood –after participants have had lunch, no exams, relaxed- in the same environment and have the same questions. The procedure would be of as follows:



An example of a slide in the PowerPoint

1. Hand out all forms, pencils and start the PowerPoint.
2. Test all participants with one simple memory test, which is to remember strings of numbers of different lengths (6 digits, 7 digits, 8 digits, 9 digits and 10 digits). The test is shown on a PowerPoint, which is the same for all people. The numbers are to be shown for only a fixed amount of time (5 seconds) before disappearing.
3. Test the participants once more with images (or short silent video clips such as "gifs") all around the numbers to be recalled.
4. Test the participants for a final time except with numbers are being called out as well as music being played (in this case YMCA by the Village People because it is, according to the ABC science research, is the second most catchiest song of all time). This audio would be the same and be controlled for all individuals.
5. Collect the forms.
6. Calculate the average score for each set of digits and for each three parts for all participants.
7. Average out the scores for each part (visual, audio and nothing).

Examples of visuals and numbers (from 10 digits to 6 digits- top to bottom)

Introduction:

The interest for the memory came from the practices of cognitive psychology and neurology and their impacts to the human life. It was from reading about the brain and the importance of short-term memory in one's life. It was always an original interest and other than this, memory diseases are most interesting and these create a budding interest for the topic and also raises many questions on the topic overall.

The memory is one of the various topics of cognitive psychology. Studies on the human short-term memory or "primary" and "active" memory would increase the chances of finding methods of aiding, and even curing, various short-term memory impairments which can vary from Alzheimer's disease to Prosopagnosia. Distractions occur in the everyday life and significantly affect one's daily cognition. Whether at work, school or home the attention level is constantly changing and this can lead to different short-term memory capacities. The short-term memory and attention is related and linked to other various scientific ideas including Miller's Law, how memories work, where the connection is between the attention, working and short-term memory, multitasking, attention, the Cognitive Load Theory, the Trace Decay Theory of Forgetting, the Displacement Theory and the limitations of the short-term memory.

The experiment to be conducted was hypothesised that auditory distraction would affect the short-term memory capacity more than the visual distraction but in all forms of distractions, ten-digit strings of numbers would be the hardest to get correct, based on Miller's Law.

Multitasking is constantly present in one's daily life. One does it so every often that most of the time they do not realise that they are multitasking. Whether it is listening to music while reading or eating while walking, these are some of the most common forms of multitasking. In the experiment to be conducted, auditory distraction is also a form of multitasking. The participant doing the test would be listening to music and to other people as well as trying to remember the numbers on the screen. Multitasking is known to decrease productivity levels (Rogers and Monsell 1995; Rubenstein, Meyer and Evans 2001) as switching from task to task does not allow full attention towards either subject and loses time in between. Based on this observation, it infers the idea that auditory distraction would have a

more drastic effect on the full attention and concentration of memorizing than visual distraction. This also relates to the cognitive load theory where the load (the tasks being done) is increased while the attention is put onto the many different tasks at once.

Attention is an important factor towards the short-term memory as it aids the more accurate memorizing of an event or object (Weber 1991). Paying attention creates a larger awareness about a particular object, situation, person or more and with a higher attention level more information could be absorbed into the short-term memory. From the short-term memory, with the attention level still high, the idea of the subject is rehearsed repeatedly which allows the clarity and accuracy of the memory if it ever were to be recalled, even at the long-term memory stage (see Fig 1). Without attention or having a low attention span, the concentration on a particular subject would cease, as the brain would focus on other objects or sounds and undivided attention would not occur. With the limitations of the memory capacity and duration, such as short-term memory, attention is one of the bases and deciders of what would be encoded into the brain and what would not be. There are many stimuli and distractions that would eventually compete against one another for one's attention towards it as it does not want to be displaced in one's memory (memories are usually forgotten, according to the Displacement Theory, due to the lack of short-term memory capacity and duration and if there are too many things trying to be remembered at once, one or the other would eventually be ignored by its competitor). From the idea of multitasking, attention is not ever fully focused on one of the tasks being done simultaneously. The majority of times, people can mainly remember what they have selectively attended to, or what they have put most of their attention towards. Distractions divert full attention and can lower productivity levels and attention levels, which both lead to a lower memory capacity (in this case, short-term memory). Attention and memory would simply not operate without one another. (Chun and Turk-Browne 2007)

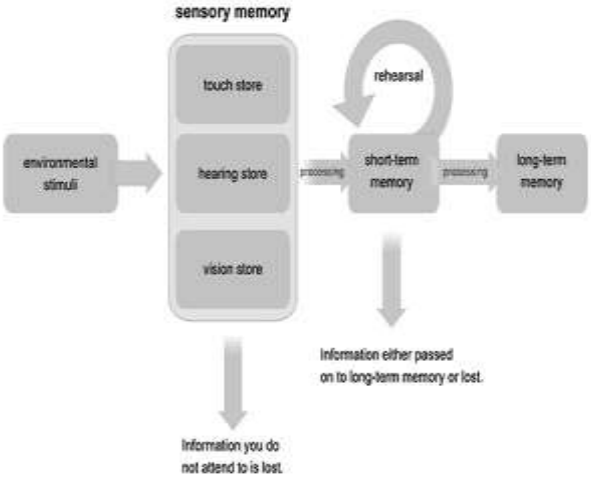


Fig 1: The Atkinson and Shiffrin Memory Model 1968 (http://www.bbc.co.uk/schools/gcsebitesize/science/images/add_ocr_memory.gif)

Overtime in the course of the human history, various scientists and researchers continue to wonder about the human mind. A large amount of knowledge is known on this field of cognitive psychology but there are many more answers to uncover. Scientists have discovered over time that short-term memory retention can be measured through recall, recognition and relearning (Weber 1991); the fact that short-term memory has three key aspects of limited capacity and duration as well as encoding (McLeod 2009); rehearsal and retrieval are two of the main uses of short-term memory (Weber 1991); the model of memory (Fig 1; McLeod 2007); the idea that, due to a limited capacity, memories compete with each other and due to this act, eventually erase each other out, (or would be simply forgotten if over duration limits) leading to forgetting- based on the Trace Decay Theory of Forgetting (Brown, Peterson and Peterson 1958-59) or on the Displacement Theory (Atkinson and Shiffrin 1968). The Trace Decay Theory of Forgetting suggests that, unless rehearsed (see Fig 1), the short-term memory can only hold a memory for about fifteen to thirty seconds before beginning to fade or decay but the difference from the Displacement Theory is that this theory believes that there may still be a trace left in the brain. On the other hand, the Displacement theory implies that forgetting in the short-term memory is due to the lack of space or availability in the mind (McLeod 2008). George A. Miller, a cognitive psychologist, had ran an experiment known as "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information" on the short-term memory in 1956. Not only had Miller tested the idea of a limited short-term memory capacity but also the idea of 'chunking' and how that had related to the short-term memory. Chunking can effectively expand the limitations of the short-term memory capacity by, for example, dividing a 10-digit number into one foursome and two threesomes, such as mobile phone numbers (Miller 1956). Miller had begun to develop some of the bases of Cognitive Load Theory (a theory which suggests that people have a certain capacity of being able to absorb new information before tiring out or losing concentration and attention; the idea that there is only a certain amount of load that is able to be put onto the working memory upon instruction where the idea is absorbed and retained) and was only one of the beginners of these researches (one of the other developers was John Sweller; Sweller 1988). Miller's Law claims that the capacity of the short-term memory is limited to seven plus or minus two chunks. More recently Nelson Cowan put another contradicting theory forward (Cowan 2001) where he suggests that the magic number is four and not seven. Due to this contradiction, the experiment to be conducted would be based on Miller's Law to avoid confusion and since it was one of the most cited papers in the history of psychology (Gorenflo and McConnell 1991). Another scientist whose results supported Miller's Law was Jacobs (1887) where he had found that digits were easier to remember than letters.

There are various forms of memory but the one that is explored in the to-be-conducted experiment is the short-term memory. The short-term memory has a very close connection with the working memory and one's attention, where they are often confused with each other but the two concepts are known to be very distinct from one another. The

working memory is different from the short-term in a way where it is the fragment of the short-term memory that is concerned with the immediate conscious linguistic and perceptual processing. This working memory associates with one's attention to become a major part of the processes of thinking while the short-term memory is based on the storage of this information (Luck 1997). The working memory is also related to the idea of the immediate conscious linguistic and perceptual processing and is based on the storage of this information. Other than this, short-term memory has a very limited capacity (around five to nine, according to Miller's Law 1956) and a limited duration (fifteen to thirty seconds, according to Atkinson and Shiffrin 1971) which makes it distinctive from long-term memory (unlimited capacity and duration) and sensory memory (up to half a second of duration and all sensory experience for its capacity; McLeod 2007).

There is an extensive network of brain regions in which forms of memory, such as sensory, short-term, long-term, working, visual, auditory and more use in order to do their processes. The neuroanatomy of this network can include the occipital lobe, frontal lobe, posterior parietal cortex, the subiculum (Wake Forest Baptist Medical Centre 2004) amygdala, hippocampus, along with the thalamus and cortex of the brain (Weber 1991). The temporal lobe is the section of the brain that is mainly associated with a variety of different forms of memory and this is the location of various minor parts of the brain such as the hippocampus and the amygdala (Smith 2007).

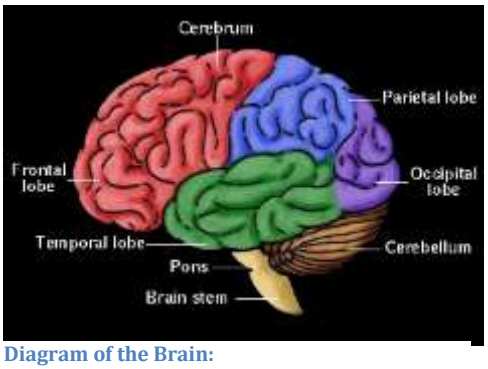


Diagram of the Brain: http://t1.gstatic.com/images?q=tbn:ANd9GcS7iCDVKuZ83-lF_hEh1RiFeGaZejFApJssNrX5zSCNhRPS4ReR

Results: The connection between none, auditory and visual distraction is linear. Not only is this correlation linear, but the relationship between each increase of digits and the accuracy of recall also had a decreasing linear pattern, as shown in the graphs below. Based on the results, auditory distraction is almost twice as distracting as visual distraction as their differences from the no distraction was 6.7% and 14.3% respectively. Using the line of best fit, it is shown that there is at least one result per distraction that is slightly off but overall still follow the linear trend. Another observation about the results is the fact that there are rare but random errors in the individual results, which is inferred to be due to the inconsistency of the human brain. The largest decrease in accuracy occurred from nine digits to ten, which suggests the support for Miller's Law.

N.B: There are three sets of results which are mentioned below including the individual results per digit set of a type of distraction per person, the average result per digit set of a type of distraction and the average result of each type of distraction. This was to compare the inconsistent variation between each individual, to contrast between the accuracy for a set of digits (to prove Miller's Law) and to show the overall relationship between short-term memory capacities under none, visual or auditory distractions.

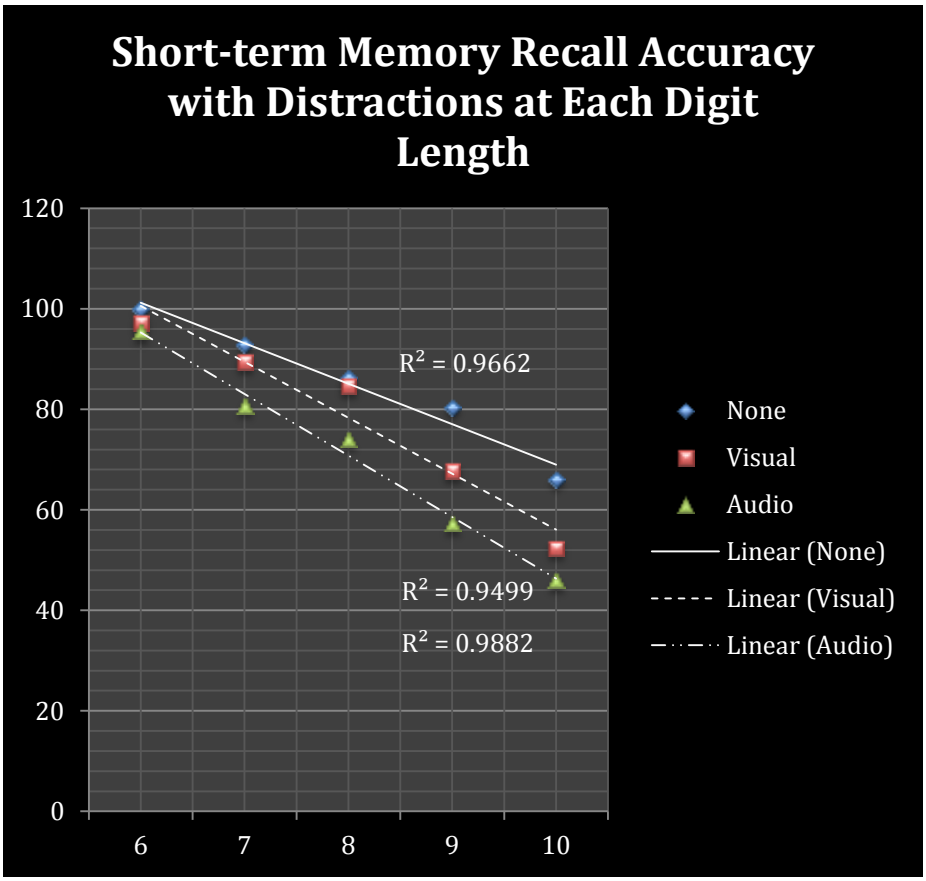
Accuracy of Short-term Memory Recall Under Distractions

Form of Distraction	Number of Digits	Accuracy of Recall Per Person (%)									
		1	2	3	4	5	6	7	8	9	10
None	6	100	100	100	100	100	100	100	100	100	100
	7	100	100	100	100	57.1	100	100	85.7	100	100
	8	100	50	100	62.5	100	100	100	100	75	100
	9	88.9	55.6	100	100	88.9	100	100	100	66.7	33.3
	10	80	30	80	100	60	80	100	80	80	40
Visual	6	100	100	100	100	100	100	100	100	66.7	100
	7	100	100	71.4	100	71.4	100	85.7	100	100	100
	8	100	100	100	100	37.5	100	100	100	87.5	100
	9	66.7	100	100	66.7	66.7	88.9	100	77.8	77.8	55.6
	10	70	60	70	50	50	70	100	100	-	30
Audio	6	100	100	100	100	100	100	100	100	100	100
	7	100	71.4	100	100	28.6	85.7	100	100	100	100
	8	50	75	100	100	62.5	100	100	100	37.5	100
	9	44.4	55.6	44.4	55.6	22.2	66.7	88.9	100	55.6	100
	10	30	50	50	60	40	50	80	30	50	30

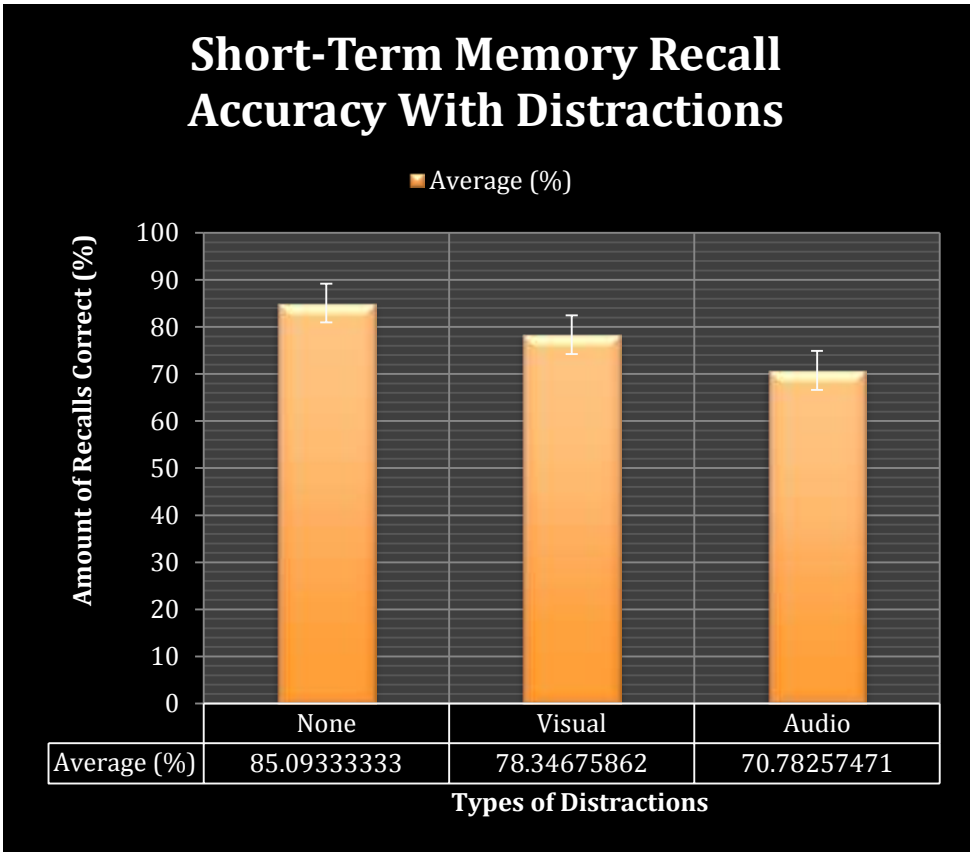
Form of Distraction	Number of Digits	Accuracy of Recall Per Person (%)									
		11	12	13	14	15	16	17	18	19	20
None	6	100	100	100	100	100	100	100	100	100	100
	7	85.7	100	100	100	100	100	100	30	100	100
	8	75	100	75	62.5	75	50	100	50	75	100
	9	22.2	77.8	66.7	55.6	88.9	44.4	100	33.3	100	100
	10	50	90	80	60	40	40	50	10	50	100
Visual	6	83.3	100	100	83.3	100	100	100	100	100	83.3
	7	57.1	71.4	100	100	71.4	57.1	100	57.1	71.4	100
	8	50	75	87.5	77.8	87.5	75	75	62.5	50	75
	9	22.2	66.7	55.6	11.1	44.4	11.1	100	33.3	44.4	77.8
	10	40	30	50	60	50	20	30	30	70	40
Audio	6	100	100	100	50	100	100	100	100	50	100
	7	-	100	100	42.9	85.7	42.9	100	42.9	57.1	100
	8	100	87.5	87.5	37.5	62.5	37.5	100	50	37.5	62.5
	9	44.4	55.6	33.3	33.3	33.3	22.2	66.7	44.4	55.6	44.4
	10	50	40	50	60	30	20	50	60	50	50

Form of Distraction	Number of Digits	Accuracy of Recall Per Person (%)									
		21	22	23	24	25	26	27	28	29	30
None	6	100	100	100	100	100	100	100	100	100	100
	7	100	100	28.6	100	100	100	100	100	100	100
	8	100	100	100	87.5	75	85.7	100	100	100	87.5
	9	100	100	100	66.7	77.8	88.9	77.7	88.9	100	88.9
	10	90	90	60	60	30	50	70	90	80	60
Visual	6	100	100	100	100	100	100	100	100	100	100
	7	100	100	100	100	100	100	100	100	100	100
	8	100	100	100	75	75	75	87.5	100	75	87.5
	9	77.8	100	100	66.7	55.6	55.6	77.8	88.9	66.7	77.8
	10	20	40	50	60	30	50	60	80	60	50
Audio	6	100	83.3	100	100	100	83.3	100	100	100	100
	7	100	71.4	100	71.4	100	71.4	71.4	71.4	28.6	100
	8	100	62.5	87.5	62.5	62.5	75	50	87.5	50	100
	9	100	66.7	88.9	55.6	44.4	44.4	55.6	100	33.3	66.7
	10	60	40	40	50	30	40	40	80	30	40

Short-Term Memory Recall Accuracy with Distractions at Each Digit Length		
Form of Distraction	Number of Digits	Average Accuracy of Recall (%)
None	**6**	100.00
	7	92.90
	8	86.19
	9	80.37
	10	66.00
Visual	**6**	97.22
	7	90.47
	8	83.84
	9	67.79
	10	52.41
Audio	**6**	95.55
	7	80.79
	8	74.17
	9	57.41
	10	46.00



Short-Term Memory Recall Accuracy with Distractions	
Form of Distraction	**Average Accuracy of Recall (%)**
None	85.093
Visual	78.347
Audio	70.783



Conclusion: The level of accurate recall decreased linearly as the amounts of digits increased. All of the participants could remember (with no distraction) six or seven digits at the least, which supports Miller's Law as the average capacity range was from five to nine. Auditory distraction took a stronger toll on the limitations of short-term memory capacity than visual distraction did but both had a decline from having no distraction. Overall, the results shows that the short-term memory capacity increases in limitations with any form of distraction as the attention is slowly being taken away from the main subject.

Discussion: The hypothesis stated was supported by the results of the experiment as both showed and stated that the auditory distraction had a larger negative effect towards the limitations of the short-term memory capacity. The results also supported Miller's Law as the capacity of the participants' minds had ranged from 7+/- 2 with only three of the thirty people being able to remember ten digits. Even though Cowan argued that the capacity levels were around 3-5 chunks (Cowan 2001), the conducted experiment had inferred that the human mind could remember even larger amounts of digits without the chunking method (Cherry 2011).

Various forms of improvements could be made towards this experiment to increase validity due to some issues, including timing (as in the preparation of the experiment) and control (the constant control of the environment around the participant). An error, which cannot be avoided or fixed, is the idea that a person cannot be mentally consistent and the fact that all humans are varied in cognitive psychological levels. This cause the occasional random errors in the results and without them would show a more reliable consistency and trend. Other than this error, the Standard Error of the Mean is also present in the averaged end result. This can add to the inaccuracy and uncertainty of the result but in the end the differences between the variables are still, very closely, the same. The results of the experiment could be more valid and reliable with more than just thirty people and even over a hundred people to be tested as having larger samples would have a more correct average. What can further improve the ideas and inferences gain from this experiment is to do other experiments on the memory such as the relationships between attention spans and the working memory and short-term memory or on the visual memory and the auditory memory. This would build onto the ideas about memory capacities, attention and distractions and their relationships to the memory. Ideas gained from further experiments can later on have benefits for learning or working environments or methods used for everyday life such as remembering mobile numbers or multi-tasking.

Selective attention was crucial for the auditory distraction otherwise even a smaller amount of digits would be recalled. From the results of this experiment, tips for the various related applications of the daily life show that auditory distraction such as people talking to or around you, music playing or even watching television while reading, learning or working doesn't provide much productivity (Rogers and Monsell 1995; Rubenstein, Meyer and Evans 2001) and it is inferred that one is better off in a quiet workspace with no auditory distractions as it is more sidetracking than most other visual distractions. The results from this experiment does agree with the fact that memory has a strong relationship with attention/distraction (Chun and Turk-Browne 2007).

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