

# Suspicion-Based Memory Enhancement in a Novel Murder Mystery Task

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## Abstract

It is known that active learning is more effective and typical of how people learn in real-life. However, laboratory experiments testing memory have traditionally utilized passive learning experiences (i.e. learning lists) and do not necessarily focus on real-life, goal-focused behavior people use in everyday life. Accordingly, my colleagues and I constructed a novel and immersive murder mystery paradigm comparable to the board game Clue where participants work toward their goal of solving the presented murder. We created this experiment to dynamically get at goal-directed behavior and seek out how individual differences such as bias influence one's memory. Participants actively engage with the task by making suspicion ratings of each of the characters, the prospective murderers, throughout the storyline. Although each participant witnessed an identical plot, subjects intermittently focused on varied aspects of the story by recalling more details about some characters compared to other characters. Individual subject's suspicion of various characters shaped the story they experienced because they viewed it through the lens of their established bias. Conducted analyses included computing correlations between variables of interest such as verifiable details and level of suspicion affiliated with each character. We found that the proportion of details recalled about a specific character correlates with the suspicion rating of that given character. Our results suggest that there is an overrepresentation of details affiliated with a given character if the participant gives a higher suspicion rating. Findings from this experiment may offer insight into the role of bias and prediction in real-world recall experiences, such as eyewitness testimony.

## Introduction

Episodic Memory refers to our ability to recall and re-experience events from our past, and a great deal of research in cognitive psychology has been dedicated to understanding the processes that support episodic memory. Although this research has revealed several important insights, it is notable that most paradigms for studying episodic memory in the lab examine learning of simple lists of stimuli. For example, with list learning, one would rehearse a series of arbitrary words like dog, car, house, flip flop, etc. These paradigms might be missing important elements, as real life events involve active, goal-focused behavior, and these memories are actively reconstructed when we attempt to recall them later<sup>2</sup>.

Remembering is constructive because we use prior knowledge to put together a narrative of what happened in the past, and the constructive nature of memory can have positive and negative consequences<sup>4</sup>. For instance, if you have been to several American weddings, you can may in a wedding ceremony, a wedding party walks down the aisle, there are opening remarks, then vows, an exchange of rings, and so on. Later, if you recall having been at your friend's wedding, you can use your general knowledge as a scaffold to put together what happened. On the negative side, constructive processes can lead us to develop biases that distort our

recollections. For instance, eyewitness testimony studies show that retrieval attempts can lead us to negatively impact future memories. When trying to identify a perpetrator, such as through mugshots, stereotypes or salient experiences can bias one to consider an innocent person guilty.

Real-world learning is often goal-driven. To continue with the eyewitness testimony example, we can see there is an investment in the experience and its goal: correctly identifying the perpetrator. People are also unintentionally biasing themselves because their goal is built upon their own expectation. The goal of identifying the correct perpetrator can actually alter one's memory of who they thought the murderer was. Everyone wants to be correct in this scenario and this inclination can actually be a form of confirmation bias. Confirmation bias is the tendency to take in information and interpret it in a way that supports one's claim or goal. Therefore, as one takes in information about different perpetrators, they could actually be orienting themselves in a way that supports their idea of who the perpetrator is even if that person did not actually commit the crime.

We developed a novel immersive paradigm to study the impact of bias on goal-driven behavior in an experimental setting. This murder mystery paradigm was inspired by the board game Clue where participants work toward their goal of solving the presented murder. We chose this scenario because it is enjoyable, engaging, and familiar, so participants would be able to easily comprehend and navigate through the storyline. Our task was constructed with 3D images to have a more realistic real-world experience. This goes along with current research because memory researchers have been moving toward using more realistic tasks like virtual reality (VR) technology.

In this experiment, each participant experiences the same storyline, but they may focus on different details within the plot. As a result, the participants' varied impressions can "dilute", or influence, the story they witness. Our experiment is especially important because we are aiming to gain insight beyond how prejudice and bias affect implicit and explicit impressions. We aim to see if emotions and bias affect how we are actually remembering information. The main project goals were to look at goal-focused behavior that people use in real-life occurrences, look into the impact of bias, specifically suspicion on memory recall, examine how individual differences influence memory recall. The hypothesis was: the proportion of details recalled about a particular character will correlate with the suspicion of that given character. Therefore, we seek to see if people tend to remember more about people they are suspicious of.

## **Materials and Methods**

### **Participants**

Twenty-one UC Davis undergraduate students (16 females, 5 males) were recruited as participants through SONA Systems and received class credit. Participants gave informed verbal consent in accordance with the UC Davis Institutional Review Board. The initial plan was to run a larger sample size of approximately forty participants, but this was unable to happen due to the COVID-19 pandemic.

### **Experimental Design**

All participants were tested at the UC Davis Center for Neuroscience. Each participant performed the task in the same room (a lab testing suite equipped with two testing computers). Participants were either ran alone or in pairs, but each completed the task individually and independently. The task was completed with participants seated at a computer workstation, and

the experimenter was seated at another table nearby within the testing room. The participants wore noise-cancelling headphones throughout the entirety of the task. Instructions were provided verbally by the experimenter and were then presented on the computer screen before the task began. The virtual experimental setting consisted of ten different rooms, five prospective murder weapons, and six characters. The participant pressed the “SPACEBAR” to proceed through the task and pressed number keys when prompted to provide suspicion ratings of each character and each murder weapon. Other than the participant, there was no more than one character or one murder weapon within a particular room. However, one room may also contain one character and one murder weapon [Figure 1]. Each participant navigated through three different rounds of the task. Each round consisted of the same rooms, characters, and murder weapons, but with different dialogue between characters and the participant. Before entering each room, the research subject was shown a map and a test prompt indicated which room they were about to enter. Dialogue was indicated by who was speaking and \*asterisks\* indicated unspoken observations and internal dialogue. The order of events, and interaction with characters throughout each round was the same for all participants. The task was self-paced; on average, participants completed the task in forty-five minutes.



Figure 1. This is a sample image from our task. Katie is pictured in the guest bedroom with the clothing iron, one of the prospective murder weapons. You’ve just asked Katie if she knew what had happened. The series of dialogue displayed on the screen is Katie’s response to you.

### Procedure

Participants were instructed that they would be navigating through a virtual murder mystery experience. Introductory background information was provided to describe the setting, as well as details about the characters encountered in the task. Any clarifying questions were answered, and participants navigated through the task round by round. With each of these three rounds, the research participant would begin in one room and speak to the character present

there. After each round, the participant rated their suspicion of each of the six characters and each of the murder weapon using a Likert scale (0 being the least suspicious and 9 being the most suspicious). While there are three rounds within the task, each round is building off of the prior round’s dialogue. Therefore, as the research subject progresses through the task, they are receiving new information about the different characters and the events that transpired.

Once the participant navigated through all three rounds, they were asked to perform a typed recall of the experienced events in as much detail as possible in a Google Docs template. The research subject was instructed to start their recall from the beginning of the task and to do their best to go in order until they reached the end. In addition, they were asked to not go back and rewrite anything they had written or go back and correct misremembered details. Furthermore, the participant was asked to not use formal language when typing their recall of the experiment. Next, each participant performed a typed murder theory describing which character they believed to be the murderer, with what murder weapon, and how the events of the murder transpired in a Google Docs template. Additionally, participants performed a recognition task via answering fifty true/false statements. The statement would be presented on the screen and the participant would be asked to press “T” for true and “F” for false. The experiment ended with the participant completing a typed feedback form about the experiment in a Google Docs template. In the document, the participants were asked to discuss if they felt the task was interesting or not and whether or not they felt immersed in the storyline. All of these follow up tasks were untimed. Therefore, participants could be as concise or as long-winded as they wanted to be.

## Results

### Analyses

Because each participant had a typed recall and typed murder theory, a rubric was created to classify and standardize the different details across individuals [see Table 1]. This was all done manually and was the most labor-intensive aspect of the data analyses. Each complete sentence of thought was followed by the number of details contained in the remark. This includes adjectives that are used as descriptors. For example, in their recall, a participant stated “There is Alice who spurts out random facts.” This sentence contains three definitive details: the character Alice is identified (1) and she spurts out random (1) facts (1). Each detail was also categorized to be affiliated with a specific character and a specific round of the task.

Table 1. Scoring Rubric categorizing participants’ recall details

| Color      | Meaning                   | Example  |
|------------|---------------------------|--|
| Light Blue | Character/Location Swap   | In the second round, ... Then, the investigator also looked at Vicki’s dead body again to see how she was murdered.<br>*this occurred in the first round |
| Pink       | Irrelevant Detail (Other) | I don’t remember much about the lady or the conversation the narrator had with her   |
| Red        | Incorrect Detail          | While everyone’s eating, there’s a scream and Vicki is found dead with a gash in her head in the living room   |
| Yellow     | Low Confidence            | Im not sure if the character ever noted the bloody glove shown in the image.   |

|            |  |  |
|------------|--|--|
| Lime Green | True and Verifiable Detail                                 | We're all sat down eating dinner when Ben has to go to the restroom  |
| Dark Green | Repetition   | During the first time, ... In the first round,   |
| Orange     | Speculation of Murderer                                    | Due to his jealousy of Vicki and anger at his lack of life accomplishments, he could have killed Vicki just to make himself feel better  |
| Purple     | Time/Round Swap  | Then, I made my second round to everyone ... In the master bedroom, the bat had some blood stains on it (which John admitted to touching it and trying to wash his blood off the bat later on).<br>*this event occurred in the third round |
| Dark Blue  | Inferences about a Character that Wasn't Explicitly Stated | the investigator assumed that Vicki's dent on her forehead came from a hammer  |

## Correlations

There was a positive correlation between suspicion rating and details recalled over time for all six characters across all three rounds [Figure 2]. For round one, there was a positive correlation between the variables [ $r(19) = -0.015$ ,  $p = 0.949$ ]. For round two, there was a positive correlation between the variables [ $r(19) = 0.247$ ,  $p = 0.280$ ]. For round three, there was a significant positive correlation between the variables [ $r(19) = 0.457$ ,  $p = 0.037$ ].

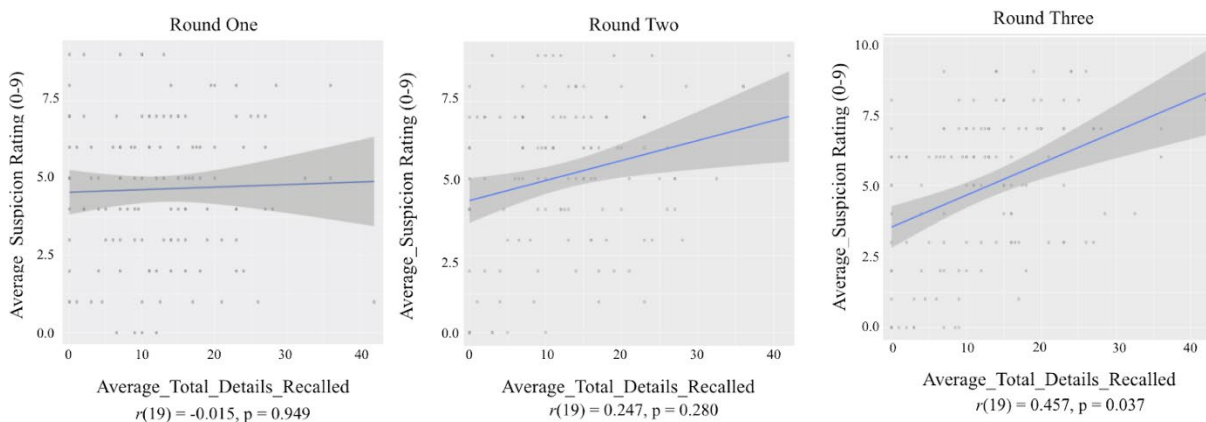


Figure 2. Average suspicion ratings (0-9) increasingly correlate with the number of details recalled about a suspected character across three “rounds.”

## Discussion

The goal of this study was to validate a novel paradigm for studying how goals and biases can influence memory. We found that the more suspicious one is of a particular character, the more details they will remember about that particular character. This is only evident after the third round our task. This shows that our memory is malleable and updated as we receive novel information.

Each participant’s memory recall is filtered through their own biased perspective of who they are suspicious of. We find that while participants explore the same story, they focus on different details and therefore have varied impressions of the different characters. Participants

are using their memory as a guide to arrive at their decision for who the murderer was<sup>3</sup>. These cues are inherently biasing the participant because the subject is constructing their own theory with the presented information. Also, out of our twenty-one participants, there was considerable variation with who they thought the murderer was. It didn't really matter who the participant was suspicious of, however, because this effect and relationship remained consistent.

As a result, these findings offer insight into real-world memory recall experiences like eyewitness testimony<sup>1</sup>. Despite experiencing the same story line, there are individual differences in how the story is remembered; this influenced participant's decision on who the guilty party was. Furthermore, just because participants are recalling more details about certain characters and are therefore more suspicious of said character does not guarantee that that character committed the crime. Additionally, this work can aid in proper conviction of perpetrators through educating jurors (i.e. through questionnaires) on their implicit memory bias via suspicion. Consequently, people's own biases and prejudices can influence their memory about particular people and situations.

### **Limitations**

While this study does offer valuable insight, there are a few limitations to address. In this task, participants only performed a typed recall at the end of the experiment rather than at the end of each round as with the suspicion ratings. By having separate recall transcripts after each round, we would be able to better analyze the role of suspicion on details across time. In addition, the participants passively navigated rather than actively navigated through the task. Meaning, for example, the participant did not freely choose who they were going to speak to or how they were going to respond to each character. Despite these criticisms, the task itself is very complex and there is a lot of flexibility with what variables we want to focus on. Moreover, while active navigation may be more comparable to a real-world experience, it was important to have some control over the task and clearly define variables of interest. We did our best to find a balance between allowing and constraining freedom for good science.

### **Future Directions**

We have a couple of prospective plans to further utilize this specific task. Because we have such a rich dataset already, there is a lot we can analyze before moving forward with additional adaptations.

Firstly, we could look more closely at how participants categorized their different details via our scoring rubric. For example, while participants were told to simply recall the experiment in as much detail as possible, many participants included some speculations of who they thought the murderer was in their recall.

Secondly, we can really take a closer look at each of the three rounds of the task. For example, my colleagues and I are currently looking at how the number of details changes across time. For example, we can see if participants are remembering more about round one and less about the subsequent rounds.

Regarding future adaptations, one idea is to allow for active navigation in this task. This would better replicate a real-world spatial memory experience. Despite this, we have to consider if having a higher degree of interaction with the environment will result in poor memory. For example, with more flexibility in the task, the participant's may not be able to remember all the details; this is referred to as central executive load. Furthermore, participants may experience inattention blindness. Inattention blindness is a phenomenon where one fails to notice fully-

visible details because their attention was engaged elsewhere. An additional prospective plan is to have separate recall transcripts after each round. This would allow us to better analyze the role of suspicion on details across time.

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