Sex differences in confidence and memory

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SUMMARY

Eyewitness testimony is important for solving crimes, but it is often subject to inaccuracy, leading to wrongful convictions and acquittal. A better understanding of the characteristics of reliable witnesses is needed, including whether a witness's confidence indicates accuracy. Prior studies have conflicted over whether males or females tend to exhibit greater accuracy or confidence in their memories. Therefore, we conducted an original experiment to study sex differences in confidence and memory. We recruited a convenience sample of 328 individuals and assessed them using an online portal. We showed participants objects and subsequently tested their memory of the color of each object. We also asked participants to rate their confidence. Results showed that males were more confident than females regarding their memories. However, females correctly recalled more objects than males. In a multivariable logistic regression model, being female was associated with 1.78 times the odds of correctly identifying two or more objects (95% confidence interval = 1.08, 2.92). However, age and confidence were not significantly associated with identifying more correct objects. Results were consistent in additional analyses. These results suggest that though males tend to be more confident regarding their memories, they may in fact remember fewer details. While this information may be useful to individuals who work in crime scene recall settings—such as police, lawyers, and judges—more research would be useful to confirm these findings before making systematic changes.

INTRODUCTION

Eyewitness testimony is important for solving crimes (1). It has been estimated to be the main source of evidence for about one-fifth of police cases (2). The New England Innocence Project suggests that about two-thirds of convictions that are later overturned by DNA evidence involved inaccurate eyewitness testimony (3).

Therefore, the National Institute of Justice (NIJ) has developed a guide for law enforcement to maximize accuracy in the context of eyewitness testimony (1). This guide outlines best practices for obtaining accurate information from eyewitnesses. For example, it emphasizes putting witnesses at ease, avoiding leading questions, reviewing testimony directly with the witness, and assessing the accuracy of each element of testimony individually (1).

While the NIJ does not specifically provide guidance on asking eyewitnesses about their confidence in their memories, doing so may be useful in predicting the accuracy of testimony. However, experts disagree about the relationship between memory accuracy and confidence (4, 5). Some researchers have found that individuals who are more confident about memorizing lists of words do often remember those words better (6). Similarly, eyewitnesses who are highly confident about their memories, especially right after an incident, generally do turn out to be correct (7). Because of research like this, textbooks state that confidence nearly always indicates accuracy (8).

However, other research suggests that there may only be a weak correlation—or even a negative correlation—between confidence and accuracy of memory. For example, while Roediger and DeSoto found that, most of the time, confidence was positively correlated with accuracy, there was a negative correlation in a minority of cases (6). Other researchers found that, after an actual supermarket robbery, confidence was "not a good predictor of accurate recall" (9). Other researchers went a step further in demonstrating that confidence and accuracy were poorly correlated—not only *between* different people but also *within* multiple statements made by the same individual (10).

Sex may also play a role in the accuracy of eyewitness testimony. Most researchers have found that females often perform better in memory tasks (11). For example, in a study of 280 people shown a 2-minute simulated crime video, females remembered more details than males (12). In a different study of 164 people who were shown a film about manslaughter, females also had better recall of events (13). However, some studies have suggested that males sometimes remember more details, especially details that are less related to emotions or people (11,12). In addition, males tend to perform better than females in visuospatial tasks (14), which may be important when recalling complex crime scenes.

It would be useful to study sex and confidence in the same context because interrelationships between sex, confidence, and accurate recall are complex. While males often exhibit more confidence in their memories (12), this is not always the case. For example, Yarmey conducted a study of 651 people who were interviewed about a woman that they interacted with for 15 seconds, and these researchers found that males and females were equally confident in their memories (15). Furthermore, people may simply be more confident when they remember the details better.

Therefore, we designed an original study to examine interrelationships between sex, confidence, and accuracy of recall in the same study. We hypothesized that males would be more confident than females regarding their memory recall. Because of studies cited above relating to sex and memory,

we also predicted that females would remember more than males when subjected to a brief memory task. Finally, we hypothesized that, in a multivariable model, both having higher confidence and being female would be independently related to higher accuracy of memory recall.

RESULTS

We conducted an original experiment with a convenience sample of people who were 11 years of age or older. Using a computer interface, we showed participants an image containing pictures of different objects for 10 seconds, and then we asked them to recall the colors of specific objects in the scene. We asked participants to rate their confidence in their memory on a scale of 0 to 10, with a score of 10 indicating the greatest degree of confidence. Additionally, we asked participants to report their age, sex (female or male), and whether they were colorblind, because the questions involved identifying color.

Our outcome variable was the accuracy of memory. We asked participants four questions about the image they were shown, specifying a correct answer for each question. We added the number of correct answers to assign participants an accuracy score that ranged from 0 to 4. We also defined a binary yes/no variable to measure overall correctness. For this variable, we defined a participant as being overall correct if they answered 2 or more of the 4 questions accurately.

After excluding 5 individuals for being colorblind, we obtained valid data from 328 people. Of our sample, 237 (72.3%) were female. The average participant age was 47.1 with a standard deviation of 13.6 and a range from 11 to 84.

The average self-confidence of participants, on a scale of 0 to 10, was 7.33 (standard deviation = 1.47). The average correct responses out of 4 was 1.63 (standard deviation = 1.20). About half of participants (n = 167, 50.9%) answered 2 or more questions correctly. Our preliminary analysis demonstrated that males were more confident than females regarding their memory **(Table 1)**. However, females correctly recalled more objects than males **(Table 1)**.

We also used a primary multivariable model to analyze predictors of the binary outcome variable of overall correctness (2 or more correct vs. 0 or 1 correct). Primary multivariable logistic regression analysis demonstrated that females, compared with males, were 1.78 times more likely to correctly identify two or more objects **(Table 2)**. However, age and confidence were not significantly associated with correctness **(Table 2)**.

	Mean (Standard Deviation)		t	p-value
	Male	**Female**		
Confidence	7.59 (1.53)	7.23 (1.45)	1.99	0.02
Objects correct	1.38 (1.18)	1.73 (1.20)	-2.34	0.01

Table 1: Confidence in Memory and Actual Accuracy of Memory by Sex in a Convenience Sample of 328 Participants The p-values presented are based on unpaired t-tests. Both confidence and objects correct were normally distributed. Confidence in memory was self-reported on a scale from 0 (lowest) to 10 (highest). The number of objects correctly identified in the memory task ranged between 0 (lowest) and 4 (highest). The t-value indicates the strength of the relationship between sex and each of the variables in the table. Statistical significance was defined using a two-tailed alpha of 0.05.

	AOR	95% CI	p-value
Sex (female vs. male)	1.78	(1.08, 2.92)	0.02
Age (years)	0.99	(0.97, 1.003)	0.12
Confidence	0.94	(0.81, 1.09)	0.42

Table 2: Associations between Sex, Confidence, Age, and Memory Accuracy in a Convenience Sample of 328 Participants Using Standard Logistic Regression. AOR indicates the adjusted odds ratio, which is the odds of high memory accuracy (vs. low memory accuracy) adjusted for all variables in the table. CI indicates the confidence interval. High memory accuracy was defined as correctly answering 2 or more questions out of 4, and confidence in memory was self-reported on a scale from 0 (lowest) to 10 (highest). Statistical significance was defined using a two-tailed alpha of 0.05.

To ensure the robustness of our results, we conducted two additional regression analyses. First, a linear regression used the number of objects correct as a continuous variable (0-4). Consistent with the analysis above, being female was significantly associated with answering questions correctly (β = 0.35, p = 0.02). However, again age and confidence in memory were not significantly associated with correctness (β = -0.007 and p = 0.14 for age, and β = -0.002 and p = 0.96 for confidence). A higher β-coefficient indicates a stronger relationship.

Finally, we performed an ordered logistic regression analysis using objects correct as an ordered categorical variable (0, 1, 2, 3, or 4) **(Table 3)**. This analysis was consistent with both multivariable analyses used above. Females, compared with males, exhibited 1.72 times the odds of correctly identifying more objects. However, age and confidence were not associated with correctness.

DISCUSSION

In this study of a convenience sample of 328 participants, there were three major findings. First, compared with females, males were more confident about their memories. Second, despite males being more confident, females tended to remember more when faced with a brief structured recall activity. Finally, we found that there was no association between an individual's confidence in their memory and performing better on the recall activity.

The fact that males were highly confident in their memories is consistent with other research that suggests

	AOR	95% CI	p-value
Sex (female vs. male)	1.72	(1.11, 2.67)	0.02
Age (years)	0.99	(0.97, 1.003)	0.11
Confidence	0.99	(0.86, 1.12)	0.83

Table 3: Associations between Sex, Confidence, Age, and Memory Accuracy in a Convenience Sample of 328 Participants Using Ordered Logistic Regression. AOR indicates the odds ratio adjusted for all variables in the table. Unlike Table 2, which used a standard logistic regression, this table presents the results of an ordered logistic regression. CI indicates the confidence interval. High memory accuracy was defined as correctly answering 2 or more questions out of 4, and confidence in memory was self-reported on a scale from 0 (lowest) to 10 (highest). Statistical significance was defined using a two-tailed alpha of 0.05.

males are generally more confident than females (12,16). One reason for this finding is that we live in a male-dominated society, in which, both consciously and subconsciously, males are often taught that their opinions matter more than those of females (16). One implication of these findings is that educators should continue programming designed to demonstrate to females that their opinions are valuable. It would also be useful to publicize the findings of studies, such as this one, that objectively demonstrate areas in which females have strengths. Another strategy is to teach educators about unconscious bias and how to reduce it. One specific suggestion is to use non-gendered language, such as "chair" instead of "chairman," because it has been shown in controlled research that changes like these do make a difference (17).

Our findings were consistent with other research showing that females tend to remember more compared with males (12). However, in that study, the author found that females were particularly accurate in remembering people, whereas our study involved memory of colors of objects, two of which were stereotypically connected with females (hair bow and lipstick) and two of which were stereotypically connected with males (baseball mitt and gun). Therefore, it is not clear why females remembered more details about objects in the current study, and this could be a direction for future research.

Our findings were not consistent with the prior studies that found that males remembered more, perhaps because those studies tended to test visuospatial tasks (14). One reason for our findings may be because our task involved a two-dimensional image. The results may have been different if we had we used a three-dimensional landscape that required more complex visuospatial processing.

Current eyewitness testimony guidelines do not suggest trusting individuals of a certain sex more than the other (1). Although we found that females exhibited greater accuracy than males in this study, this finding should be interpreted with caution for two reasons. First, it was a very small difference that was statistically significant but may or may not have real life significance. Second, it should be emphasized that our results showed an overall tendency for females to exhibit higher accuracy and not an absolute finding.

Our finding that confidence was not associated with correctness is interesting, given that police and others tend to trust people who are more confident in their judgments. However, it is important to note that in our protocol we asked people about their confidence as a general question, but not specifically related to individual responses. In future studies, it may be useful to ask participants to rate their confidence after answering each individual question. Our findings suggest that people involved in collecting eyewitness testimony should be open to the opinions of both those who are and are not generally confident of their memories.

It is interesting that there were no independent associations between age and memory in our study. This is not consistent with prior research, which often finds that memory declines over time (18). This is likely because our snowball sampling approach resulted in a skewed population, with many people in their forties. Therefore, it would be useful in future studies to recruit a more even distribution in terms of age.

Two future studies may come from this work. First, it would be interesting to repeat this protocol but involve a memory task more directly relevant to crime scenes. While we simply tested participants' memory of the color of certain objects, having people answer questions about details from a video of a crime scene may be more informative. Second, it may be interesting to test whether females or males are more susceptible to outside influence. For example, participants could first answer questions about a video they watched without hearing others' perspectives. Then, participants would be exposed to a planted "participant" who would be instructed to be highly confident about an incorrect response. Finally, actual participants would re-take their assessment to see if their opinions were swayed. This would be interesting to examine because it would relate not only to memory but also to confidence.

The major limitation of this study is that we used a convenience sample obtained using a snowball methodology. It would be useful for future research to use a more carefully obtained random sample. An important consequence of the snowball methodology was that we were not able to obtain a balanced sample. Therefore, future random samples may be able to ensure representation from various demographic groups. Another limitation of this study is that we created our own simple memory task involving cartoon pictures, which does not represent an actual crime scene.

Despite these limitations, our findings provide important insight in demonstrating that, at least in a specific setting, males tend to be more confident in their memories, even while not recalling memories as accurately as females. This information may be useful to individuals who work in crime scene recall settings, such as police, lawyers, and judges.

MATERIALS AND METHODS
Participants

We used a snowball sampling method, which involves reaching out to community members and then encouraging those people to invite their contacts to also participate, and so on. We began this sampling by posting links to encourage study participation on various personal social media accounts, inviting individuals at schools and in the local neighborhood, and emailing personal contacts. We limited recruitment to individuals 11 years of age and above. We chose this age cutoff because participants were required to navigate an interactive web page that involved reading text written at approximately a fourth grade reading level. In addition to the age requirement, we required participants to speak and read English, because this was needed for the experimental activity. We also required participants to see color because recognizing color was part of our experiment. Therefore, as part of our questionnaire, we asked participants if they were colorblind, and they were removed from the dataset if they marked yes.

Procedures

Using HTML, we created a website that led people through an experimental activity and collected all the data. When participants first went to the study website, they received the following message: "Thanks for completing this project! After you click 'Begin' below, you will see a picture. You will then be directed to a very brief survey. Thanks again!" When they clicked the "Begin" button, they were shown an image for 10 seconds. We created the image, which included 8 pictures, 4 of which were common objects (a baseball mitt, a hair bow, a gun, and a tube of lipstick) and 4 of which were cartoon

figures of people for distraction. We selected two objects that were more stereotypically female and two objects that were stereotypically male to reduce bias. A timer counted down 10 seconds. After exactly 10 seconds, participants were directed to the questionnaire. In the questionnaire, they were asked to recall the color of each of the 4 objects listed above. They were not usual or obvious colors. For example, the mitt was green, the bow was orange, and the gun was blue. For each question, they were given 4 options, as well as an "I have no idea" option. They also were asked about their age in years, sex (male or female), whether they were colorblind (yes or no), and how much confidence they have in their memory on a scale from 0 to 10. The study was approved by the University of Pittsburgh Institutional Review Board (protocol #1903007: "Sex Differences in Confidence and Memory").

Measures

Our outcome variable was the accuracy of their memory based on our task. We added the number of correct answers to give participants an accuracy score. If they selected "I have no idea," it was scored as an incorrect response. Because we asked four questions about the image and each question had a right and wrong answer, the accuracy score ranged from 0 to 4. We also defined a binary yes/no variable for overall correctness for the primary analysis. For this overall variable, people were considered overall correct if they answered 2 or more of the 4 questions accurately.

Key predictor variables were sex, age, and confidence in their memory. For confidence in their memory, participants were asked to rate themselves on a scale from 0 to 10, 0 being not at all confident and 10 being extremely confident.

Analysis

All statistical analyses were performed using Stata version 14 (Statacorp, College Station, TX). We used an unpaired t-test to compare males and females according to their confidence in their memory. We then used a separate unpaired t-test to compare males and females according to the number of objects they got correct.

We then built a multivariable model with the dependent variable of accuracy of memory. The independent variables in our model were sex, age, and confidence. For our primary model, we used logistic regression, because our primary dependent variable (whether they got two or more objects correct) was dichotomous. Therefore, the resulting adjusted odds ratio indicated the odds of getting at least two objects correct at different levels of a given characteristic.

We then conducted two additional analyses to make sure that our results were robust. For the first additional analysis, we conducted a linear regression with the outcome variable as a continuous variable from 0 to 4 objects correct. Finally, we conducted an ordered logistic regression, again using objects correct as a number between 0 and 4.

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