

ABSTRACT

Title of Thesis: MEMORY OVER TIME: EXAMINING THE EFFECT OF
RETENTION INTERVAL ON RECALL ACCURACY

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This meta-analysis study examined the relationship between retention interval and recall accuracy, continuing the previous work of meta-analysis published by Deffenbacher et al. (2008). Retention interval refers to the time between witnessing a crime and making a testimony on it. Recall accuracy signifies the correctness of remembered details about an event relative to what actually occurred. All relevant literature from 2005 to 2022 were searched and analyzed to test whether increasing the retention interval length would decrease the recall accuracy. The effect of retention interval on recall accuracy was measured by comparing the total number of studies that supported this hypothesis to the total number of studies that did not support the hypothesis. Findings show that the vast majority of studies concluded that longer retention intervals led to reduced recall accuracy. However, distinct from Ebbinghaus's forgetting curve theory, the memory did not stabilize after a period of time. This research provided analysis of newer research since 2008 and demonstrated that the effect of retention interval on recall accuracy is still relevant.

MEMORY OVER TIME: EXAMINING THE EFFECT OF RETENTION INTERVAL ON
RECALL ACCURACY

by

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Chapter 1: Introduction

Consider this real-world scenario by Gross and Shaffer (2012): In July of 1982, in Hanover, Virginia, a young white woman was sexually assaulted and beaten by an unidentified black man. According to the victim, the rapist stated that he had a white girlfriend. At the time, the only black male who shared a home with a white woman, whom the police were aware of, was a guy named Marvin Anderson. A photo lineup was conducted, where the victim saw multiple black-and-white mug photographs of persons in the police lineup, including the picture of Marvin Anderson that the police had obtained from his employment (since Anderson had no criminal record). Anderson was identified by the victim as the offender. Less than an hour later, when the victim was shown a live lineup again, she selected Anderson once more because he was the only man whose photo she had previously been shown. Consequently, Anderson was convicted in 1983, sentenced to 15 years in prison, and was later released on parole. Some years after his release, DNA testing on the rape kit proved Anderson's innocence, and he was exonerated in 2002.

Eyewitness testimony and identification is one of the most common and compelling forms of evidence in criminal cases (Buckhout, 1974; Fraser et al., 2022). Although the precise number of uses of eyewitness testimony in criminal investigations is not documented, according to one estimate, it is believed that eyewitness testimony is used in tens of thousands of criminal cases every year (Albright & Garrett, 2022). Despite being one of the most important players in the criminal justice system, eyewitness error can lead to wrongful convictions, as seen above in the Anderson case (Gross & Shaffer, 2012). In fact, eyewitness error is one of the leading causes of wrongful convictions, with one in three eyewitnesses making an erroneous identification (Wise et al., 2014).

In response to the high number of eyewitness errors, the Supreme Court established a due process test for evaluating eyewitness evidence in the 1977 case of *Manson v. Brathwaite* (Garrett, 2020). A part of the test directs the judge to examine: 1) the eyewitness's opportunity to view the defendant at the time of the crime, 2) the eyewitness's level of attention, 3) the accuracy of the eyewitness's description of the criminal, 4) the eyewitness's degree of certainty at the time of the identification procedure, and lastly 5) the amount of time that had passed between the crime and the identification procedure (Garrett, 2020). Among these five variables, what this paper seeks to focus on is the last variable - the amount of time that had passed between the crime and the identification procedure. The term that is used to describe this variable is called the retention interval¹. Instructing judges to weigh in this variable when measuring the credibility of eyewitness evidence supports the idea that human memory deteriorates as the time between witnessing a crime and subsequent memory testing of that witness increases (King et al., 2002). Not only that, it can be further understood that the court is aware of the delay in the system of receiving eyewitness testimonies.

When looking at the tendency of the court system, criminal prosecutions generally move slowly, sometimes taking months or even years (Petis, 2026). In a typical criminal case, there is a process called discovery, which is a formal evidence-sharing process that ensures each party is fully informed about the witnesses and evidence that the other party will present at trial (American Bar Association, 2021; Petis, 2026). This is also the process where the defense gets witness statements to prepare for their defense. However, states vary on the policies of discovery. For example, the state of Colorado requires the sharing of witness statements 21 days after

¹ For the purpose of this paper, retention interval is defined as the amount of time that elapses between the end of a witness's encounter with a perpetrator and any subsequent testing of the witness's memory for that encounter (Deffenbacher & Cutler, 2008).

appearance - when a party attends the court proceedings (Petis, 2026). On the other hand, other states like Louisiana or Mississippi do not require any written or recorded statement of witnesses until immediately before the opening statement at trial (Petis, 2026). Although witnesses generally first testify during pre-trial stages, such as during interviews with the prosecution, there are other cases where the first time a witness is questioned is during the trial because witnesses are not legally required to talk to the defense in pre-trial interviews (Bergman, 2023). What this ultimately depicts is that there are certainly delays in obtaining eyewitness testimonies, depending on the state, and human memory would continue to deteriorate. If delays are inevitable, it would be reasonable to explore how longer retention intervals truly affect the recall accuracy² of eyewitnesses to minimize discrepancies in testimonies.

While much prior research has examined the relationship between retention interval and recall accuracy, only a few studies have conducted a meta-analysis on it. The last meta-analysis study examining the effect of retention interval on memory accuracy was conducted by Deffenbacher et al. (2008). The study has reviewed a total of 53 independent studies to test the hypothesis that longer retention intervals have a negative effect on memory accuracy. This paper aims to pick up from where it was left off 18 years ago and find new discoveries by examining studies conducted on the relationship between retention interval and recall accuracy.

² This paper defines recall accuracy as the correctness of remembered details about an event relative to what actually occurred.

Chapter 2: Literature Review

WRONGFUL CONVICTIONS AND EYEWITNESS TESTIMONY

Wrongful Convictions and Exonerations

Unlike the long-held belief of judges and prosecutors that “innocent men are never convicted,” this idea has been dismissed due to various errors made within the criminal justice system (Garrett, 2020, p. 246). According to the National Registry of Exonerations (NRoE) (2022), which is an organization that conducts studies of the process of exoneration and the factors that lead to wrongful convictions, those who were wrongfully convicted were later exonerated for the following errors: mistaken witness ID, false confession, perjury or false accusation, misleading forensic evidence, and official misconduct (The National Registry of Exonerations, 2026).

The NRoE presents a total of 3,807 cases of exonerations since 1989 up to this day. Out of those cases, 1,030 cases, or nearly one-third, involved convictions caused by mistaken witness identification, while 2,461 cases, or two-thirds, involved convictions by perjury or false accusation (NRoE, 2026). Here, mistaken witness identification refers to a situation where at least one witness mistakenly identified the exoneree - a person who was convicted of a crime and later formally declared innocent of that crime - as a person the witness saw commit the crime (NRoE, n.d.). Moreover, perjury or false accusation depicts a scenario when a person made a false statement, under oath, that incriminated the exoneree for the crime for which they are later exonerated (NRoE, n.d.). When looking at this in more detail, the leading cause of false

conviction for homicide exonerations was perjury or false accusations, and the vast majority of sexual assault and robbery convictions were caused by mistaken eyewitness identifications (Gross & Shaffer, 2012). As seen here, perjury, false accusations, and mistaken eyewitness identifications - all of which are errors made by human words - cause innocent individuals to be wrongfully imprisoned.

Although there are 3,807 cases of successful exonerations of the wrongfully convicted individuals, it must be noted that exoneration does not happen instantly, as it is a lengthy process that may last many years (Garrett, 2020; Gould & Leo, 2015). The Innocence Project, a national litigation and public policy organization that works to exonerate the wrongfully convicted individuals through DNA and other scientific methods, and other regional innocent projects require an application and an extensive screening process of a defendant's case before even starting the actual investigation, demonstrating why exonerations take a long time (Gould & Leo, 2015). Looking at this in numbers, Gross and Shaffer (2012) examined the pattern of exonerations from 1989 to 2012, and found that half of the exonerees served time in prison for at least 10 years, and more than 75% served at least 5 years. When studying the innocent death-sentenced prisoners alone, the average length for exoneration has tripled in the past twenty years, with 2024 having the greatest average wait time of 38.7 years (Roemer, 2024). As demonstrated here, systemic errors made by human words cause many innocent people to be wrongfully imprisoned for a countless number of years, thereby emphasizing the need to address the fallibility of human memory.

Impact on the Innocent and the Victims

As one might expect, there are long-lasting psychological impacts on those wrongfully convicted (Brooks & Greenberg, 2020). For instance, some reported that they had experienced permanent changes in their personality, such as being paranoid, anxious, hypervigilant, and less confident (Brooks & Greenberg, 2020). In more severe cases, some had completely lost their hope and purpose for the future (Brooks & Greenberg, 2020). Moreover, there is a standard health diagnosis coding system called the International Classification of Diseases, Tenth Revision (ICD-10), which is used to code and classify medical diagnoses (Centers for Disease Control and Prevention [CDC], 2024). In one study, several of the men met the ICD-10 diagnostic criteria for post-traumatic stress disorder (PTSD), with the symptoms relating to events following their arrest or time in prison, such as nightmares of assaults in prison (Grounds, 2004). Overall, one common statement made by these individuals was that they “feared for their lives,” as they experienced extreme fear of being assaulted or killed by other prisoners (Grounds, 2004, pp. 169-170).

Additionally, wrongful convictions of innocent people put crime victims in a difficult situation, which is sometimes worse than their original victimization (Irazola et al., 2016). Oftentimes, crime victims participate in the investigation and prosecution by pointing out the perpetrator who they think has committed a crime against them (Scott, 2009). However, if it is later found out that the perpetrator they have singled out is, in reality, not the culprit, they may become overwhelmed with feelings of guilt and fear (Irazola et al., 2016). In one study, 11 criminal victims involved in wrongful conviction cases were interviewed. One victim, who misidentified the culprit during her eyewitness account of the case, recounted her experience, stating that it was harder going through the process of realizing that she was wrong and putting

an innocent person behind bars than going through the rape (Williamson & Niedzwiecki, 2016). While the feelings of pain, fear, and panic during their victimization remained the same, they were now burdened by a “flood” of guilt on top of that for the innocent person, which made the situation much more difficult (Williamson & Niedzwiecki, 2016, p. 160).

Other crime victims reported that they became helpless and fearful of the wrongfully convicted individuals, thinking that they would come to hurt them and their family (Williamson & Niedzwiecki, 2016). Some may say that these feelings stemmed from the victims’ delusional thoughts, and that nothing would happen to them in reality. However, when shifting the perspective from the crime victims to victims of wrongful convictions, it is entirely reasonable for the wrongfully convicted individuals to feel anger towards those who found them guilty. In fact, when looking at the personal recollection of one exonerated individual who was put into prison due to wrongful conviction, his initial feelings of sympathy toward the crime victim were replaced with feelings of resentment and hatred toward the jurors who found him guilty, the judge who sentenced him, the prosecutor who labeled him a “monster,” and lastly the victim who took the stand and identified him as the perpetrator (Scott, 2009, p. 11). Hence, as seen through the experiences of the wrongfully convicted and the crime victims, mistakes in eyewitness testimony and/or identification made by individuals may inflict irreversible damage on the lives of those involved.

Factors Affecting Eyewitness Testimony

As illustrated above, there have been and will likely continue to be errors in eyewitness identification (Glomb, 2022; Wells & Turtle, 1987). Therefore, it would be useful to note what causes errors in eyewitness identifications. To do so, two distinct variables must first be

understood. The first type of variables is called system variables, which are variables that are under the direct control of the criminal justice system, an example being photo lineups (Wells, 2018). In fact, one of the most commonly used methods of eyewitness research is the identification of criminal suspects through police lineups (Wells & Turtle, 1987). However, with such complex procedures come a wide array of errors (Wells, 1978). For example, the wording of the police instructions to the witness could cause an error in the identification (Wells, 1978). In one field study by Malpass and Devine (1981), a staged act of vandalism was presented in front of 350 students in a large lecture hall. Thinking the situation was real, students viewed the act. At the end, the students were told that vandalism was staged and were then instructed to identify the vandal from a photo lineup. When the police instructions during the photo lineup implied that the offender was one of the lineup members, there was an increased chance for witnesses to make an identification, even when they were not sure (Malpass & Devine, 1981). This shows that eyewitness misidentification could easily occur through the practices of those involved in the criminal justice system.

On the other hand, the second type of variables are called estimator variables, which are variables that affect eyewitness accuracy but cannot be controlled by the criminal justice system (Wells, 2018). Just as its name suggests, the criminal justice researchers can only estimate the role of these factors (Wells, 1978). One example of estimator variables would be the lighting conditions when the crime occurs (Cormia et al., 2022). In other words, if there was poor visibility at the crime scene, there is a chance that the witness may not have clearly seen the face of the perpetrator, resulting in misidentification during the eyewitness testimony. Another example of an estimator variable is the retention interval (Wells, 1978). If the time between the first encounter of the perpetrator and/or the scene of crime and the recollection of that event is

lengthened, that is how much memory the witness loses, since memory starts to diminish as time passes (Roque et al., 2010). Hence, it is worth examining research on the memory of eyewitnesses.

HUMAN MEMORY

Theoretical Frameworks

Consider this quote by Elizabeth F. Loftus: “Memory works like a Wikipedia page: You can go in there and change it, but so can other people” (Wiechert et al., 2025, p. 2). This explicitly depicts the fallibility of human memory by demonstrating that it is susceptible to distortions from external forces (Wiechert et al., 2025). The misinformation effect proposed by Loftus alludes to individuals’ distorted recollection of an event after being exposed to false postevent information, thereby forming false memories (Loftus et al., 2005). This was proven true in a neuroimaging study done by Loftus, in which college students, who served as witnesses, integrated misleading information into their own memory of the event (Loftus et al., 1978). In the study, participants were shown a series of slides followed by a questionnaire testing what they saw (Loftus et al., 1978). However, the questionnaire included misleading information meant to impede the memory of the participants (Loftus et al., 1978). For instance, researchers misled their subjects into remembering certain items differently, such as a yield sign as a stop sign, hammers as screwdrivers, and even attempted to make the students recall nonexistent objects (Loftus et al., 1978). Loftus et al. (1978) found that the memories of the students were actually altered through misleading information. Therefore, when inaccurate details of memory

are put into a person, whether intentional or unintentional, the person can easily take in that information and believe it to be true.

The fragile nature of human memory can also be explained by the trace decay theory of forgetting, which examines the relationship between time and the finite duration of memory (McLeod, 2025). According to McLeod (2025), memories leave a trace, that is, a form of physical and/or chemical change in the nervous system created by new memory formation. Forgetting takes place simply because of the automatic fading of this memory trace, and to avoid this, memory must therefore be rehearsed, that is, accessed frequently (McLeod, 2025). Contrary to the explanation of memory in the misinformation effect, the trace decay theory of forgetting asserts that events between learning, or seeing, and recall does not affect the recollection of memory, but rather it is the length of time the information has been retained that matters (McLeod, 2025). In other words, the longer the time since the recalled event occurred, the more that memory deteriorates or is forgotten. Ebbinghaus, who is known for creating more than 2,000 nonsense syllables like dax, bap, and rif, and learning those words to test his memory on them, found his memories getting weaker as time passed, with the most forgetting occurring early on after learning (Andrade & Walker, 2021). According to Ebbinghaus's findings, if memory is not rehearsed or reactivated over an extended period of time, it could completely vanish or deteriorate to the point that it no longer becomes accessible (Andrade & Walker, 2021). Overall, all the above theories agree on one thing: memory is fallible, and it worsens with increased time or longer retention intervals.

Retention Interval and Eyewitness Testimony

Going back to the earlier example of the study done by Loftus et al. (1978), when misleading information was included in the questionnaire given immediately after an event, the memories of the students were not significantly distorted. However, when false information was introduced after some delay in time, it was able to influence the subjects' memory more effectively, with the effect increasing along with an increase in delay (Loftus et al., 1978). Hence, this suggests that it is easier to influence and/or distort memory when the original trace of information starts to fade.

When looking at past research studies on the relationship between retention interval and accuracy of memory, a study by Lipton (1977) examined the effects of delay in time of identification on recall accuracy. In the study, participants were shown a crime occurring and were asked to carefully observe the film and "testify" by writing down everything they could remember on two separate instances (Lipton, 1977). First, the participants were asked to immediately write down what they saw after viewing the film, and they were brought back one week later and were asked to recall the scene again. Lipton (1977) measured the accuracy and quantity of identification in both instances. After compiling the data, Lipton (1977) found that a delay between an eyewitness's observation and subsequent testimony adversely affected the accuracy and quantity of the testimony. In essence, the longer the wait time between seeing the film and identifying the details, the less accurate their answers were, and the less they were able to remember.

More recently, a similar study was conducted on the same topic. In a lab study done by Gustafsson, Lindholm, and Jönsson (2022), participants were asked to watch a staged crime video of two people assaulting another person. Then, the participants were asked to recall details

of the event immediately after the video ended (Gustafsson et al., 2022). The participants returned two weeks later and reported the details of the event again. During the retention interval, half the participants were told that they would be asked to write down all their memories of the event on four occasions between the current and the second session, two weeks later, to repeatedly retrieve the event (Gustafsson et al., 2022). To carry this out, Gustafsson et al. (2022) emailed the participants an online survey in intervals of 2–3 days. On the other hand, the other half of the participants received no additional instructions besides coming back two weeks later to report the details (Gustafsson et al., 2022). When the group that did not repeatedly retrieve the memory of the event for two weeks was asked about the details of the event, they were not able to provide more correct details than the group that continued to retrieve their memories (Gustafsson et al., 2022). Hence, after comparing the two groups, Gustafsson et al. (2022) concluded that memory deteriorated when it was not retrieved continuously and early in time.

GAPS IN THE LITERATURE

As depicted above, the issue of retention interval in eyewitness testimony and identification has been studied on multiple levels over the years. In particular, seeing the need to examine literature on memory decay, Deffenbacher et al. (2008) conducted a meta-analysis study on the relationship between long retention intervals and eyewitness identification, compiling data from 39 published studies, with a total of 53 independent tests. Using this sample, Deffenbacher et al. (2008) sought to test the hypothesis that longer retention intervals would have a negative effect on memory strength. In fact, the 2008 meta-analysis concluded that 31 out of 55 studies

supported the hypothesis (Deffenbacher et al., 2008). However, no newer meta-analysis has been conducted on the topic of retention interval and recall accuracy for 18 years, while more studies on eyewitness testimony and human memory were conducted. Therefore, the present study seeks to bridge the gap between 2008 and the present by observing more recent literature that provides new information on the topic.

Chapter 3: Present Study

To address the gap that the meta-analysis study on retention interval and recall accuracy already exists, the present study aims to further develop the topic by reviewing any and all relevant literature published after 2008 to identify any developments of research on the relationship between retention interval and eyewitness testimony accuracy.

Similar to the research goal of Deffenbacher et al. (2008), who attempted to examine the effects of retention interval on the strength of a witness's memory representation, the present study seeks to answer the following research question: Does an increase in retention interval length decrease the accuracy of recall in eyewitness testimony? There are two hypotheses that follow this question: 1) As the retention interval increases, the recall accuracy will decrease, and 2) Recall accuracy will stabilize after a given period of time. Here, the concept of stabilization was derived from Ebbinghaus's forgetting curve theory, and it means that the rate of forgetting will slow down with time after a sharp decline in memory at first (Murre & Dros, 2015). By testing these hypotheses, the present study strives to explore how accurate or inaccurate memories become after a period of time.

Chapter 4: Data and Methods

Data Collection

The overall aim of this study is to understand the impact of retention interval on the recall accuracy through meta-analysis. Hence, the predictor variable is retention interval and the outcome variable is the recall accuracy. To describe the procedures that were used for the systematic review of the literature review, for the purpose of conducting a thorough search of all relevant citations, Google Scholar, JSTOR, the library database of the University of Maryland (UMD), and journal articles' references were used. The keywords retention interval* OR response latency* OR eyewitness delay* OR repeated recall* OR eyewitness memory* OR accuracy of memory and recall* OR recall accuracy* OR memory accuracy* OR memory traces were entered into search engines. Databases were searched from September 2025 to December 2025, and then searched again in February 2026.

Sample

Using this method, over 50 studies and peer-reviewed journals on the topic of retention interval and recall accuracy were found. Then, the titles of the studies and journals were evaluated for their relevance to the topic, and any that were clearly not relevant were excluded. The studies' abstracts were then evaluated, and again any studies clearly not relevant to the review were removed. For studies that were ambiguous, the full-text articles were read and analyzed to determine their correlation with the topic of this study. To explain the inclusion criteria for the present study a little better, to be considered for inclusion in the review, studies were required to report specifically on the relationship between elapsed time, that is, retention

interval, and recall accuracy. For example, studies that examined the relationship between retention interval and confidence of witnesses were excluded from data in the study. Since the present study sought to examine new research since 2008, the initial search of studies focused on journal articles published after 2008. However, considering that the meta-analysis study by Deffenbacher et al. (2008) was originally submitted in October 2007, and that it takes roughly two years to write a research paper, the present meta-analysis study also chose to look at studies conducted two to three years prior to 2008. Therefore, the earliest literature in this meta-analysis came from a 2005 study.

To reiterate, as for the peer-reviewed journal articles that were selected for inclusion, their individual reference lists were also examined. The *Cited by* feature presented in the Google Scholar database was used to locate all studies that cited the study that had already been examined. Moreover, the *Case law* section in Google Scholar was also utilized to see if there were federal or state court cases on the relationship between retention interval and recall accuracy. At the end of the search, all identified studies were exported to EndNote Click.³ Hence, the present study sample consists of 28 published studies, which produced 33 independent tests. There were more independent tests than published studies because some of the studies conducted more than one test in testing the hypothesis. The total number of subjects in the 33 independent studies was 5,045, with the average number of subjects being 152.88.

After all peer-reviewed articles were chosen, a separate document was created to extract relevant findings from each paper. The information recorded from each paper included the authors' names, year of publication, and significant statistics, such as the total number of subjects and retention intervals for each study (see Appendix A).

³ An application that searches for full text PDFs of published journals and gives users access to the website via a button, to remove any duplicate papers (Clarivate, 2025).

Chapter 5: Results

The results of the 33 independent tests were used to test the 2 hypotheses. Recall that the first hypothesis stated that with an increased retention interval, there would be a decrease in recall accuracy. Moreover, the second hypothesis theorized that recall accuracy will stabilize after a given period of time. In order to be considered support for the first hypothesis, which was labeled as test 1, the results of the studies had to show memory accuracy decreasing over time. To exemplify this, studies that showed participants remembering an event better at immediate memory testing than at memory testing 1 week later were considered supporting literature. Using the same criteria, any studies that exhibited better recall accuracy of participants in memory testing after 1 week than at immediate testing were categorized as opposing literature.

Moving on to the next hypothesis, support for the second hypothesis, that is, test 2, meant that the results of the studies had to show a steep decline in memory accuracy early on after first obtaining the memory, and a slower rate of decline after a certain period of time. Take a study with the following retention intervals, for example: 1) immediate, 2) 48 hours, and 3) 72 hours. If the study presented a result depicting greater memory decline between immediate testing and testing after 48 hours than between testing after 48 hours and 72 hours, the study was considered support for test 2. On the contrary, if the recall accuracy decreased more between 48 hours and 72 hours than between immediate testing and testing after 48 hours, the study was deemed not to support test 2.

Test 1 Results

After a thorough look at the 33 independent studies, a chart was created to see which studies supported the two hypotheses and which did not. For test 1, the studies were recorded as

either of the two categories: a positive (+) category, meaning recall accuracy decreases as the retention interval increases, and a negative (-) category, meaning accuracy of recall does not decrease as the retention interval increases (see Appendix B).

Test 1: Supporting literature

When considering the list of 24 studies that supported the hypothesis, some studies looked at shorter interval periods. For instance, Goldsmith et al. (2005) conducted two separate experiments, with experiment 1 looking at immediate memory, memory after 1 day, and memory after 1 week, and experiment 2 looking at immediate memory and memory after 1 day. In the study, participants read a fictitious police interview containing various items of information, such as heights, weights, dates, and times of day, etc. In experiment 1, a memory questionnaire was created to test the participants' memory for a total of 22 such items (Goldsmith et al., 2005). It was found that the accuracy of the precise answers dropped from 58% on immediate testing to 30% after one day, and 21% after one week (Goldsmith et al., 2005). In experiment 2, Goldsmith et al. (2005) revealed that the accuracy of the answers decreased from 64% (immediate testing) to 42% (1-day testing) (Goldsmith et al., 2005). Similarly, Mackay and Paterson (2015) tested memory recall immediately, after a 1-day delay, and after a 1-week delay, and concluded that the delay in recall led to a reduced amount of accurate details in memory. Moreover, Paterson et al. (2015) tested the same retention intervals and identified that recall accuracy was significantly higher at immediate recall than at delayed recall.

Out of all the studies, the most common retention intervals used by researchers were immediate testing and testing after 1 week. Despite the retention intervals being equal, the results varied, with five studies supporting the test and six studies showing no support. To look at

studies that supported the hypothesis, Evans and Fisher (2011) made two conclusions: 1) less information was remembered after a longer delay than a shorter delay, and 2) less precise responses were given after a longer delay than a shorter delay. Palmer et al. (2013) stated that increased retention intervals were associated with decreased recognition accuracy, and Hope et al. (2014) stated that participants remembered more in the immediate testing than at delayed testing. Moreover, Wang et al. (2014) found that immediate recall resulted in a greater amount of correct post-event information being accurately recalled than after 1 week.

In exploring recall accuracy after 1 week, Krix et al. (2014) conducted two experiments, which yielded different results. The first experiment, which will be discussed in more detail later, did not support the hypothesis. On the other hand, the second experiment has shown that people who recalled immediately had more accurate memories a week later than those who did not make recall efforts immediately after a staged crime (Krix et al., 2014). This depicts that memory is not only accurate in shorter retention intervals, but when recalled immediately, the memory remains accurate in the long term as well.

Other studies tested people's recall accuracy for consecutive days. For example, Pansky (2012) looked at recall accuracy at immediate testing, and testing after 24 hours, 48 hours, and 72 hours. Pansky (2012) found that fewer memory responses were reported after 48 hours and 72 hours than at immediate testing and after 24 hours. In another study done in the same year, Pansky and Nemets (2012) examined recall accuracy immediately, and after 48 and 72 hours, and confirmed that immediate memory testing improved both memory quantity and accuracy, while delayed testing did not improve memory accuracy. Similarly, Dando et al. (2020) looked at immediate testing and testing after 48 hours, and found that the participants who made immediate recall were notably more accurate than those who recalled after a delay. One study by

Odinot et al. (2013) distributed participants into three different groups: 1) immediate testing and testing after 2 days, 2) immediate testing and testing after 7 days, and 3) testing after 7 days and after 9 days. The study discovered that the mean number of errors made by the participants increased from the first testing to the subsequent testing, meaning accuracy decreased after a delay.

Additionally, some studies looked at the change in recall accuracy over the span of weeks. Among the two experiments done by Chevroulet et al. (2022), the first experiment examined memory accuracy after 24 hours and 1 week, while the second experiment further looked at accuracy after 2 weeks and 1 month. Both experiments highlighted that those who recalled within 24 hours provided more accurate details than those who recalled after longer delays. Sauer et al. (2010) noted that accuracy was higher in the immediate condition than in the delayed condition after several weeks, while Gustafsson et al. (2022) stated that memories that are not recalled and retrieved are weakened. Odinot and Wolters (2006) examined the effect of retention interval on the number of correct and incorrect units of information that could be given by the participants, and concluded that there was a significant decrease in the number of correct information as retention interval increased from 1 week to 5 weeks. Further, Paterson et al. (2009) measured the recall accuracy of undergraduate students and concluded that students' memory was more accurate 20 minutes after witnessing the event than 2 weeks later.

A few of the studies researched how recall accuracy may change after months. First, Flin et al. (2011) identified that children's memories faded to a greater extent than the older subjects' memories over the 5-month retention interval period. Also, Wheatcroft et al. (2015) determined that a 6-month delay before questioning significantly reduced the accuracy of the recall. Last but not least, La Rooy et al. (2005) conducted three separate experiments⁴, where experiment 3

⁴ Experiment 2 in the study was excluded for review, as it did not involve the predictor variable used for the current study.

supported the hypothesis, while experiment 1 did not support the hypothesis. In the third experiment, La Rooy et al. (2005) identified that the number of details the children were able to report decreased after a 6-month delay, compared to the immediate recall.

To give a better understanding of how longer retention intervals may affect recall accuracy for a vivid murder, the current study will describe the procedure used by two varying studies. First, Paz-Alonso and Goodman (2008) identified that delay in eyewitness identification appeared to weaken the original memory trace. In this study, the participants were shown a film of murder. Then two separate narrative texts about the film were created, one including 10 false post-event details and one with no false post-event details, which are independent and control variables, respectively. To assess the participants' memory, a multiple choice recognition test with 60 specific questions was given. Half of the questions were specific-correct. What this means is that the question would ask specific questions like "was the young man's hair light and wavy?" and the answer is yes. 20 of the 60 questions were specific-misleading, such as "were the children wearing school uniforms?" and the answer is no, the children were not wearing uniforms. The remaining 10 questions were the same 10 false items presented in the narrative. After the study was done, it was found that as memory faded along with time, participants in the study became more prone to accept misinformation and adhere to misleading questions (Paz-Alonso & Goodman, 2008).

If the study by Paz-Alonso and Goodman (2008) depicted a lab study, the study by Rose and Beck (2014) shows an example of an observational study - a staged crime that resembles a real-life situation. In the study, Rose and Beck (2014) staged a nonviolent crime before a group of university students, where the thief entered a classroom and stole the professor's purse. Then, the students were asked to identify the perpetrator and provide a detailed description of him

(Rose & Beck, 2014). In discussing their study, Rose and Beck (2014) stated that there was a significant association between the length of time since witnessing the crime and initiating a testimony on it after one week. According to Rose and Beck (2014), as this time period increased, the percentage of subjects who provided accurate information tended to decrease. Hence, the above 24 studies demonstrated that longer retention intervals do, in fact, lead to reduced recall accuracy.

Test 1: Opposing Literature

On the other hand, 9 studies demonstrated that the increased retention interval does not decrease the recall accuracy of eyewitnesses. Interestingly, the retention intervals used by the studies that did not support the present study's first hypothesis were all within 1 week, with the exception of one study, which had a retention interval of 2 weeks.

As mentioned above, La Rooy et al. (2005) found in the first experiment that recall accuracy did not decrease with time. In particular, the number of errors did not increase across a delay of 24 hours in this experiment (La Rooy et al., 2005). Next, in one experiment by Chan and LaPaglia (2011), it was found that memory accuracy did not worsen after a 1-week delay when the memory was recalled before the testing. Furthermore, Oeberst (2011) found in two separate studies that recall performance did not decline after a delay. In fact, there was a small but significant increase in the subsequent testing (delay of 5 min and 20 min), and the amount recalled was significantly higher than had been estimated for a 1-week delay (Oeberst, 2011).

Krix et al. (2014) found that the number of correct details remained stable, rather than decreasing over time, within the free recall (FR) group. Here, free recall refers to a memory retrieval process in which participants recall as many studied items as they can in any order,

without any cues for memory enhancement (Roediger III & Karpicke, 2005). Moreover, Gittins et al. (2015) contradicted the present study's hypothesis by predicting that although early initial recall could help individuals organize their memories, some types of immediate recall processing may not be beneficial to individuals who have just witnessed a traumatic accident. In the study, participants were shown a stressful video of a car accident (Gittins et al., 2015). Then, they were asked to recall the accident immediately after watching the video and a week after (Gittins et al., 2015). As predicted, the participants in the study remembered the event better one week after the event than at immediate recall (Gittins et al., 2015).

On the other hand, unlike the hypothesis of Krix et al. (2015) that recall accuracy would decline with time, it did not in reality. At the same time, however, Krix et al. (2015) also noted that this may be the result of reduced recall quantity overall, rather than reduced memory accuracy. In other words, accuracy seemed to have remained the same only because the participants were not able to provide enough details. Ma et al. (2021) did not find that immediate recall improved memory performance at subsequent memory testing. Lastly, Hope et al. (2013), who tested the retention interval of 2 weeks, calculated recall accuracy by dividing the total number of correct items by total responses, and concluded that there was no effect of retention interval on accuracy rate over time.

Test 2 Results

While all 33 studies either supported or rejected the first test, only one study was applicable for test 2, which examined whether recall accuracy would stabilize after a given period of time. To reiterate, in order to pass test 2, the study's findings had to demonstrate a steep reduction in memory accuracy in the early stages and a slower rate of decline in the latter stages,

in accordance with Ebbinghaus's forgetting curve. The only study to present and pass this test was the study by Goldsmith et al. (2005). As mentioned earlier, the percentage of accurate answers dropped from 58% on immediate testing to 30% after a one-day delay and 21% after a one-week delay. When this data is entered, a graph that resembles the forgetting curve would be produced. However, none of the other studies demonstrated this.

Table 1. *Categorization of Studies for Test 2*

	Supporting Studies	Contradicting Studies	Total Studies
Test 2: Recall accuracy would stabilize after a given period of time	1	0	N/A

Null Hypothesis and Weighting Analysis

The null hypothesis for the first hypothesis was that if a study is drawn at random, there is an equal chance that the study that is drawn will have a positive and a negative result. To test this hypothesis, 95% confidence intervals were calculated in the R software⁵ using the logit method for both weighted and unweighted analysis. Here, unweighted analysis means that each study carries the same weight. For the unweighted method, the sample estimate, that is, the fraction of studies that show correlation between retention interval and recall accuracy, was 0.727, with a lower bound of 0.553 and an upper bound of 0.852. On the other hand, the weighted analysis is grounded on the idea that the weight is proportional to the size of the study. Therefore, studies with bigger sample sizes get more weight, and a larger sample size means

⁵ An open-source language and environment for statistical computing and graphics (R Project, n.d.).

there is a larger probability of being selected. For the weighted method, the sample estimate was 0.856, with a lower bound of 0.681 and an upper bound of 0.943. Since neither of the hypothesis testing included the null hypothesis value of 0.5, the null hypothesis was rejected.

Table 2. *95% Confidence Interval (CI) Testing*

	Sample Estimate	Lower Bound	Upper Bound
Unweighted Analysis	0.727	0.553	0.852
Weighted Analysis	0.856	0.681	0.943

Chapter 6: Discussion

In response to the high number of eyewitness testimony errors in the criminal justice system, the present meta-analysis attempted to understand the role of retention interval on memory accuracy. According to the literature identified, over 70% stated that the accuracy of human memory decreases with increased time, thereby supporting hypothesis 1. This finding is worth highlighting, as it shows the modern literature's support for the fallibility of human memory, which directly correlates with eyewitness testimony and identification. However, although it constitutes less than 30% of the total literature in the study, there is still evidence stating that human memory does not always deteriorate with time. Yet, when looking at the range of retention intervals for the studies that concluded that recall accuracy did not deter with increased retention interval, it is relatively shorter than the studies that stated that recall accuracy decreased with time. Hence, these results can shed light on the idea that human memory is more susceptible to longer retention intervals than shorter retention intervals. In other words, memory retention may continue to worsen the more time passes.

The second hypothesis predicted that recall accuracy would stabilize after a certain period of time. After reviewing and analyzing all the literature, it was concluded that only one study provided data and evidence on this hypothesis. Hence, the results were statistically insignificant in the context of retention interval and recall accuracy, and Ebbinghaus's forgetting curve theory was deemed irrelevant to the present study.

Chapter 7: Limitations and Future Directions

The main limitation of this meta-analysis is that extremely few studies actually examined variables related to the second hypothesis. In fact, only one study directly addressed the relationship between the forgetting curve theory and recall accuracy, while most of the others did not include comparable measures. Due to the lack of data, it was not possible to properly evaluate the hypothesis. However, lack of evidence does not always mean evidence of no effect. This lack of evidence likely reflects a gap in the existing literature rather than evidence that the relationship does not exist, which shows a need for more focused research in this area. For instance, future research can look at what other factors besides retention interval may correlate with the forgetting curve theory.

Another limitation this study faces is that the study's results are not generalizable to real world situations. In human memory experiments, there are no consequences for inaccurate reporting. In other words, in lab studies, participants know there are no real consequences, so they may feel less pressure to be accurate, while in real criminal cases, where there are consequences for misidentifications, real witnesses may be more cautious about making testimonies and feel emotional stress, which could affect memory. Therefore, results obtained from lab studies, as with the present study, may not fully reflect how eyewitnesses behave in real-life situations.

This leads to the final limitation, which is that this research is not settled enough to incorporate into courtroom practice. What this study communicates is that there is research literature that presents evidence about eyewitness testimony. Since the understanding of retention intervals and human memory is not complete yet, it is challenging to persuade, let alone inform, courtroom participants, such as the judge, prosecutors, defense attorneys, and jurors, that

eyewitness errors occur due to long retention intervals. Just as it was demonstrated in the study that retention interval is not the only factor affecting human memory, future research should continue to examine factors affecting memory to improve the credibility of eyewitness testimonies in the real-world, and to ultimately assess how much weight should be given for eyewitness testimonies.

Chapter 8: Conclusion

Just as Marvin Anderson, many individuals are being wrongfully convicted due to eyewitness errors, even at this moment. Considering that false eyewitness identifications and false accusations are the leading causes of wrongful convictions, further research is needed to minimize errors made by false eyewitnesses. Through the use of various literature, this study established the idea that human memory becomes fallible as the time between the witness's encounter with a perpetrator and subsequent testing of the memory for that encounter increases. It is crucial that the research on eyewitness memory be continued by other researchers to reduce eyewitness errors and, therefore, prevent innocent lives from being wrongfully imprisoned.

Appendices

Appendix A. Description of the Studies

Study (year)	n	Retention Interval (RI)
Goldsmith <i>et al.</i> (2005)		
Experiment 1	72	Immediate, 1 day, 1 week
Experiment 2	48	Immediate, 1 day
La Rooy <i>et al.</i> (2005)		
Experiment 1	40	Immediate, 24 hours
Experiment 3	21	6 months
Odinot & Wolters (2006)	67	1, 3, 5 weeks
Paz-Alonso & Goodman (2008)	232	Immediate, 2 weeks
Paterson <i>et al.</i> (2009)	171	20 min, 2 weeks
Sauer <i>et al.</i> (2010)	1,063	Immediate, 20-50 days
Flin <i>et al.</i> (2011)	177	Same day, 5 months
Evans & Fisher (2011)	138	10 minute, 1 week
Chan & LaPaglia (2011)		
Experiment 3	101	1 week
Oeberst (2011)		
Experiment 1	76	Immediate, 5 min, 20 min, 1 week

Experiment 2	59	Immediate, 1 week
Pansky & Nemets (2012)	120	Immediate, 48 hours, 72 hours
Pansky (2012)	96	Immediate, 24 hours, 48 hours, 72 hours
Palmer <i>et al.</i> (2013)	986	Immediate, 1 week
Odinot <i>et al.</i> (2013)	80	Immediate & 2 days, Immediate & 7 days, OR 7 days & 9 days
Hope <i>et al.</i> (2013)		
Experiment 1	81	Immediate, 2 weeks
Wang <i>et al.</i> (2014)	88	1 week
Rose & Beck (2014)	185	1 hour, 2 days, 7 days
Hope <i>et al.</i> (2014)	60	Immediate, 1 week
Krix <i>et al.</i> (2014)		
Experiment 1	88	1 week
Experiment 2	81	1 week
Mackay & Paterson (2015)	80	Immediate, 1 day, 1 week
Wheatcroft <i>et al.</i> (2015)	21	Immediate, 6 months
Gittins <i>et al.</i> (2015)	85	Immediate, 1 week
Paterson <i>et al.</i> (2015)	104	Immediate, 24 hours, 1 week
Krix <i>et al.</i> (2015)	84	Immediate, 1 week

Dando <i>et al.</i> (2020)	134	Immediate, 48 hours
Ma <i>et al.</i> (2021)	111	Immediate, 1 week
Gustafsson <i>et al.</i> (2022)	56	Immediate, 2 weeks
Chevroulet <i>et al.</i> (2022)		
Experiment 1	80	24 hours, 1 week
Experiment 2	160	24 hours, 1 week, 2 weeks, 1 month

Appendix B. Categorization of Studies for Test 1

Study	+ (Support)	- (Not Support)
Goldsmith <i>et al.</i> (2005)		
Experiment 1	*	
Experiment 2	*	
La Rooy <i>et al.</i> (2005)		
Experiment 1		*
Experiment 3	*	
Odinot & Wolters (2006)	*	
Paz-Alonso & Goodman (2008)	*	
Paterson <i>et al.</i> (2009)	*	
Sauer <i>et al.</i> (2010)	*	
Flin <i>et al.</i> (2011)	*	
Evans & Fisher (2011)	*	
Chan & LaPaglia (2011)		
Experiment 3		*
Oeberst, A. (2011)		
Experiment 1		*
Experiment 2		*
Pansky & Nemets (2012)	*	
Pansky (2012)	*	
Palmer <i>et al.</i> (2013)	*	
Odinot <i>et al.</i> (2013)	*	
Hope <i>et al.</i> (2013)		
Experiment 1		*

Wang <i>et al.</i> (2014)	*	
Rose & Beck (2014)	*	
Hope <i>et al.</i> (2014)	*	
Krix <i>et al.</i> (2014)		
Experiment 1		*
Experiment 2	*	
Mackay & Paterson (2015)	*	
Wheatcroft <i>et al.</i> (2015)	*	
Gittins <i>et al.</i> (2015)		*
Paterson <i>et al.</i> (2015)	*	
Krix <i>et al.</i> (2015)		*
Dando <i>et al.</i> (2020)	*	
Ma <i>et al.</i> (2021)		*
Gustafsson <i>et al.</i> (2022)	*	
Chevroulet <i>et al.</i> (2022)		
Experiment 1	*	
Experiment 2	*	

References

- Albright, T. D., & Garrett, B. L. (2022). The law and science of eyewitness evidence. *BUL Rev.*, 102, 511.
- American Bar Association. (2021). *How courts work*. ABA.
https://www.americanbar.org/groups/public_education/resources/law_related_education_network/how_courts_work/discovery/
- Andrade, M., & Walker, N. (2021). 8.1.5: *Forgetting*. LibreTexts Social Sciences.
[https://socialsci.libretexts.org/Under_Construction/Purgatory/PSYC_316%3A_Cognition_\(Carbary\)/08%3A_Working_Memory_and_Long_Term_Memory/8.01%3A_Working_Memory/8.1.05%3A_Forgetting](https://socialsci.libretexts.org/Under_Construction/Purgatory/PSYC_316%3A_Cognition_(Carbary)/08%3A_Working_Memory_and_Long_Term_Memory/8.01%3A_Working_Memory/8.1.05%3A_Forgetting)
- Bergman, P. (2023). *Can the defense interview a prosecution witness?* NOLO.
<https://www.nolo.com/legal-encyclopedia/investigating-criminal-case-interviewing-prosecution-witnesses.html>
- Brooks, S. K., & Greenberg, N. (2021). Psychological impact of being wrongfully accused of criminal offences: A systematic literature review. *Medicine, science, and the law*, 61(1), 44–54.
- Chan, J. C., & LaPaglia, J. A. (2011). The dark side of testing memory: Repeated retrieval can enhance eyewitness suggestibility. *Journal of Experimental Psychology: Applied*, 17(4), 418.
- Chevroulet, C., Paterson, H. M., Yu, A., Chew, E., & Kemp, R. I. (2022). The impact of recall timing on the preservation of eyewitness memory. *Psychiatry, Psychology and Law*, 29(3), 471-486.
- Clarivate. (2025). *Access millions of research papers in one click*. Endnote Click.

- Cormia, A., Shapland, T., Rasheed, A., & Pezdek, K. (2022). Laypeople's beliefs about the effects of common estimator variables on memory. *Memory*, 30(6), 733-743.
- Dando, C. J., Gabbert, F., & Hope, L. (2020). Supporting older eyewitnesses' episodic memory: the self-administered interview and sketch reinstatement of context. *Memory*, 28(6), 712-723.
- Deffenbacher, K. A., Bornstein, B. H., McGorty, E. K., & Penrod, S. D. (2008). Forgetting the Once-Seen Face: Estimating the Strength of an Eyewitness's Memory Representation. *Journal of Experimental Psychology: Applied*, 14(2), 139–150.
- Deffenbacher, K.A., & Cutler, B. L. (2008). Retention Interval and Eyewitness Memory. *Psychology of Law*.
- Evans, J. R., & Fisher, R. P. (2011). Eyewitness memory: Balancing the accuracy, precision and quantity of information through metacognitive monitoring and control. *Applied Cognitive Psychology*, 25, 501–508.
- Flin, R., Boon, J., Knox, A. and Bull, R. (2011). The effect of a five-month delay on children's and adults' eyewitness memory. *British Journal of Psychology*, 83, 323-336.
- Fraser, B. M., Mackovichova, S., Thompson, L. E., Pozzulo, J. D., Hanna, H. R., & Furat, H. (2022). The influence of inconsistency in eyewitness reports, eyewitness age and crime type on mock juror decision-making. *Journal of Police and Criminal Psychology*, 37(2), 351-364.
- Garrett, B. L. (2020). Judging eyewitness evidence. *Judicature*, 104, 30.
- Garrett, B. L. (2020). Wrongful convictions. *Annual Review of Criminology*, 3(1), 245-259.
- Gittins, C. B., Paterson, H. M., & Sharpe, L. (2015). How does immediate recall of a stressful

- event affect psychological response to it?. *Journal of Behavior Therapy and Experimental Psychiatry*, 46, 19-26.
- Głomb, K. (2022). How to improve eyewitness testimony research: theoretical and methodological concerns about experiments on the impact of emotions on memory performance. *Psychological research*, 86(1), 1-11.
- Goldsmith, M., Koriat, A., & Pansky, A. (2005). Strategic regulation of grain size in memory reporting over time. *Journal of Memory and Language*, 52(4), 505-525.
- Gould, J., & Leo, R. A. (2015). The path to exoneration. *Albany Law Review*, 79, 325.
- Gross, S. R., & Shaffer, M. (2012). Exonerations in the United States, 1989-2012. *SSRN Electronic Journal*.
- Grounds, A. (2004). Psychological consequences of wrongful conviction and imprisonment. *Canadian Journal of Criminology and Criminal Justice, Suppl. Wrongful Convictions*, 46(2), 165-182.
- Gustafsson, P. U., Lindholm, T., & Jönsson, F. U. (2022). Eyewitness accuracy and retrieval effort: Effects of time and repetition. *PLOS ONE*, 19(7).
- Hope, L., Gabbert, F., Fisher, R. P., & Jamieson, K. (2014). Protecting and enhancing eyewitness memory: The impact of an initial recall attempt on performance in an investigative interview. *Applied Cognitive Psychology*, 28, 304–313.
- Hope, L., Mullis, R., & Gabbert, F. (2013). Who? What? When? Using a timeline technique to facilitate recall of a complex event. *Journal of applied research in memory and cognition*, 2(1), 20-24.
- Innocence Staff. (2020). *How eyewitness misidentification can send innocent people to prison*. Innocence Project.

- Irazola, S., Williamson, E., Stricker, J., & Niedzwiecki, E. (2014). Addressing the impact of wrongful convictions on crime victims. *NIJ Journal*, 274, 34-38.
- King, D. L., Jones, F. L., Pearlman, R. C., Tishman, A., & Felix, C. A. (2002). The length of the retention interval, forgetting, and subjective similarity. *Journal of experimental psychology. Learning, memory, and cognition*, 28(4), 660–671.
- Krix, A. C., Sauerland, M., Gabbert, F., & Hope, L. (2014). Providing eyewitnesses with initial retrieval support: What works at immediate and subsequent recall? *Psychology, Crime & Law*, 20, 1–5-1027.
- Krix, A. C., Sauerland, M., Lorei, C., & Rispens, I. (2015). Consistency across repeated eyewitness interviews: Contrasting police detectives' beliefs with actual eyewitness performance. *PloS one*, 10(2), e0118641.
- Lacy, J. W., & Stark, C. E. (2013). The neuroscience of memory: implications for the courtroom. *Nature reviews. Neuroscience*, 14(9), 649-658.
- La Rooy, D., Pipe, M. E., & Murray, J. E. (2005). Reminiscence and hypermnesia in children's eyewitness memory. *Journal of Experimental Child Psychology*, 90(3), 235-254.
- Loftus, E. F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory*, 12(4), 361-366.
- Loftus, E.F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory*, 4(1), 19-31.
- Ma, J., Paterson, H. M., & Temler, M. (2021). The effects of immediate recall and subsequent

- retrieval strategy on eyewitness memory. *Psychiatry, psychology, and law: an interdisciplinary journal of the Australian and New Zealand Association of Psychiatry, Psychology and Law*, 29(5), 788–805.
- Mackay, T. L., & Paterson, H. M. (2015). How does timing of recall affect eyewitness memory and psychological distress?. *Journal of Police and Criminal Psychology*, 30, 242-253.
- Malpass, R. S., & Devine, P. G. (1981). Eyewitness identification: Lineup instructions and the absence of the offender. *Journal of Applied Psychology*, 66(4), 482–489.
- McLeod, S. (2022). *Theories of forgetting in psychology*. Simply Psychology.
<https://www.simplypsychology.org/forgetting.html>
- Murre, J. M., & Dros, J. (2015). Replication and Analysis of Ebbinghaus' Forgetting Curve. *PloS one*, 10(7).
- National Registry of Exonerations. (2026). *Exonerations By Year: DNA and Non-DNA*. NRoE.
<https://exonerationregistry.org/exonerations-year-dna-and-non-dna>
- National Registry of Exonerations (n.d.). *Understanding the Registry*. NRoE.
<https://exonerationregistry.org/understanding-registry>
- Odinot, G., Memon, A., La Rooy, D., & Millen, A. (2013). Are two interviews better than one? Eyewitness memory across repeated cognitive interviews. *PloS one*, 8(10), e76305.
- Odinot, G., & Wolters, G. (2006). Repeated Recall, Retention Interval and the Accuracy - Confidence Relation in Eyewitness Memory. *Applied Cognitive Psychology*, 20, 973-985.
- Oeberst, A. (2011). If anything else comes to mind... better keep it to yourself? Delayed recall is discrediting—unjustifiably. *Law and Human Behavior*, 1-11.
- Palmer, M. A., Brewer, N., Weber, N., & Nagesh, A. (2013). The Confidence-Accuracy

- Relationship for Eyewitness Identification Decisions: Effects of Exposure Duration, Retention Interval, and Divided Attention. *Journal of Experimental Psychology: Applied*, 19(1), 55-71.
- Pansky, A. (2012). Inoculation against forgetting: Advantages of immediate versus delayed initial testing due to superior verbatim accessibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 38(6), 1792.
- Pansky, A., & Nemets, E. (2012). Enhancing the quantity and accuracy of eyewitness memory via initial memory testing. *Journal of Applied Research in Memory and Cognition*, 1(1), 2-10.
- Paterson, H. M., Eijkemans, H., & Kemp, R. I. (2015). Investigating the Impact of Delayed Administration on the Efficacy of the Self-Administered Interview. *Psychiatry, Psychology and Law*, 22(2), 307–317.
- Paterson, H. M., Kemp, R. I., & Forgas, J. P. (2009). Co-witnesses, confederates, and conformity: The effects of discussion and delay on eyewitness memory. *Psychiatry, Psychology and Law*, 16, 112-124.
- Paz-Alonso, P. M., & Goodman, G. S. (2008). Trauma and memory: Effects of post-event misinformation, retrieval order, and retention interval. *Memory*, 16(1), 58–75.
- Roediger III, H. L., & Karpicke, J. D. (2005). Learning and Memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.
- Roemer, L. (2025). *New analysis: Innocent death-sentenced prisoners wait longer than ever for exoneration*. Death Penalty Information Center.
<https://deathpenaltyinfo.org/analysis-innocent-death-sentenced-prisoners-wait-longer-than-ever-for-exoneration>

- Roque, M., Burd, K., Diaz, C., & Kitson, A. (2010). *Eyewitness testimony and making a murderer*. Cornell University Law School Social Science and Law.
- Rose, C., & Beck, V. (2016). Eyewitness accounts: false facts, false memories, and false Identification. *Journal of Crime and Justice*, 39(2), 243-263.
- R Project (n.d.). *What is R?* R Project.
<https://www.r-project.org/about.html>
- Sauer, J., Brewer, N., Zweck, T., & Weber, N. (2010). The Effect of Retention Interval on the Confidence-Accuracy Relationship for Eyewitness Identification. *Law and Human Behavior*, 34(4), 337-347.
- Scott, L. (2009). It never, ever ends: The psychological impact of wrongful conviction. *Crim. L. Brief*, 5(2), 10-22.
- Wang, E., Paterson, H., & Kemp, R. (2014). The effects of immediate recall on eyewitness accuracy and susceptibility to misinformation. *Psychology, Crime and Law*, 20(7), 619-634.
- Wells, G. L. (1978). Applied eyewitness-testimony research: System variables and estimator variables. *Journal of Personality and Social Psychology*, 36(12), 1546.
- Wells, G. L. (2018). Eyewitness identification. In E. Luna (Ed.), *Reforming criminal justice: Volume 2, Policing* (pp. 259-278). Tempe, AZ: Sandra Day O'Connor College of Law.
- Wells, G. L., & Turtle, J. W. (1987). Eyewitness testimony research: Current knowledge and emergent controversies. *Canadian Journal of Behavioural Science*, 19(4), 363.
- Wheatcroft, J. M., Wagstaff, G. F., & Manarin, B. (2015). The influence of delay and item difficulty in criminal justice systems on eyewitness confidence and accuracy. *International Journal of Humanities and Social Science Research*, 1.

- Wiechert, S., Verschueren, A., Ben-Shakhar, G., Pertzov, Y., Loftus, E. F., & Verschueren, B. (2025). The misinformation effect: A contemporary replication and extension of Loftus et al. (1978) to investigate its underlying mechanisms. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.
- Williamson, E. J., & Niedzwiecki, E. (2016). Wrongful convictions: Understanding the experiences of the original crime victims. *Violence and victims*, 31(1), 155.
- Wise, R. A., Sartori, G., Magnussen, S., & Safer, M. A. (2014). An examination of the causes and solutions to eyewitness error. *Frontiers in psychiatry*, 5, 102.