



CRANLEIGH
EX CULTU ROBUR

EXTENDED PROJECT QUALIFICATION

EPQ 2019

EPQ Title: Are Memories Reliable?

Centre Number:

Candidate Number:

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Abstract

Our brain is the most complex organ known to man which, at its essence, controls most of our internal body conditions (homeostasis) and response to stimuli. It is the organ we know the least about but it is believed that the reason we are able to develop the intelligence needed to become who we are from a foetus is subject to the brain's ability to store memories and interpret the information that resides within them. The saying 'we learn from our mistakes' is felicitous to describing the way we get on with our daily lives. From a young age, we grasp concepts either from our own experiences and their outcomes or from the people and environments around us, for instance when our parents teach us right from wrong. However, we often recognise the blanks or inconsistencies in our memory which suggests a critical flaw in the way our memories are interpreted or the way in which they are recalled. So, if our memories are so unreliable, should we trust them? In this investigation, I am testing whether or not it is possible to manipulate memory recall using language; specifically synonymical verbs. I will be reproducing a study from 1974 by Elizabeth Loftus and John Palmer, whereby the concept is inspired by the number of cases that have been provided with false evidence due to depositions from eyewitnesses. The discussion at the moment behind the reliability of eyewitness testimonies is an important one as it raises the concern and second-guessing of the outcome of past cases whereby innocent people have been unjustly convicted or even criminals who have been let free on the basis of inaccurate evidence.

Introduction

The inspiration to choose this title originates from my curiosity in Psychology and desire to study the subject at university. My experience with Psychology is currently limited as I did not have the option to study it at school, which is why this was the perfect opportunity for me to do some of my own personal research into a topic that I am very much interested in. The purpose of this investigation is to test the reliability of memories and to do so, my research will be heavily centred on the different mechanisms that could induce inaccurate memories. After my literature review, I am also going to replicate a successful, previously conducted study that directly experiments how memory recall can be manipulated through language.

The chosen title is quite broad, therefore my investigation will briefly cover the factors that could potentially be influential on a person's memory recall and, to simply prove if memories are reliable, the experiment replication will hopefully confirm my question. Moreover, throughout the course of my investigation, I aim to attain results with strong correlations that will support my conclusive argument.

Literature Review

In the next few segments, I will be exploring different methods that are able to alter the recollection of memories and any experiments previously conducted that test the authenticity of recalled memories.

Manipulation of Memory Recall Through Language

During this segment, it would be required to address Elizabeth Loftus and John Palmer's study to investigate the effect of language on the development of false memories. It includes two different studies. One consisted of 45 participants who were randomly chosen to watch three different videos of a car accident whereby the collisions were shown at 20 mph, 30 mph, and 40 mph. Each of the participants filled out a survey afterwards with the question; "About how fast were the cars going when they smashed into each other?" This question remained the same throughout; however, the verb used to describe the collision varied between 'smashed', 'bumped', 'collided', 'hit', 'contacted' or a similar synonym. Each participant had estimated collisions between 35 mph to just below 40 mph. If the actual speed had been the main factor for estimation, it could be assumed that the participants would have had lower estimations for the lower speed collisions. Instead, the verb being used to describe the collision in the question seemed to be a more influential factor in the estimation of speed, rather than the speed itself.

During the second experiment, participants were shown videos of a car accident, but the important change was the verb used in the questionnaire. The 150 participants were randomly assigned to three groups. Those in the first were all asked the same question as the first experiment using the verb 'smashed'. The second group was asked the same question but instead of 'smashed' the verb 'hit' was used. The final group was not asked about the speed of the crashed cars. Instead, they were asked if they had seen any broken glass when, in fact, the video showed no such broken glass. The responses largely depended on the verb used. Most of the participants in the group that used 'smashed' in their question decided that there was broken glass.¹

¹ **"False Memory." Wikipedia, Wikimedia Foundation, 24 Apr. 2018**

In 1978 Loftus and two others, D.G. Miller and H.J. Burns, showed participants a number of pictures of a car at a junction. Afterwards, they were questioned whether they had seen 'a' stop sign or 'the' stop sign. The psychologists discovered that the participants who were asked about 'the' stop sign had a higher chance of recollection than another group. The use of a definite article therefore appears to make people presume the existence of an object without questioning its accuracy.²

The first conclusion that can be drawn from this study showed that language can heavily alter a person's memory of an event. Secondly, the study presents that the way in which a question is phrased can provide certain expectations of ignored details, and as a result, a 'misconstruction' of our memory recall. Both of these conclusions do support false memories as an existing occurrence.³

Reliability of Memory Recall

The reliability of memory recall is highly dependent on many factors that could influence the specifics of a memory. The following factors that will be explored are:

- Presuppositions
- The Misinformation Effect
- The Construction Hypothesis
- The Skeleton Theory,
- Relational Processing
- The Mandela Effect

Presuppositions

Presuppositions are when an idea or conclusion has been drawn without knowing all the information or result. People can assume something through the implication of language. For example, if the question "What shade of green was the bag?" was asked, it could be translated to "The bag was green. What shade was it?". The statement-question phrasing gives a

² Waude, Adam. "How False Memories Can Affect Our Ability To Recall Events." *Psychologist World*, 15 Jan. 2016

³ "False Memory." *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018

supposed fact which provides two different effects: true effect and false effect. True effect implies that detail exists which increases the accuracy of the respondent's recollection so it is easier to extrapolate from. False effect is when the object supposed to exist was never present. Even if the effect is true or false, the question is answered trying to conform to the supplied information as they believe it to be true.⁴

The Misinformation Effect

The misinformation effect occurs when a person's recall of episodic memories becomes less accurate due to post-event information. It is an excellent example of retroactive interference. The interference of new memories with the recall of older ones would result in a distorted memory of the original event. The phenomenon displays two paramount sins of memory; suggestibility (how others' expectations can manipulate our memory) and misattribution (when information has been attributed to an incorrect source).⁵

The Construction Hypothesis

Construction hypothesis is the proposal that if a true piece of information provided within the question can change a person's response, then so can a false piece of information. Thus if a respondent is asked a question with a true piece of information and their answer can be altered, then a false piece of information can do the same.⁶

The Skeleton Theory

The Skeleton Theory is another of Loftus' development after having run an experiment at the University of Washington. The theory demonstrates how a memory is recollected, which is divided into two different categories - the acquisition process and the retrieval process.

In the acquisition process, there are 3 steps. Firstly, the observer selects a stimulus to focus on and while doing so they only take in a small amount of information from the surroundings. Next, the visual perception needs to be translated into statements and descriptions. These represent a collation of ideas and objects, which are the connection between the happening of the event

⁴ **"False Memory." *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018**

⁵ **"Misinformation Effect." *Wikipedia*, Wikimedia Foundation, 26 Sept. 2018**

⁶ **"False Memory." *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018**

and the recollection of it. Lastly, any perceptions are dependent on any 'external' information which could resultantly alter the memory recall.

Next, during the retrieval process, there are 2 steps. First of all, the memory and imagery is regenerated, this is subject to what foci the observer has chosen on top of any information given before and after observation. Secondly, the connection is prompted by a statement responding to the process what has been observed. The retrieval determines the outcome being an accurate or false memory.⁷

Relational Processing

Relational processing is often connotated with influencing memory retrieval. By affiliating two common events, there are two representations; verbatim and gist. The verbatim representation connects the specific occurrences whilst the gist relates the general occurrences. This complies with the fuzzy-trace theory which suggests that false memories are stored as gist representations. Stores and Clore in 2005 conducted a study to investigate how mood affects the recollection of false memories by using the measure of a word association tool called the 'Deese–Roediger–McDermott Paradigm'. The people's moods were shifted towards more positive, more negative or unchanged. The results presented that a more negative mood made critical details, stored as gist representations, more difficult to access. This suggests that false memories are less likely to occur while being in a negative mood.⁸

The Mandela Effect

After 1962 when Nelson Mandela went to prison, it became common thought that he had died during his 27-year sentence and people even thought they could recount his funeral on television. Many people believed they remembered the same as Fiona Broome, a paranormal researcher, "See, I thought Nelson Mandela died in prison," wrote Broome. "I thought I remembered it clearly, complete with news clips of his funeral, the mourning in South Africa, some rioting in cities, and the heartfelt speech by his widow." Psychologists describe the disconnection between our memories and reality as an example of confabulation which is the idea that we produce fabricated, distorted, or misinterpreted memories without the intention to

⁷ **"False Memory." Wikipedia, Wikimedia Foundation, 24 Apr. 2018**

⁸ **"With Sadness Comes Accuracy; With Happiness, False Memory." *Psychological Science***

deceive. A neuroscientist Caitlin Aamodt proposed another explanation for the Mandela Effect; suggestibility - our tendency to believe what others are suggesting to be true. When enough people begin to believe the idea, the internet is the perfect place for that thought to thrive even if it is not true. The false memories produced are a result of society's collective belief that begins to affect everyone on a large scale.⁹

The Cross-Race Effect

The 'Cross-Race Effect' is the idea that it tends to be easier to remember another person if they are of one's most familiar race (which is often their own race). A study examined 271 real court cases where, in photographic lineups, 231 witnesses participated in a cross-race against same-race identification. During the cross-race lineups, only 45% were identified correctly whereas it was 60% for the same-race identifications. Social psychology describes this as an in-group advantage. Looking closer at the effect, two types of processing for the recognition of faces are demonstrated. Holistic processing (occurs beyond individual parts of the face) is utilised more commonly in same-race situations, however, there is an experience-effect whereby if a person is more familiar with a particular race, they will begin to use more holistic processing. Featural processing is more common when an unfamiliar stimulus or face is being identified.¹⁰

Therapy-Induced Memory Recovery

The next two sections describe how repressed memories are recovered and how the techniques have been used in specific legal cases to either prove or disprove a crime. It is important to look into these two areas in order to understand the experiments used to investigate how true memories are.

Recovery Strategies

Using therapy for memory recovery has become increasingly challenging to differentiate between disregarding or if the memory ever existed. Therapists have used approaches such as

⁹ Ratner, Paul. "How a Wild Theory About Nelson Mandela Proves the Existence of Parallel Universes." *Big Think*, Big Think, 27 Dec. 2017

¹⁰ "Cross-Race Effect." *Wikipedia*, Wikimedia Foundation, 10 Apr. 2018

hypnotherapy, repeated questioning, and bibliotherapy. A problem with these strategies is that they could recover nonexistent events or inaccurate memories.^{11 12}

Laurence and Perry, in 1983, conducted an experiment to test if memory recall could be induced through hypnosis. Their subjects were placed into a hypnotic state and were later woken up. Laurence and Perry suggested to the subjects that they were awoken by a loud noise. Approximately half of the subjects agreed that it was true when it was, in fact, false. This proves that it is possible to alter a person's state through therapy resulting in a false recall.¹³

In 1989 a study explored the hypnotizability and false memories managed to divide accurate and inaccurate memories that were being recalled. Part of the test used open-ended questions and 11.5% of the subjects were able to recall the false memory that was intended by the observers. However, when multiple-choice questions were asked, none of the subjects could recall the false memory. Conclusively, the hypnotic suggestions shifts focus, awareness and attention but despite this, the subjects did not mix between reality and the false memories.¹⁴

Therapy-induced memory recovery is a prevalent subcategory regarding the topic of false memory syndrome. It is stated as a syndrome because the recall of a nonexistent or inaccurate memory can dramatically affect one's life; false memory syndrome can drastically change a person's lifestyle and personality.¹⁵

Legal Cases

This section is significant as it provides examples of where false memories have occurred and been recorded which can be used to prove the possibility that memories can be unreliable. The

¹¹ **WARE, ROBERT C. "Scylla and Charybdis." *Journal of Analytical Psychology*, Wiley/Blackwell (10.1111), 27 Oct. 2006**

¹² **"False Memory." *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018**

¹³ **Laurence, JR, and Perry. "Hypnotically Created Memory among Highly Hypnotizable Subjects**

¹⁴ **Gleaves, David H., et al. "False and Recovered Memories in the Laboratory and Clinic: A Review of Experimental and Clinical Evidence." *Clinical Psychology: Science and Practice*, Wiley/Blackwell (10.1111), 11 May 2006**

¹⁵ **Gleaves, David H., et al. "False and Recovered Memories in the Laboratory and Clinic: A Review of Experimental and Clinical Evidence." *Clinical Psychology: Science and Practice*, Wiley/Blackwell (10.1111), 11 May 2006**

recovery strategies are often used to aid the solving of legal cases that especially involve sexual abuse. By using these therapeutic strategies, therapists are able to create a false memory in a victim's mind in order to associate their behaviour with the knowledge of them being sexually abused. The techniques used are to enhance memories and they do this by hypnosis dream analysis to stimulate any memories of the sexual abuse so as a result, the memory occurs. The False Memory Syndrome Foundation (FMSF) states that the memories are false and only produced while stimulating the memory and while employing them into a life narrative. In 1997 a court case regarding Plaintiff Holly Ramona who claimed that she had been sexually abused by her father Gary Ramona included two therapists wrongly prompting a recall of the abuse. One of the therapists, Marche Isabella, requested the use of the hypnotic drug sodium amytal to recover and recall Holly's alleged sexual abuse memories. The suggestion was that Isabella had implanted a memory during the therapy and the almost unanimous decision was that Isabella was negligent towards Holly Ramona. The case played an important part in highlighting the possibility of the occurrence of false memories.¹⁶

Another legal case, in which false memories were used, helped a man have his charges rightly dropped. Joseph Pacely was accused of breaking into a woman's home to sexually assault her. The woman had given her statement and description of the culprit to the police soon after the crime had allegedly happened. During the trial, Elizabeth Loftus testified that a memory isn't always accurate and that there were too many emotions that could have easily altered the woman's description given.

Maxine Berry grew up in the custody of her mother, who disagreed with the father having contact with her. When the father wanted to attend his daughter's high school year graduation, the mother put Maxine in psychotherapy, in order to deal with the stress of her father. Her therapist pressed Maxine to recover the memories of sexual abuse by her father. Maxine had to be psychiatrically hospitalized as she broke down under the pressure. Maxine's fallopian tubes were tied, so she wouldn't be able to have children. Eventually, with the support of her husband and primary care physician, Maxine realized that the memories of sexual abuse were, in fact, false. She later filed a lawsuit for malpractice.¹⁷

¹⁶ **"Ramona v. Superior Court (Ramona) (1997)." *Justia Law***

¹⁷ **"False Memory." *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018**

Biological Factors

Nutrition

The deficiency of certain vitamins or minerals can have a noticeable impact on the brain's efficiency. A lack of vitamin B12 has the largest influence on the brain's memory and reducing brain shrinkage as you age. According to the Harvard Health Newsletter, vitamin B12 deficiency is the most common vitamin deficiency in the world and recognised by some as a growing epidemic. Studies approximate that around 50% of elderly individuals are deficient in B12.¹⁸

Brain Injury

There are three categories of brain injury; congenital brain damage, traumatic brain injury (TBI) and acquired brain injury (ABI). They have the ability to cause memory loss and difficulties in information processing depending on what areas of the brain have experienced the trauma. Brain damage rarely recovers completely because lost neurons cannot grow back, however, the synapses can. This creates new pathways between the healthy neurons and parts of the brain which do not usually control certain functions and can then take over to allow the person to relearn how to do things. The repercussions can take a toll on the individual's ability to process thoughts, decision-making and cause memory loss. These symptoms are all capable of leading the sufferer to believe inaccurate accounts of a memory.¹⁹

Disease

People who suffer from some illnesses can experience confusion and also memory loss. The negative effects on thought processing and memory recall will vary between them but the repercussions will be worse for some compared to others. Dementia is the most associated ailment to memory loss and faults in cognitive skills. Different versions of dementia will deteriorate the brain differently and therefore cause a range of symptoms. The most common symptoms include impairments in reasoning, judgement, memory and the inability to focus; all factors in the reliability of memories. The conditions of depression take a large toll on short term

¹⁸ **"The #1 Vitamin Deficiency Damaging Your Brain." *Green Healing Wellness*, 4 Dec. 2017,**

¹⁹ **"Brain Damage: Symptoms, Causes, Treatments." *WebMD*, WebMD,**

memory; this was demonstrated in 2013 when researchers discovered that depression sufferers were unable to identify objects displayed on a screen that were identical or similar to an object previously seen. The conclusion was that the study suggests that depression can diminish memory.²⁰ Other illnesses that can affect our ability to remember and cause cognitive problems are hypothyroidism and hyperthyroidism. A malfunction in the thyroid gland can mimic some of the symptoms of mild dementia. Sufferers will often exhibit cognitive compromises such as poor concentration, slower reaction times, decreased spatial organization and decreased visual processing skills.²¹

²⁰ **“Depression and Memory Loss: Know the Facts.”** *Healthline*, Healthline Media

²¹ **Heerema, Esther, and Claudia Chaves. “Do Thyroid Disorders Cause Forgetfulness and Brain Fog?”** *Verywell Health*

Methodology

I believe that the best way to support the investigation in my title is to collect my own data by annexing an experiment. From my research, I have made the decision to replicate the 1974 Loftus and Palmer study into the manipulation of memory recall through language.

Aim

To investigate if language can alter an eyewitness' memory. The aim will be to challenge the idea of manipulation of memory recall through language. By using leading questions, it will be studied whether an eyewitness testimony can be distorted through rephrasing the questions. If the results show evidence of a confabulating effect, it will provide a strong argument towards proving that memories are not always reliable and that the investigation has been conducted successfully.

Hypothesis

From my research, I have decided that I will predict that:

1. There will be evidence of memory recall being manipulated through the change in language.
2. The order of mean estimated speed, from highest to lowest, will be: smashed, collided, hit, bumped and then contacted. My reason for choosing this order is that the sequence of words follow an order of severity as well as a decreasing aggression in how onomatopoeic the sound of the two cars touching each other is.
3. Only some of the changes in language will have statistical significance as the majority of my sample will be between the age range of 13 - 18 years of age which means that the frontal lobe in the brain, associated with judgment, has not entirely developed yet. Therefore estimating the speed of which the cars meet will not necessarily be well deduced.²²

²² "At What Age Is The Brain Fully Developed?" *Mental Health Daily*, 19 Feb. 2015

Procedure

Thirty people will be randomly selected for the first experiment and as a result, there are five people for each verb used in the question (independent variable). A different group of people of thirty participants will be used for the second experiment. The original first experiment used 45 and the second used 150 undergraduate psychology students. I would like to highlight that the 1974 study used a series of car crash videos and asked questions after each one. I cannot find any of the original study's videos and I do not have the ability to get multiple car crash videos that will be appropriate for the experiment. In spite of this, I have found a viable crash video on YouTube that has been used by other replications and generated results that agree with the original study.^{23 24}

Experiment 1: Participants are showed a car crash video and asked to describe what had happened as if they were eyewitnesses. Afterwards, they are asked a few specific questions including "About how fast were the cars going when they smashed/collided/bumped/hit/contacted?". The independent variable is the wording of the question and the dependent variable was the speed estimated by the participants. Estimating a vehicle's speed is generally something people are poor at doing so they may be more open to suggestion; the participant will be asked to estimate the speed to the nearest 5 mph.

Experiment 2: Two groups of ten people are asked "About how fast were the cars going when they smashed/hit?" and "Did you see any broken glass? Yes or no?" is included. A final group of ten participants won't be asked about the speed of the car (to act as a control) but will be asked about the broken glass.²⁵

The question sequence will be as follows:

- Describe the accident.
- What colour were the two cars at the beginning of the clip?
- **About how fast were the cars going, to the nearest 5 mph, when they __(verb)__?**

²³ Psychology, Baverstock. "Loftus & Palmer Replication Crash Footage." *YouTube*

²⁴ Yogi, Psych. *Psych Yogi*, 27 May 2016

²⁵ McLeod, Saul. "Saul McLeod." *Simply Psychology*, Simply Psychology, 1 Jan. 1970

- What can you remember specifics about the surroundings?
- Were there any buildings?
- Where there any other cars except for the three on the road?

The footage that I am using is of a low quality and therefore is very difficult to tell if there is any broken glass. Due to this, I know that I can expect the participants to comment on the blurriness of the video and consequently produce inaccurate results. Despite this, out of curiosity, I will still carry out the second experiment to see whether or not some of the participants could possibly confabulate a memory that includes the broken glass. In order for my experiment to be as successful as the original, I will need to make sure my results are as reliable, precise and accurate as possible. By repeating the question with the same verb for more than one person, the reliability of the results of that question will increase. To ensure that my results are precise, I will ask all the questions with the same phrasing except the verb. Finally, to keep my results as accurate as possible, I will try to keep my experiment as close as possible to the replication of the 1974 Loftus and Palmer study because the results they obtained agreed with their predictions. Unfortunately, I am unable to use the same sample size as the original study because the only people I am able to use are from my secondary school of around 900 staff and pupils.

Sample Selection

To choose the participants for the experiment I will adopt an opportunity sampling approach as it is what the original study used. It will guarantee a random and unbiased sample with a large range of age, mental condition and ability to judge. The brain's rational understanding and reasoning (controlled by the frontal lobe) only fully matures around the age of 25. Unfortunately, under the circumstances, the availability of individuals being 25 and over is significantly less than students, therefore, I will have no choice but to include them as well. This shouldn't be such a big issue as the brain's frontal lobe is already well established in late teenage years but is minimally less reliable in its judgment than that of a full grown adult.²⁶ A larger concern, that could limit the reliability of someone's perception of the car crash video, is the factor of individual experience. Over someone's lifetime, their unique collection of experiences can affect the way they interpret the information in their environment. For example, watching motion

²⁶ **"At What Age Is The Brain Fully Developed?" Mental Health Daily, 19 Feb. 2015**

through media will especially change an individual's understanding and processing of what they see in everyday movement. Unfortunately, this is a variable that I cannot control and therefore it should be taken into account while analysing my results.

Pilot Experiment

Data Collection

Experiment 1 - As explained on page 13

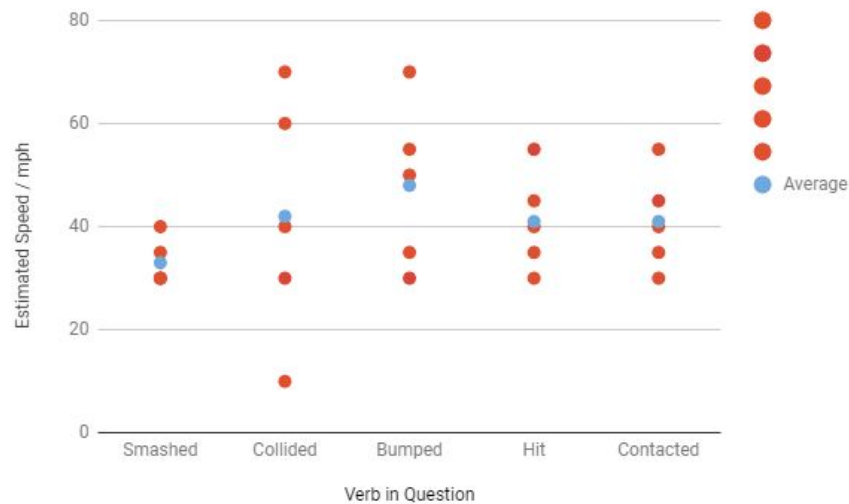
<u>Verb in Question:</u>	Smashed/ mph	Collided/ mph	Bumped/ mph	Hit/ mph	Contacted/ mph
1	30	10	55	45	40
2	30	30	30	55	45
3	35	60	50	30	55
4	30	70	70	35	35
5	40	40	35	40	30
Average	33	42	48	41	41

Experiment 2 - As explained on page 14

<u>Verb in Question:</u>	Smashed / mph	Glass seen? Y/N	Hit / mph	Glass seen? Y/N	Control - Glass seen? Y/N
1	30	N	55	Y	N
2	35	Y	35	N	N
3	35	N	45	N	N
4	30	N	40	N	N
5	40	Y	30	N	N
Average Mode	34	N	41	N	N

Data Analysis

Experiment 1



Average Estimated Speed

The results that I acquired are surprising in the sense that they very much disagree with my hypothesis, however, they do show some interesting correlations. Although the average speed estimated for the verb 'smashed' was the lowest, it has the lowest variance among the other verbs and therefore the highest precision. This largely contrasts with the verb I predicted to be the second highest mean estimated speed - collided. The variance for the verb 'collided' was the highest with the least precision. I think that this was due to the analogous result of 10 mph which was the lowest estimated speed amid all the results by 20 mph. Ignoring this, 'collided' would have had the same variance as 'bumped' and all the sets of results would have the same lowest estimated. Another interesting observation is how the results for 'hit' and 'contacted' are completely identical. Normally, with such similarity between two sets of results, at least one result would disagree especially with a sample size of 5 for each verb. This suggests that there is a statistical significance between the means of the verbs 'hit' and 'contacted' and that these results are not due to chance. Judging the entirety of the results and from my research, I can conclude that there is no obvious explanation as to how each verb takes effect on the averages.

Despite this, there is some correlation in the variances and precisions of the sets of results for each verb but once again I am unable to suggest why this is the case.

Chi-Squared Test

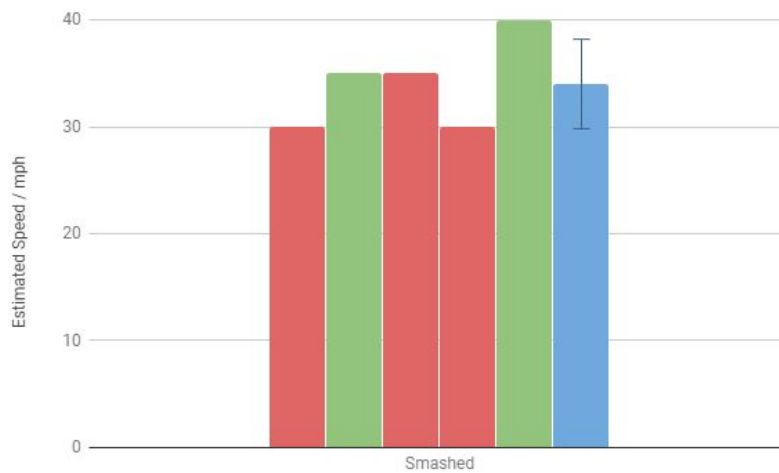
Verb	Observed Estimated Mean Speed / mph	Expected Estimated Mean Speed / mph	(O-E)	(O — E) ²	(O — E) ² / E
Smashed	33	40.5	7.5	56.25	1.39
Collided	42	39.3	2.7	7.29	0.19
Bumped	48	38.1	9.9	98.01	2.57
Hit	41	34	7	49	1.44
Contacted	41	31.8	9.2	84.64	2.66
				x² =	8.25

The null hypothesis for this experiment is:

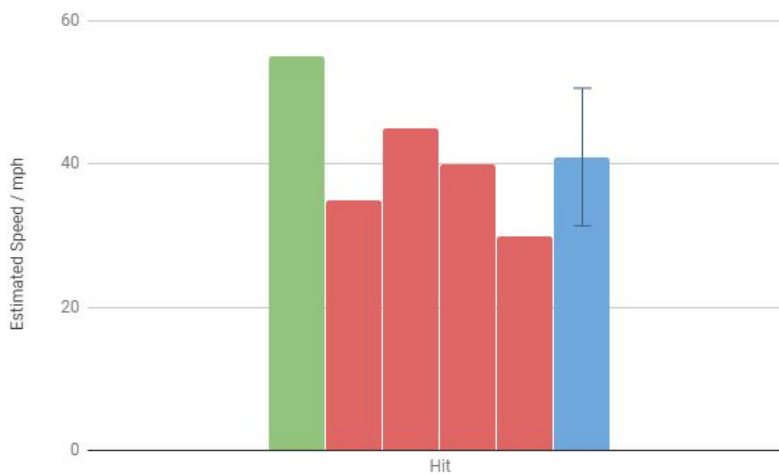
There is no statistical difference between the observed estimated mean speeds and expected estimated mean speeds of each verb.

The degrees of freedom in this instance is 4 as there are 5 variables, (5-1). Therefore when the probability is at $p=0.05$, the critical value is 9.49. As a result, the null hypothesis is accepted as the chi-squared value is below the critical value; $8.25 < 9.49$. This means that there is a more than 5% certainty that the results are due to chance. From this, it can be concluded that the observed and expected values are independent and therefore have no correlation. On the other hand, if $p=0.1$ then the critical value is 7.78 which would then conclude my results to be statistically significant as $8.25 > 7.78$. This means that there is a more than 90% certainty the results are not due to chance or caused by another unknown factor. From these two critical values, I can deduce that there is between 5% to 10% certainty that the results have no statistical significance between the observed and expected values.

Experiment 2



Glass seen? Yes / No
Average Estimated Speed



Glass seen? Yes / No
Average Speed

Comparing these graphs is particularly interesting as they agree with the conclusions I drew from the set of results from the first experiment. Like the previous results, the average estimated speed is lower, the variance is smaller and there is a higher precision around the mean for 'smashed' than 'hit'. Moreover, the highest results from each set of results have cases whereby the participants have answered claiming to have seen broken glass from the car crash video. From my research, I can assume that this could be a result of confabulation through

presupposition. As the question “Did you see any broken glass? Yes or no?” does include a specific noun, it does not suggest but states unequivocally what is being looked for. Therefore, the question does, in fact, allow room for the participant to presume the existence of glass and fabricate, distort, or misinterpret their memory of the car crash. In addition, the data points to a strong correlation between the speed the participant estimates and the likeliness for them to confabulate a memory of broken glass. The correlation represents; the higher the estimated speed, the more likely it is for the participant to present a case of confabulation - this is all relative to the verb used in the question (i.e. estimated speed of 45 mph for ‘hit’ did not see broken glass but an estimated speed of 35 mph for ‘smashed’ did see glass)

Chi-Squared Test

Verb	Observed Number No Glass Seen	Expected Number No Glass Seen	(O-E)	(O — E) ²	(O — E) ² / E
Smashed	0.6	0.227	0.373	0.139	0.613
Hit	0.2	0.287	-0.087	0.008	0.026
Control	0	0.293	-0.293	0.071	0.243
				x² =	0.882

The null hypothesis for this experiment is:

There is no statistical difference between the observed number of ‘glass seen’ and the expected number of ‘glass seen’ of each verb.

The degrees of freedom in this instance is 2 as there are 3 variables, (3-1). Therefore when the probability is at $p=0.05$, the critical value is 5.99. As a result, the null hypothesis is accepted as the chi-squared value is below the critical value; $0.882 < 5.99$. This means that there is a more than 5% chance that the results are due to chance. In conclusion, the observed and expected values are independent and therefore have no correlation. From this, it can be concluded that the observed and expected values are independent and therefore have no correlation.

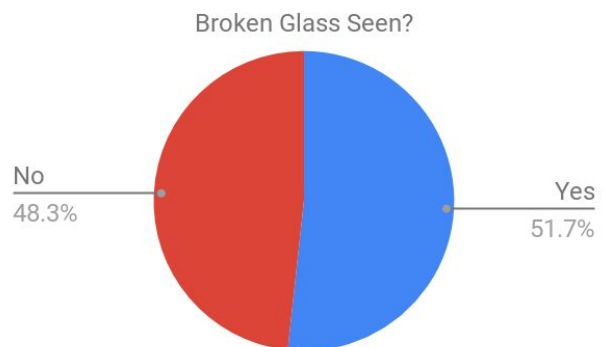
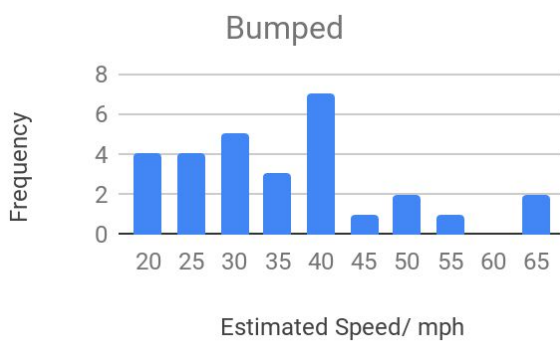
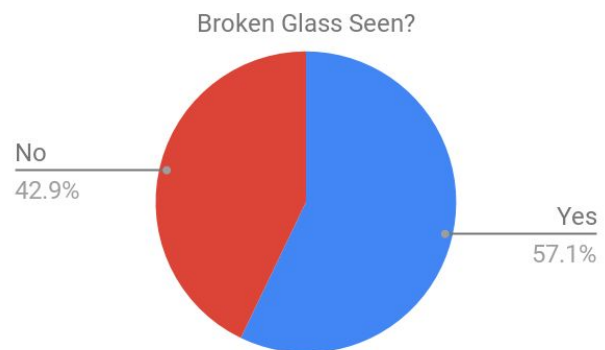
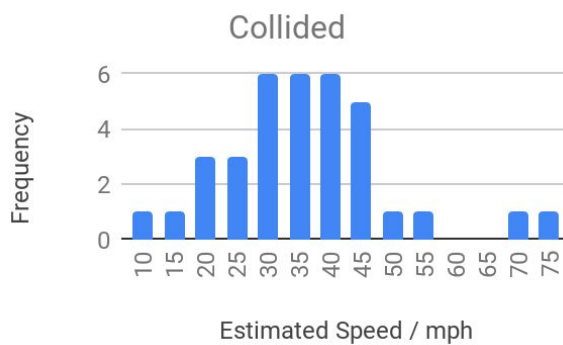
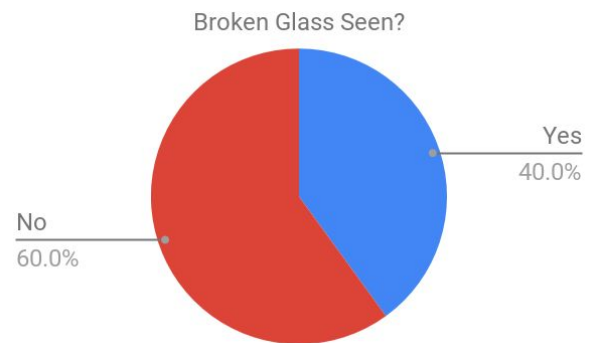
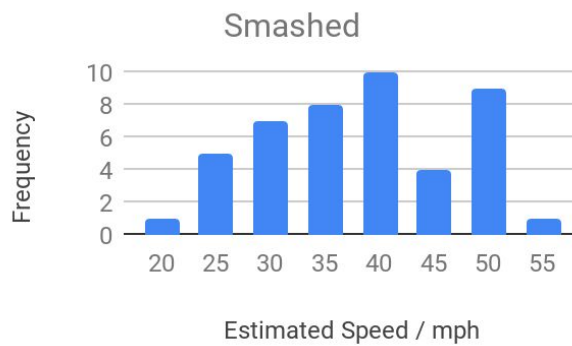
Moreover, if we check the chi-squared value at $p=0.1$ then the critical value is 4.61 which would still allow the null hypothesis to be accepted and conclude my results to be statistically insignificant because of $0.882 < 4.61$. These critical values would then suggest that there is over a 10% certainty that the results have no statistical significance between the observed and expected values.

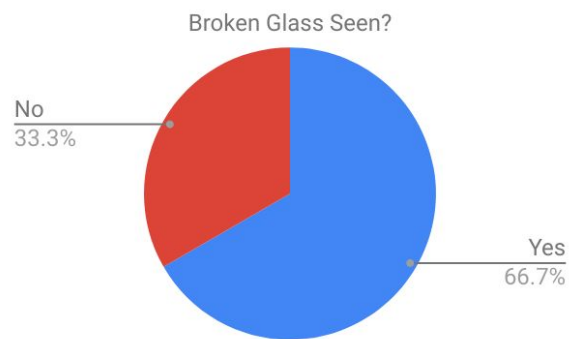
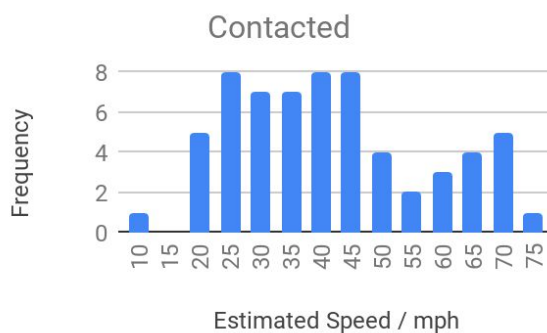
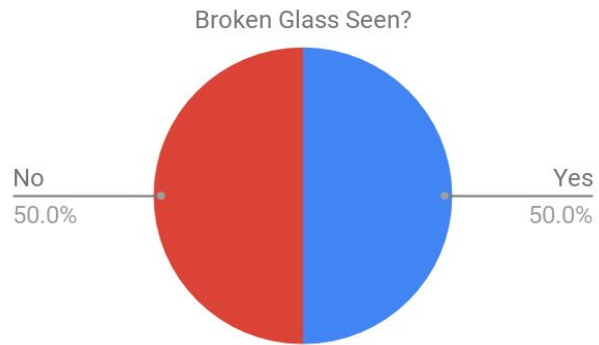
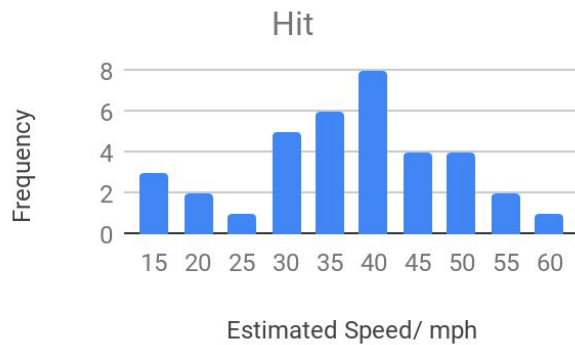
Evaluation

The purpose of the pilot test is designed to highlight any flaws with the way I carried out my replication. As I did not follow the sample size of the original experiment, my method has evidently allowed much room for anomalies because the results that I have obtained are extremely different from the expected values. Due to the nature of my disagreeing results, I cannot make an accurate conclusion to my investigation. In the final experiment, I will be changing my approach to opportunity sampling. In 1974, when the original experiment took place, the modern day internet had not been developed yet which means that Loftus and Palmer did not have access to creating online questionnaires. The benefit of utilising an electronic approach is that more data can be collected in a short space of time because it eliminates the need to physically find someone willing to participate. However, a concern with adopting this strategy is that the format of the questionnaire could have an effect on the results; it will lack the vocal intonation and enunciation of the verb's pronunciation which is what supposedly dictates the tendency to estimate a higher or lower speed of the car. Despite the potential disadvantage, I will be changing the question sequence within my method to an electronic form purely because this will ultimately enable me to conduct statistical analyses that will test the significance of the results reliably. In doing so, the method I used for the original study will be adapted to suit the electronic form better. I will be adapting the procedure for the experiments - the first experiment will follow the same method, however, the aim of the second experiment will be to test if memories can be confabulated, instead of testing for a correlation between the estimated speed and whether or not glass is seen.

Main Experiment

Data Collection - See appendix for data tables





Data Analysis

The data that I have contradicts my hypothesis of there being evidence supporting memory recall being manipulated through language and my prediction of the order of mean estimated speeds. Much like my pilot test, the variance for 'smashed' is the smallest whilst collided has joint largest. All the graphs generally have smaller peaks for the more extreme speeds with gradually increasing peaks converging around the mean speed. The graphs for 'smashed' and 'hit' seem to have noticeable shapes whereas, the other graphs do not have any obvious correlations. Most of the graphs do not have a definitive profile yet they all have possible comparability to a normal distribution, due to obvious peaks around the mean, and some could even be described as displaying a bimodal profile. The verb 'smashed' shows some resemblance of a negative skew, the only result that is anomalous to the shape is the frequency for 50 mph which is the second highest peak. Another likeness to the pilot experiment is the

medium variance for the verb 'hit'. It is apparent that there is some similarity to the pilot test but on the whole, there is little to none distinct graphical significance between the results of each verb.

Statistical Analysis

To statistically analyse my results I decided to first use confidence intervals as it is the best way to appropriately test the significance within my results. My reasoning to choose confidence intervals was because standard deviations will not work well with the means of each verb being so close together which would, therefore, it would be very likely that they would overlap too much.

Confidence Intervals

	Smashed	Collided	Bumped	Hit	Contacted
Frequency	45	35	29	36	63
Mean	38.22	36.14	36.03	37.22	41.59
S Deviation	8.93	13.51	12.42	11.49	16.01
0.5 CI	2.61	4.48	4.52	3.75	3.95
95% UB	40.83	40.62	40.55	40.98	45.54
95% LB	35.61	31.67	31.51	33.47	37.63

From the calculations, it is evident that my worry about the standard deviations was correct and although the confidence intervals of my results do overlap for all the verbs, the overlaps are less prominent than the standard deviations around the means. Conclusively, my results, with over 95% confidence, have no statistical significance between the means. Despite all of this, I will be testing for significance between the observed and expected means in a chi-squared test.

Chi-Squared Test

Verb	Observed Estimated Mean Speed / mph	Expected Estimated Mean Speed / mph	(O-E)	(O — E) ²	(O — E) ² / E
Smashed	38.22	40.5	2.28	5.20	0.128
Collided	36.14	39.3	3.16	9.99	0.254
Bumped	36.03	38.1	2.07	4.28	0.112
Hit	37.22	34	3.22	10.37	0.305
Contacted	41.59	31.8	9.97	99.40	3.125
				x² =	3.813

The null hypothesis for this experiment is:

There is no statistical difference between the observed estimated mean speeds and expected estimated mean speeds of each verb.

Similarly to the pilot chi-squared test, the degrees of freedom is 4 because there are 5 variables. When $p=0.05$, the critical value is 9.49 so the null hypothesis is accepted because the chi-squared value is below the critical value; $9.49 > 3.813$. There is a greater than 5% certainty that the results are by chance. Even at $p=0.1$, the critical value of 7.78 is still greater than the chi-squared value, the same verdict can be drawn. In conclusion, the observed and expected values are independent and have no correlation.

Discussion

Although my results do not correspond with Loftus and Palmer's original 1974 study, my pilot test did show some statistical significance with the expected value but it is unfortunate that that conclusion was only between 90% to 95% certain. I believe that there was no statistical significance between the confidence intervals of each verbs' mean because of the way the methodology was carried out with an electronic form. It is possible that the lack of verbal intonation and enunciation removed the effect the verb would have had on the participant's estimated speed if the questions were asked vocally. As I discussed in my sample selection in the methodology, another possibility could be that each individual's unique experience of motion

has affected their judgement of speed. For example, those who have more experience with driving are likely to have a better understanding of the speeds of moving objects because they regularly have to check the dashboard whilst on the road.

Conclusion

It is difficult to make a definite conclusion with my experiment's data analysis as it neither agrees with the original experiment's expected results nor does it suggest there is any statistical significance between the estimated means. I will therefore argue, with regards to my own results, that memory recall cannot be manipulated through language but memories are able to be confabulated. There was no evidence in my statistical analysis that definitively indicated that changing the verb in the critical question had an effect on the mean estimated speed of the car. With the research I have compiled, it is likely that the reason why my results are so different from the original study is because of how dissimilar the sample I used was. Loftus and Palmer used students from the University of Washington who would collectively have had a higher mean age and lesser age range. In addition, the legal driving age in the U.S. is 16 so there is a good chance that there is a higher proportion of the sample who have driving experience. However, there was clear evidence of confabulation where a considerable proportion of the participants claimed to have seen broken glass as a result of the car crash when there was in fact none. This implies that these participants have presumed the existence of the broken glass because the noun itself was used in the question which is why their memory could have been confabulated. I believe that, even though this evidence of memories being altered is negligible, it is enough to answer my investigation title and establish that memories are not reliable.

Evaluation

My investigation began with a literature review where I researched the factors that affect the reliability of a memory, the instances where it has become an important consideration and the ideas behind why memory recollection could be altered. Whilst doing so, I came across the Loftus and Palmer 1974 study which I eventually decided on replicating. At the beginning of this investigation not only did I aim to conduct a memory-altering based experiment in a school environment but also to collect substantial research, consolidate and compile it. I believe that I have successfully fulfilled these targets.

Many parts of my investigation could have been improved because the majority of my results did not provide a clear-cut conclusion or agree with the original results that Loftus and Palmer obtained. I feel that the pilot test went better than the second time because I followed the original method more closely which suggests that the electronic method was a worse approach as it worked against the experiment's objective. Despite the flaws in my method, I was happy with the way I carried out the experiment as I made sure each questionnaire was consistent with its format and the critical question.

If I ran the experiment again, I would follow the original method exactly and use a larger sample size with a larger proportion of adults to collect more accurate and reliable data. I would also consider developing the original method further, if I had the facilities, by including a detailed mental and physical examination because from my research I discovered that mood and certain health circumstances can have a direct impact on false memories. The information from the examinations would allow me to determine how accurate my results would be from knowing the number of unseen factors that could potentially be affecting the data.

The statistical tests that I chose were the most applicable to the types of significance I was looking for. An alternative method would have been to do many t-tests between each of the mean values but I decided against this, as it would not have been time-efficient and also too complicated.

To summarise, I believe that my investigation went well with the exception of the methodology, which affected my results, so I could not make the conclusion I predicted that I would. The rest of the investigation was carried out well and I met all the objectives I set at the beginning of the project. I have gained many valuable skills such as collecting relevant research, conducting a replication experiment and thoroughly analysing data which will be useful for my Psychology course at university.

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"With Sadness Comes Accuracy; With Happiness, False Memory." *Psychological Science*,
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Yogi, Psych. *Psych Yogi*, 27 May 2016,
psychyogi.org/loftus-and-palmer-1974-eyewitness-testimony/.

Source Evaluation

"At What Age Is The Brain Fully Developed?" Mental Health Daily, 19 Feb. 2015

I believe this source is, in fact, reliable because they have listed their sources which are all credible websites and articles. The quality of writing is high and the design of the website looks of a good standard which shows that the site is trustworthy.

"Cross-Race Effect." Wikipedia, Wikimedia Foundation, 10 Apr. 2018

It is a Wikipedia page means that anyone can change the article however there are many credible sources cited and the quality of writing is high so I think it is a reliable source.

“False Memory.” *Wikipedia*, Wikimedia Foundation, 24 Apr. 2018

Similarly to the previous source, it is a Wikipedia page so people can change the content but all the sources cited check out to be quite credible.

Gleaves, David H., et al. “False and Recovered Memories in the Laboratory and Clinic: A Review of Experimental and Clinical Evidence.” *Clinical Psychology: Science and Practice*, Wiley/Blackwell (10.1111), 11 May 2006

Two of the authors come from Texas A&M University and the other two come from Stanford University. They all have PhDs and are frequent authors. The professors have also cited all their sources which seemed to be credible. As a result, I believe that this source is reliable.

Laurence, JR, and Perry. “Hypnotically Created Memory among Highly Hypnotizable Subjects

This article is written by well-respected psychologists of the cognitive development side of psychology. They have all contributed to many articles and write often therefore what they write should be credible.

McLeod, Saul. “Saul McLeod.” *Simply Psychology*, Simply Psychology, 1 Jan. 1970

The page has reference all the sources that they have used and it seems to be credible. The website is dedicated to any psychology topics and hosts many articles so it should be a reliable source.

“Ramona v. Superior Court (Ramona) (1997).” *Justia Law*

This is an actual court record of a criminal case where there are stated facts, as a result this source is unbiased.

Ratner, Paul. “How a Wild Theory About Nelson Mandela Proves the Existence of Parallel Universes.” *Big Think*, Big Think, 27 Dec. 2017

This source has an author stated and has quoted people's personal accounts. The website even claims their website is 'unbiased, trusted and reliable'. The only issue is that there are no cited sources so it is questionable whether what has been written is accurate.

WARE, ROBERT C. "Scylla and Charybdis." *Journal of Analytical Psychology*, Wiley/Blackwell (10.1111), 27 Oct. 2006

The author Robert C. Ware has written a few articles but this particular one is the only one about science, the rest addressing theology. This raises the question of whether he is a reliable source of information because he has little familiarity in psychology.

Waude, Adam. "How False Memories Can Affect Our Ability To Recall Events." *Psychologist World*, 15 Jan. 2016

The article has many references from the sources that they have used but there isn't any author's name. The website has dedicated its content to psychology-related topics and news, therefore I think that the website is very credible.

"With Sadness Comes Accuracy; With Happiness, False Memory." *Psychological Science*

Both authors have written many well-published articles addressing different concepts of psychology and sociology, therefore, this source should be dependable.

"Misinformation Effect." *Wikipedia*, Wikimedia Foundation, 26 Sept. 2018,

It is a Wikipedia page so people can change the content. Despite this, the sources that are cited seem to check out to be quite reliable.

"The #1 Vitamin Deficiency Damaging Your Brain." *Green Healing Wellness*, 4 Dec. 2017,

The author is a doctor in environmental biology who studied at the National College Naturopathic Medicine in Portland, Oregon. Dr Passero is a well respected pioneering doctor in the field of natural medicine which is why I believe this source is highly credible.

"Brain Damage: Symptoms, Causes, Treatments." *WebMD*, WebMD,

WebMD is a trusted website for analysing symptoms of illness online and has been running since 1996. It has had its fair share of criticism for reliability but has been extremely successful. The articles are all written by doctors and medical writers. I believe that the website's information is reasonably reliable.

“Depression and Memory Loss: Know the Facts.” *Healthline*, Healthline Media,

The article has been medically reviewed by Timothy J Legg who is a geriatric and psychiatric mental health practitioner who is also licensed as a psychologist. He has reviewed and written many mental health articles over the length of his career which the reason why I think he is a trusted source.

Heerema, Esther, and Claudia Chaves. “Do Thyroid Disorders Cause Forgetfulness and Brain Fog?” *Verywell Health*,

The article is written by Esther Heerema and reviewed by Claudia Chaves both well-credited scientists. Esther Heerema holds degrees in psychology and social work, she particularly specialises in dementia. Claudia Chaves has a medical degree and completed her residency in neurology at New England Medical Center in Boston. Due to their experience and education achievements, I have decided that they pose as strongly credible sources.

Yogi, Psych. *Psych Yogi*, 27 May 2016,

All the information on this website agrees with other websites writing about the same study. The website dedicates its content to A Level Psychology modules and many articles. On top of this, the author has cited all of their sources so I would assume it has credible information. However, the author is anonymous which would allow for doubt regarding their experience in the subject.

Psychology, Baverstock. “Loftus & Palmer Replication Crash Footage.” *YouTube*

This footage has been used multiple times to recreate the same experiment and has produced accurate results which is why I have decided to use it myself.

Appendix

Smashed	Estimated Speed / mph	Frequency	fx	fx^2	Broken Glass Seen?	Frequency
	20	1	20	400	Yes	18
	25	5	125	3125	No	27
	30	7	210	6300		
	35	8	280	9800		
	40	10	400	16000		
	45	4	180	8100		
	50	9	450	22500		
	55	1	55	3025		
	Mean	38.22	1720	69250		
Collided	Estimated Speed / mph	Frequency	fx	fx^2	Broken Glass Seen?	Frequency
	10	1	10	100	Yes	20
	15	1	15	225	No	15
	20	3	60	1200		
	25	3	75	1875		
	30	6	180	5400		
	35	6	210	7350		
	40	6	240	9600		
	45	5	225	10125		
	50	1	50	2500		
	55	1	55	3025		
	60	0	0	0		
	65	0	0	0		
	70	1	70	4900		
	75	1	75	5625		
	Mean	36.14	1265	51925		

Bumped	Estimated Speed / mph	Frequency	fx	fx^2	Broken Glass Seen?	Frequency
	20	4	80	1600	Yes	15
	25	4	100	2500	No	14
	30	5	150	4500		
	35	3	105	3675		
	40	7	280	11200		
	45	1	45	2025		
	50	2	100	5000		
	55	1	55	3025		
	60	0	0	0		
	65	2	130	8450		
	Mean	36.03	1045	41975		
Hit	Estimated Speed / mph	Frequency	fx	fx^2	Broken Glass Seen?	Frequency
	15	3	45	675	Yes	18
	20	2	40	800	No	18
	25	1	25	625		
	30	5	150	4500		
	35	6	210	7350		
	40	8	320	12800		
	45	4	180	8100		
	50	4	200	10000		
	55	2	110	6050		
	60	1	60	3600		
	Mean	37.22	1340	54500		

Contacted	Estimated Speed / mph	Frequency	fx	fx^2	Broken Glass Seen?	Frequency
	10	1	10	100	Yes	42
	15	0	0	0	No	21
	20	5	100	2000		
	25	8	200	5000		
	30	7	210	6300		
	35	7	245	8575		
	40	8	320	12800		
	45	8	360	16200		
	50	4	200	10000		
	55	2	110	6050		
	60	3	180	10800		
	65	4	260	16900		
	70	5	350	24500		
	75	1	75	5625		
	Mean	41.59	2620	124850		