

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Devu Rajeev^{1*}

ABSTRACT

Introduction: Eyewitness memory plays a crucial role in criminal investigation. The present study examined the effect of retention interval on the accuracy of eyewitness memory and the effect of emotional arousal on the memory of plot relevant and plot irrelevant details. **Method:** A video (Ghosh, 2020) depicting a shooting scene was chosen to be used in this study. In this video, two men try to shoot a shopkeeper and then run away. A total of 16 subjects, 8 females and 8 males, of the age range 18-55 years participated in this study. All of them were shown the same video clip. Two similar questionnaires, containing 12 questions each was prepared. Each questionnaire contained six plot relevant and six plot irrelevant questions. Plot relevant questions are based on the central details of the crime, which revolves around the violent part, that is, gun shooting (e.g. How many guns did the shooters have). Plot irrelevant questions are related to the peripheral details shown in the video (e.g. Identify the object present in the shopkeeper's table). One questionnaire was administered immediately after watching the video and the second questionnaire was administered after three days. In order to prevent learning effect, the wording of the questions and response options were slightly changed. **Result:** A significant difference was observed between the scores in immediate and delayed condition. However, no significant difference was observed between the scores of plot relevant and irrelevant questions. The effect of suggestibility was also observed as some participants who gave a correct answer during the first report gave a completely different answer in the second report, when the wording was slightly changed. **Conclusion:** It was found that the accuracy of eye witness memory is poorer in delayed condition compared to immediate condition. Thus, the study suggests that criminal investigators should take the testimony of eye witnesses as early as possible, any delay could reduce the amount of details recalled.

Keywords: *Evaluation, Eyewitness Memory, Virtual Crime Scene*

One of the vital source of information for understanding what happened during a criminal act is eyewitness testimony. Even though eyewitness testimonies play a major role in investigations, studies have shown that eyewitness evidence can be unreliable, and therefore, is one of the major contributing factor for wrongful convictions (Garrett, 2011). This happens because human memory is malleable (Loftus, 2005).

¹University of Delhi, South Campus, India

*Corresponding Author

Received: December 08, 2023; Revision Received: February 10, 2024; Accepted: February 14, 2024

Suggestibility and other factors affecting memory

According to Loftus (2005), "misinformation effect refers to the impairment in memory of past events that occur after being exposed to misleading information". Misinformation can influence some people more than others.

Age. It has been found that young children are easily influenced by misinformation than adults (Ceci & Bruck, 1993). Compared to young adults, the elderly population are more susceptible (Davis & Loftus, 2005).

Gender. Lindholm & Christianson (1998) studied the role of gender in eyewitness memory of a violent crime. They found that females showed better recall of the crime than males. Females performed better in recalling episodic memory as well (Lindholm & Christianson, 1998).

Affect. Affect has also been recognized as a factor that influences the accuracy of eyewitness memory. Studies have shown that increased emotional arousal increases the chance of remembering items (Phelps, 2006). In a study, participants induced with negative mood did not get influenced by misleading information as much as participants who were induced with positive mood (Forgas et al, 1995). The effect of stress and arousal on eyewitness memory can be explained using Yerkes Dodson Law (1908). This law suggests that, "attention is best focused when there is an optimal level of stress and arousal". If the arousal or stress is too high or too low levels, it could negatively affect attention resulting in decreased ability to perceive and further recall details (Loftus, 1986).

Misinformation can influence us in many ways. There is a chance of memory being contaminated when witnesses talk with each other, or when the investigators use leading questions or when they are exposed to information from social media. At times, when we try to reconstruct the event using our memory, even in the absence of external factors, distortions could occur, which further become part of misinformation (Schmolck et al., 2000). Most times people encode information, based on their prejudices, without any conscious awareness. When we have to retrieve this information, we modify it based on our belief system. Therefore, memories of witnessed events which the people are unsure of, may readily be contaminated by information they received from different sources like investigators, other eye witnesses, family and social media, which further reduce the accuracy of eyewitness testimony leading to wrongful convictions. (Albright, 2017).

Researchers have accepted that the quality of memory reduces as time passes (Kassin et al., 1989). A review of the eyewitness literature done by Penrod et al (1982), found that the loss of eyewitness memory follows Ebbinghaus curve. Kassin et al (1989) suggested that eyewitness memory rapidly decrease with time and then levels off.

Memory of emotional events

According to Easterbrook hypothesis, "attention will be narrowed during emotional events that involve physiological arousal, because of which, some aspects of the event will be excluded from attention and therefore poorly remembered later on" (Easterbrook, 1959). These details, when recalled later on, are likely to be reconstructed and, thus, open to error. Other aspects of the event, like the central details, will get more attention, and thus remembered well. Therefore, this hypothesis suggests that the effect of emotion on memory will not be even. It could vary based on several factors such as the type of information to be recalled (Heuer & Reisberg, 1990).

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Different studies have shown different results regarding memory of negative emotional events. A relation between the emotional arousal and retention interval was studied by Kleinsmith and Kaplan (1963). According to their study, highly arousing events are less remembered at short retention intervals. However, as the time between test and study increased, the memory of high arousal events also increased (Kleinsmith & Kaplan, 1963). These findings are in contradiction to Ebbinghaus forgetting curve. Some studies have shown that negative events are well remembered (Heuer & Reisberg, 1990; Bohannon, 1988). Study by Loftus & Burns (1982), however, showed that unpleasant emotional events are less remembered compared to unemotional events. Researchers like Burke et al (1992) and Christianson (1987) tried to understand the interaction between type of event that occurred (emotional or non-emotional) and type of information (central or peripheral) to be recalled. This diversity in research findings makes it difficult to come to a conclusion regarding memory of unpleasant negative events.

Laboratory Studies. In most of the highly unpleasant and emotional events that occur in real life, researchers have no proper idea regarding the original event. He/she only know what the witnesses or police have reported. In order to make the research more valid, most researchers use simulation approach., Here, the participants are made to observe an emotional or neutral event through videos or slides. Their memory of the event can then be measured immediately or after some time (delayed condition) (Loftus & Burns, 1982). Studies that were conducted on real events have shown that emotional events are remembered well. However, no such consistency has been observed in studies that have used simulation approach. Some of the simulation studies have found that negative emotional events are less remembered than neutral events, which indicates that emotional arousal could affect memory negatively (Loftus & Burns, 1982)

Hence, a dilemma exists with the researchers working in the eye-witness memory field. Real life events are difficult to control, whereas simulation studies bring in contradictory results. Considering the current circumstances of COVID-19, this study is conducted using the virtual medium, wherein participants were made to watch violent videos.

REVIEW OF LITERATURE

Table 1 shows some of the major researches that have been conducted in the area of eyewitness memory.

Table 1: Review of Literature

Author (year)	Participants	Design	Results
Mittal et al (2013)	Fifty-five participants	Subjects were made to watch a video of a crime scene and their memory of central and peripheral details were tested under immediate and delayed conditions.	Subjects with high emotional arousal showed better immediate recognition for the central details of events. But in delayed recognition condition the two groups did not differ significantly. The two groups did not differ significantly in terms of peripheral details tested under immediate and delayed recognition conditions as well.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Author (year)	Participants	Design	Results
Yarmey (2004)	590 men and women	Participants were tested for interrogative recall and photo identification of a woman. Subjects spoke to her approximately for 15 seconds, either 2 minutes earlier or 4 hours earlier. Imagery retrieval instructions were given to half of the witnesses before the two memory tests.	The gender of witnesses, retention interval and instructions had no significant effects on identification. 49% of the witnesses given the target-present lineup rightly identified the target, and 62% rightly rejected the target-absent lineup.
Ebbesen & Rienick (1998)	150 participants, 60 served only as witnesses and 90 served in both roles, as the stranger and as the witness.	The effect of differing retention intervals on the accuracy of memory for events and for identifying characteristics after an interaction with a stranger at 2 recall attempts was studied.	Retention interval had no effect on the accuracy of memory for both recall attempts. Confidence predicted the accuracy of personal descriptions.
Christianson and HübINETTE (1991)	58 witnesses who had observed a post office robbery, either as a victim or a bystander	Subjects were asked questions about the event. The reliability of the witnesses' memory were assessed by comparing police reports and the information given during interview conducted between 4 and 15 months after the robberies.	They found that the witnesses' recollections of central details related to the actual robbery like weapon and clothing, were consistent, whereas recollections of the specific circumstances such as date and time were less consistent with what was reported in the police report.
Heuer & Reisberg (1990)	40 undergraduates from Reed College, ranging in age from 19 to 24 years.	Subjects were shown two sets of story materials through presentation. One was a violent version and the other was neutral. 2 weeks later, the subjects were asked to recall as much as they could of the first presentation. Recognition was measured using 120 forced-choice questions that included 78 peripheral and 42 central items	The study concluded that emotion improves memory of both central and peripheral details. Emotional arousal increased subjects' range of attention, which is in contradiction to Easter Brook hypothesis.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Author (year)	Participants	Design	Results
Wagenaar and Groeneweg (1990)	78 former prisoners of Camp Erika (Nazi camp) collected in the periods of 1943–1947 and 1984–1987	A comparison was made between testimonies from these two periods.	Almost all participants remembered their experiences in concentration camp accurately, even after 40 years. Even the recall of smaller details were accurate.
Yuille & Cutshall, 1986	13 witnesses of a real murder	Subjects were assessed soon after the crime occurred (that is, within 2 days of the murder) and then 4–5 months later.	The subjects who reported the highest amount of stress showed a mean accuracy of 93% in the initial police interview and a mean accuracy of 88% 4–5 months later. The study concluded that emotional response to a real life event does not affect memory negatively.
Loftus and Burns (1982)	226 university students	Participants were shown either a violent or a nonviolent videotape of a simulated bank robbery. In the violent version, a boy was shot in the head by the robber towards the end. The nonviolent version was same as that of the violent version but the shooting episode was replaced with a neutral episode. Twenty five multiple-choice and fill in the blank questions were used to test memory.	Participants who saw the violent version showed poorer retention of details. Retention was poor for both recognition and recall.
Clifford and Hollin (1981)	60 undergraduates with an average age of 21.7 years	Participants were shown a videotape, that involved a violent event (mugging) or a nonviolent event (asking for directions). Their memory was measured immediately using a questionnaire that asked for detailed descriptions of the persons seen in the incident.	It was found that the description of the main character was more precise in the nonviolent condition. The quality of details recalled reduced with the increase in number of perpetrators in violent condition.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Author (year)	Participants	Design	Results
Clifford and Scott (1978)	8 groups of 6 male or 6 female non psychology undergraduates	Four-way split-plot design to study the effect of nature of the witnessed incident (violent, nonviolent), mode of questioning (narrative, interrogative), sex of witness, and type of information probed (actions, descriptions) on eyewitness accuracy.	Memory was poorer in the violent condition. Females recalled less accurately than males in violent condition. Type of questioning had no effect on accuracy. But subjects were misled by leading questions. Actions were remembered better than descriptions.

The objective of this study is to examine the effect of emotional arousal on the accuracy of eyewitness memory measured under immediate and delayed recognition conditions. It is hypothesized that the accuracy of memory in delayed condition will be lesser than in immediate condition. It is also hypothesized that the memory of plot relevant information will be more accurate in both immediate and delayed condition, in comparison to plot irrelevant details.

METHOD

Objective

To study the effect of retention interval in the accuracy of eye witness memory and to compare the effect of emotional arousal on memory of plot relevant and irrelevant details.

Participants

A total of 16 subjects, 8 females and 8 males, of the age range 18-55 years were contacted to participate in this study. All of them were shown the same video clip. Convenient non-random sampling was used to collect the data.

Tools

Crime Scene Video clip

After a careful examination of several videos, a YouTube video (Ghosh, 2020) depicting a shooting scene was chosen to be used in this study. In this video, two men try to shoot a shopkeeper and then run away. It is of one minute and 47 seconds duration.

Questionnaire

Two similar questionnaires, containing 12 questions each was prepared. Each questionnaire contained six plot relevant and six plot irrelevant questions. Plot relevant questions are based on the central details of the crime, which revolves around the violent part, that is, gun shooting (eg. How many guns did the shooters have). Plot irrelevant questions are related to the peripheral details shown in the video (eg. Identify the object present in the shopkeeper's table). Each correct response was given a score of one and incorrect response was marked zero. The questionnaire included true or false, multiple choice, fill in the blanks and one word answer questions. One questionnaire was administered immediately after watching the video and the second questionnaire was administered after three days. In order to prevent learning effect, the wording of the questions and response options were slightly changed. The questionnaire is attached in the appendix.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Procedure

After establishing rapport, the participants were given a brief introduction about the study. Informed consent was obtained. Through a video call, the participants were made to watch the crime scene video clip. After this, they were asked questions based on the video, one by one, from the first questionnaire. Following this, they were asked to participate in the second part of the study, after three days. However, they were not informed about what the second part would comprise of. They were not allowed to re-watch the video. After three days, the second questionnaire was administered. Later, participants were debriefed about the study.

A comparison was made between the total score obtained by participants in immediate and delayed conditions, between scores of plot relevant and plot irrelevant details in immediate condition, and in delayed condition. A comparison of scores of plot relevant details in immediate and delayed condition, and of plot irrelevant details in both conditions.

Wilcoxon signed rank test was used for this purpose.

RESULT

Table 2: Wilcoxon Signed Rank Test comparing scores in immediate and delayed conditions.

	Mean	SD	Median	Total N	Standardised Test Statistic (Z)	Asymptotic significance (2 tailed)
Immediate condition	9.13	2.029	9.5	16	-2.03*	.042
Delayed condition	8.13	2.363	8			

Table 2 shows that scores in immediate condition (M=9.13, SD=2.029, Mdn=9.5) is greater than scores in delayed condition (M=8.13, SD=2.363, Mdn=8). A Wilcoxon signed rank test indicated that scores in delayed condition was significantly lower than immediate condition, $Z = -2.03$, $p < .05$. The median score in immediate condition was 9.5 compared to 8 in delayed condition.

Hence, the hypothesis that there will be a significant difference in the scores obtained in immediate and delayed condition is accepted.

Table 3: Wilcoxon Signed Rank Test comparing scores of plot relevant and irrelevant questions in immediate condition.

	Mean	SD	Median	Total N	Standardised Test Statistic (Z)	Asymptotic significance (2 tailed)
Plot relevant details	4.69	1.138	5	16	-.921	.357
Plot irrelevant details	4.44	1.153	4			

Table 3 shows that scores of plot relevant details (M=4.69, SD=1.138, Mdn=5) is greater than scores of plot irrelevant details (M=4.44, SD=1.153, Mdn=4). However, a Wilcoxon signed rank test indicated that there is no statistically significant difference between scores of plot relevant and plot irrelevant questions in immediate condition, $Z = -.921$, $p = .357$.

Hence, the hypothesis that there will be a significant difference in the scores of plot relevant and plot irrelevant details in immediate condition is rejected.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

Table 4: Wilcoxon Signed Rank Test comparing scores of plot relevant and irrelevant questions in delayed condition.

	Mean	SD	Median	Total N	Standardised Test Statistic (Z)	Asymptotic significance (2 tailed)
Plot relevant details	4	1.549	4	16	.270	.787
Plot irrelevant details	4.13	1.455	5			

As shown in Table 4, a Wilcoxon signed rank test indicated that there is no statistically significant difference between scores of plot relevant and plot irrelevant questions in delayed condition, $Z = .270$, $p = .787$.

Hence, the hypothesis that there will be a significant difference in the scores of plot relevant and plot irrelevant details in delayed condition is rejected.

DISCUSSION

The study tried to compare the effect of retention interval on accuracy of eye witness memory and the effect of emotional arousal on memory of plot relevant and irrelevant details. It was hypothesized that there will be a significant difference in the accuracy of memory between immediate and delayed condition. The results reveal that the memory of the crime is more accurate in immediate condition than in delayed condition. The other hypothesis was that, there will be a significant difference in the memory of plot relevant and plot irrelevant details in both delayed and immediate conditions. However, it was rejected.

The first finding of the study suggests that the memory of an emotionally arousing event decreases over time. The recall and recognition of details viewed in the crime video significantly decreased after a three-day interval. This is in agreement with the study done by Odinet & Wolters (2006), who found that longer retention intervals resulted in weakened memory performance. The testimony given by the witness is usually heard by the juror after a long time. As observed from the results, there is a high chance that the accuracy of eye witness memory would decrease as the retention interval increases. Thus, the witnesses need to be questioned as early as possible after the occurrence of an event (Odinot & Wolters, 2006). The amount of information recalled reduces as time passes. But the results from this study cannot be generalised as the participants only watched a crime video. The experience of a real crime or violent act might have different effects on the memory, as observed by Yuille & Cutshall, 1986, who found that the memory of a real-life crime declines very little over time.

Some participants who gave a correct answer during the first report gave a completely different answer in the second report, when the wording was slightly changed. This shows the effect of suggestibility. The way questions are worded plays an important role. For instance, during the immediate condition, participants were asked 'how many guns did the shooters have in total?' and in the delayed condition, they were asked, 'how many gun/guns did the shooter have in total?'. Interestingly, many subjects who said two guns in the first report said one gun in the second report.

Even though, an overall decrease in scores was seen in delayed condition, in comparison to immediate condition; the scores of two participants increased after a three day interval. This could be because the change in the wording of the questions provided them with better retrieval cues that helped them identify the correct answer. Hence, while taking an eye

Evaluation of Eyewitness Memory in A Virtual Crime Scene

witness testimony for a real-life incident, officers need to make sure that they ask questions in different formats and styles to see if the witness gives the same answer each time. It is also to be noted that the biases held by the individual could interfere with the response they give. For example, the participants were given the option to select which of the following was present in the table of shopkeeper. The options included cup, paper and mobile phone. A majority of the participants chose mobile phone even though the correct answer was paper. This could be because of the fact that mobile phones are indispensable objects used in our day-to-day life and are used by almost everyone.

It was also observed that all the participants gave correct answer for a descriptive type of question asked, but when it came to recognition and one-word answers, they made mistakes. This suggest that participants have an overall idea about what happened, but is not sure about the specific details.

The second finding of this study indicates that there is no significant difference in the memory of plot relevant and plot irrelevant details. Similar results were observed by Wessel et al (2000). However, the results contradict with the Easter brook hypothesis (1959), which states that, when emotionally aroused, individuals tend to have narrowed attention, wherein they focus only on the central details and ignore the peripheral details. Here, the result of this study supports the conclusion drawn earlier by Christianson (1992) that "the link between attentional narrowing and emotional memory is imperfect". The result also contradicts the findings of many other researches, which suggest that the central details are better retained than peripheral details (Stebly, 1992; Christianson & Loftus, 1990). These conflicting findings may be due to procedural differences. It appears that in this study, the emotional arousal increased the participants' range of attention, thus producing a detailed memory of the event (Heuer & Reisberg,1990). Or maybe, the crime video was not emotionally arousing enough to create a narrowing of attention to the plot relevant details.

Limitations

As in the case of all laboratory studies, this study lacks ecological validity. Whether or not the video was arousing enough to create potential effects on memory is questionable, since it cannot be compared to a real-life crime. A small sample size decreases the generalizability of the results. The study did not take into account of factors like age, gender, personality, that could have influenced the results. Finally, convenient sampling was used to draw participants which may have also contributed to possible differences in the findings of the study.

CONCLUSION

The study aimed at understanding the effect of retention interval on eyewitness memory, and the effect of arousal on memory of plot relevant and plot irrelevant details of an event. It was found that the accuracy of eye witness memory is poorer in delayed condition compared to immediate condition. Also, no significant difference was observed between the memory of plot relevant and plot irrelevant details. Thus, the study suggests that criminal investigators should take the testimony of eye witnesses as soon as an event has occurred, since the amount of information recalled reduces as time passes. Future studies could use a larger sample size with a more emotionally arousing simulation to study the accuracy of eyewitness memory over time.

REFERENCES

- Ahola, A. (2012). How reliable are eyewitness memories? Effects of retention interval, violence of act, and gender stereotypes on observers' judgments of their own memory regarding witnessed act and perpetrator. *Psychology, crime & law*, 18(5), 491-503.
- Albright, T. D. (2017). Why eyewitnesses fail. *Proceedings of the National Academy of Sciences*, 114(30), 7758-7764.
- Areh I., & Umek P. (2004). Personal characteristics and validity of eyewitness testimony. In: Mesko G., Pagon M., & Dobovsek Bojan (Eds.), *Policing in central and eastern Europe: Dilemmas of contemporary criminal justice*. Solvenia: Faculty of Criminal Justice, University of Maribor
- Bohannon, J. N. (1988). Flashbulb memories of the space shuttle disaster: A tale of two theories. *Cognition*, 29, 179–196
- Burke, A., Heuer, F., & Reisberg, D. (1992). Remembering emotional events. *Memory & cognition*, 20(3), 277-290.
- Ceci, S. J., & Bruck, M. (1993). Suggestibility of the child witness: A historical review and synthesis. *Psychological bulletin*, 113(3), 403.
- Christianson S. A. (1992). Emotional stress and eyewitness memory: a critical review. *Psychological bulletin*, 112(2), 284–309.
- Christianson, S. & Loftus, E.F. (1990). Some characteristics of people's traumatic memories. *Bulletin of the Psychonomic Society*, 28, 195–198
- Christianson, S. A., & Hübinette, B. (1991). People's emotional reactions and memory associated with post office robberies. In *Third Annual Convention of American Psychological Society*.
- Christianson, S. A., & Loftus, E. F. (1987). Memory for traumatic events. *Applied cognitive psychology*, 1(4), 225-239.
- Clifford, B. R., & Hollin, C. R. (1981). Effects of the type of incident and the number of perpetrators on eyewitness memory. *Journal of Applied Psychology*, 66(3), 364.
- Clifford, B. R., & Scott, J. (1978). Individual and situational factors in eyewitness testimony. *Journal of Applied Psychology*, 63(3), 352.
- Davis, D., & Loftus, E. F. (2005). *Age and functioning in the legal system: Victims, witnesses, and jurors*. Florida: CRC Press
- Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological review*, 66(3), 183.
- Ebbesen, E. B., & Rienick, C. B. (1998). Retention interval and eyewitness memory for events and personal identifying attributes. *Journal of Applied Psychology*, 83(5), 745-762. doi:10.1037/0021-9010.83.5.745
- Ebbinghaus H (1885) *Über das Gedächtnis*. Leipzig: Dunker.
- Forgas, J. P., Laham, S. M. & Vargas, P. T. (1995). Mood effects on eyewitness memory: Affective influences on susceptibility to misinformation. *Journal of Experimental Social Psychology*, 41 (6), 574–588.
- Garrett, B. (2011). *Convicting the Innocent*. Cambridge: Harvard University Press. doi: 10.4159/harvard.9780674060982
- Ghosh,A. (2020, May 6). *Murder caught in shop CCTV footage* [Video]. YouTube. <https://www.youtube.com/watch?v=z2eLlfiSj9k>
- Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Sciences*. 5, 394- 400.
- Heuer, F., & Reisberg, D. (1990). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory & cognition*, 18(5), 496-506.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

- Karpel, M. E., Hoyer, W. J., & Togliola, M. P. (2001). Accuracy and qualities of real and suggested memories: Nonspecific age differences. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 56(2), P103-P110.
- Kassin, S. M., Ellsworth, P. C., & Smith, V. L. (1989). The “general acceptance” of psychological research on eyewitness testimony: A survey of the experts. *American Psychologist*, 44, 1089–1098.
- Kleinsmith, L., & Kaplan, S. (1963). Paired-associate learning as a function of arousal and interpolated interval. *Journal of Experimental Psychology*, 65, 190–193.
- Liebman J. I., McKinley-Pace M. J., Leonard A.M., Sheesley L. A., Gallant C. L., Renkey M. E., & Lehman E. B. (2002). Cognitive and psychological correlates of adult's eyewitness accuracy and suggestibility. *Personality and Individual Differences*, 33, 49–66. doi: 10.1016/S0191-8869(01)00135-0
- Lindholm, T., & Christianson, S. Å. (1998). Gender effects in eyewitness accounts of a violent crime. *Psychology, Crime and Law*, 4(4), 323-339.
- Loftus, E. F. (1986). Ten years in the life of an expert witness. *Law and Human Behavior*, 10, 241- 263.
- 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., & Burns, T. E. (1982). Mental shock can produce retrograde amnesia. *Memory & Cognition*, 10(4), 318–323. <https://doi.org/10.3758/BF03202423>
- Madsen K., & Holmberg U. (2015). Personality affects memory performances and psychological well-being in investigative interviews: A therapeutic jurisprudential approach. *Psychiatry, Psychology and Law*, 22, 740–755. doi: 10.1080/13218719.2014.986838
- Mittal, S., Singh, T., Arya, Y. K., & Tiwari, M. K. (2013). Effect of emotional arousal on eyewitness memory. *Indian Journal of Social Science Researchers*, 10(1), 24-30.
- Moore, P. J., Ebbesen, E. B., & Konecni, V. J. (1994). *What does real eyewitness testimony look like? An archival analysis of witnesses to adult felony crimes*. Unpublished manuscript.
- Murdock, B. B. (1974). *Human memory: Theory and data*. Lawrence Erlbaum.
- Pajón, L., & Walsh, D. (2017). Examining the effects of violence and personality on eyewitness memory. *Psychiatry, psychology and law*, 24(6), 923-935.
- Penrod, S., Loftus, E. F., & Winkler, J. (1982). The reliability of eyewitness testimony. In N. L. Kerr & R. M. Bray (Eds.), *The psychology of the courtroom* (pp. 119–168). New York: Academic Press.
- Phelps, E. (2006). Emotion and Cognition: Insights from studies of the human amygdala. *Annual Review of Psychology*, 57, 27-53.
- Rienick, C. B., Moore, P. J., & Ebbesen, E. B. (1997). *Eyewitness identification research: How well does it reflect the real world?* Unpublished manuscript.
- Roediger, H. L., McDermott, K. B., & Goff, L. M. (1997). Recovery of true and false memories: Paradoxical effects of repeated testing. In M. A. Conway (Ed.), *Recovered memories and false memories* (pp. 118-149). Oxford: Oxford University Press.
- Schmolck, H., Buffalo, E. A., & Squire, L. R. (2000). Memory distortions develop over time: Recollections of the OJ Simpson trial verdict after 15 and 32 months. *Psychological Science*, 11(1), 39-45.
- Scrivner, E., & Safer, M. A. (1988). Eyewitnesses show hypermnesia for details about a violent event. *Journal of Applied Psychology*, 73, 371-377.
- Shaw, J. S., Bjork, R. A., & Handal, A. (1995). Retrieval-induced forgetting in an eyewitness-memory paradigm. *Psychonomic Bulletin and Review*, 2, 249–253.

Evaluation of Eyewitness Memory in A Virtual Crime Scene

- Stebly, N. M. (1992). A meta-analytic review of the weapon focus effect. *Law & Human Behavior, 16*, 413-424.
- Tulving, E. & Gazzaniga, M. S. (1995). *Organisation of memory: quo vadis? The cognitive neurosciences*. Massachusetts : MIT Press
- Tulving, E. (1972). Episodic and semantic memory. *Organization of memory, 1*, 381-403.
- Turtle, J. W., & Yuille, J. C. (1994). Lost but not forgotten details: Repeated eyewitness recall leads to reminiscence but not hypermnesia. *Journal of Applied Psychology, 79*, 260–271.
- Underwood, B. J., & Postman, L. (1960). Extraexperimental sources of interference in forgetting. *Psychological Review, 67*(2), 73.
- Wagenaar, W. A., & Groeneweg, J. (1990). The memory of concentration camp survivors. *Applied cognitive psychology, 4*(2), 77-87.
- Ward R. A., & Loftus E. F. (1985). Eyewitness performance in different psychological types. *The Journal of General Psychology, 112*, 191–200. doi: 10.1080/00221309.1985.9711003
- Wells, G. L., Memon, A., & Penrod, S. D. (2006). Eyewitness evidence: Improving its probative value. *Psychological science in the public interest, 7*(2), 45-75. doi: 10.1111/j.1529-1006.2006.00027.x
- Wessel, I., De Kooy, P. V., & Merckelbach, H. (2000). Differential recall of central and peripheral details of emotional slides is not a stable phenomenon. *Memory, 8*(2), 95-109.
- Wilkinson, A. C., & Koestler, R. (1984). Generality of a strength model for three conditions of repeated recall. *Journal of Mathematical Psychology, 28*, 43–72.
- Wixted, J. T. (2004). The psychology and neuroscience of forgetting. *Annual Reviews Psychology, 55*, 235-269.
- Yarmey, A. D. (2004). Eyewitness recall and photo identification: A field experiment. *Psychology, Crime and Law, 10*(1), 53-68.
- Yerkes, R. M. & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit formation. *Journal of Comparative Neurology and Psychology, 18*, 459–482.
- Yuille, J. C., & Cutshall, J. L. (1986). A case study of eyewitness memory of a crime. *Journal of applied psychology, 71*(2), 291.

Acknowledgment

The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

Conflict of Interest

The author(s) declared no conflict of interest.

How to cite this article: Rajeev, D. (2024). Evaluation of Eyewitness Memory in A Virtual Crime Scene. *International Journal of Indian Psychology, 12*(1), 822-833. DIP:18.01.077.20241201, DOI:10.25215/1201.077