RECOGNITION AND RECALL OF VEHICLES AND MANUFACTURER SYMBOLS: IMPLICATIONS FOR EYEWITNESS VEHICLE IDENTIFICATIONS

Meredith Allison, Amy A. Overman, Meghan Braun, and Molly Campbell
Elon University

John R. Price
Carolina Child Psychology, PLLC

The purpose of this study was to examine people's recall and recognition of cars because some witnesses to crimes may see only the getaway car. We compared participants' accuracy in identifying vehicles and manufacturer symbols in a free recall versus recognition questionnaire format. Participants in the recognition condition were more accurate than those in the free recall condition on many of the questions. Across conditions, participants had the most difficulty in remembering the Mazda 3-Series Truck symbol and the Buick and Subaru symbols. The majority of participants were accurate at identifying the Jeep Grand Cherokee and the Honda symbols, and participants with more driving experience were more accurate on some of the questions. Men were more accurate than women on several of the vehicle questions, but on only one manufacturer symbol question. We discuss future eyewitness research and the implications of this study.

Keywords: crime, vehicles, memory, eyewitness, recognition and recall, gender

In 1992 15 year old Kristen French went missing while walking home from school in Canada. Police officers interviewed several witnesses along the girl's route who described a man in a yellowish-green Camaro talking to a girl in a school uniform; a man pushing someone into a car that resembled a Camaro; a Camaro-like car driving erratically; and a cream-colored car running a red light (McCrary, 2003). As part of their attempt to find the missing girl, investigators used the media to let the public know about their search for a "cream-colored Camaro." A special task force started searching all cars in the area that met the description (over 125,000 Camaros) (McCrary, 2003). Tragically, Kristen French's body was found two weeks later, and it was clear that she had been assaulted before being strangled. When the culprits Paul Bernardo and Karla Homolka (see *R v. Bernardo*, 1995) were found, the car they had been driving at the time of the kidnapping was actually a gold Nissan.

Considerable time and effort was spent searching for the wrong vehicle, and Homolka later recounted that Kristen French was kept alive for several days before Bernardo killed her (McCrary, 2003). Multiple eyewitnesses made their best efforts to recall what they had seen while driving on a busy street one afternoon. However, several

Correspondence concerning this article should be addressed to Meredith Allison, Elon University, CB 2337, Elon, NC, 27244-2010. Email: mallison5@elon.edu

incorrectly zeroed in on a Camaro as the make of the kidnappers' car. How could so many eyewitnesses have been mistaken? Could Kristen French's death have been prevented had the eyewitnesses been able to pinpoint the vehicle type? Researchers have systemically studied eyewitnesses' memories for people and events since the 1970s and have long discussed the fallibility of eyewitness testimony (Wells, Memon, & Penrod, 2006). Since the 1990s and the advent of DNA testing, the legal system has started to take notice of such research. As of September 2014, 318 people have been exonerated in the United States for crimes they did not commit (Innocence Project). Analyses of these cases have shown that the leading cause of the exonerations is mistaken eyewitness identifications (e.g., Wells, Small, Penrod, Malpass, Fulero, & Brimacombe, 1998).

The majority of eyewitness research has focused on memory for faces and events. As the Kristen French case shows, however, another avenue worthy of inquiry is memory for vehicles. The U.S. Department of Transportation (2011) noted that there are more than 250 million registered highway vehicles and more than 190 million of those are light-weight vehicles such as cars and pickup trucks. Americans' "love affair" with cars (Jeanes, 2011) means that cars are everywhere and can be targets for theft. For example, according to the Uniform Crime Reports, there were 737,142 motor vehicle thefts in 2010 (Federal Bureau of Investigation, 2010). But vehicles also can be used to help commit crimes as occurred in Kristen French's case and many others. A more recent example of the importance of vehicle recognition occurred in the 2002 Washington D.C. sniper case. Eyewitnesses reported that a white "box truck" was seen in the area of several of the shootings, and the investigation focused on box trucks ("Vehicles sought," 2002). However, later leads led law enforcement to John Allen Muhammad who drove a dark blue Chevrolet Caprice, not a white box truck. A truck driver who had heard the media releases about the Caprice saw the car stopped at a rest stop and notified police. This call led to officers finding Muhammad and Lee Boyd Malvo asleep in the car. They were arrested for thirteen shootings (Duffy, 2002). Eyewitness accounts early in the investigation were clearly incorrect, but it was an eyewitness' ability to correctly identify the Chevrolet Caprice that led to the arrests.

Although real-life cases demonstrate that people's knowledge of cars is important to the legal system, car knowledge has received little attention from researchers. In the marketing field, several researchers have studied car brand loyalty and consumer behavior (e.g., Baltas & Saridakis, 2010; Terech, Bucklin, & Morrison, 2008). However, in psychology, few studies of people's abilities to recognize cars exist. Rossion and Curran (2010) compared self-identified car novices and experts on their accuracy at choosing the correct upright and inverted images of faces and vehicles that they had seen previously. Participants completed a forced-choice task in which the stimulus vehicles were Japanese and European models not available in the American market (the study took place in the United States). They found a significant correlation between the reaction time (RT) inversion costs for car pictures and the degree of expertise. Car experts showed a decrease in RT when cars were inverted that was equal to that for inverted faces. That is, the car experts had learned to process cars holistically, just as everyone does for faces (Tanaka & Farah, 1993). Processing holistically includes using local features (ex: shape) and distances between features. The inversion of cars was especially problematic for car experts, unlike for novices, because car experts could not process holistically when presented with cars that were inverted (they could not extract local features and determine the distance between those features), which impaired their ability to detect a match between the two choices of car and the target car they were supposed to be matching. Given that the majority of the population are not car experts, they are not able to process cars holistically. Thus novices cannot make the best use of the available cues, which explains why they often experience confusion when presented with cars that have some similar features (color or style), despite the fact that the cars are distinct from each other when processed as a whole (as experts would process them).

To date there has been only one psychological research study on vehicle identification in a legal context (Villegas, Sharps, Satterthwaite & Chisholm, 2005). Villegas and colleagues studied college students' ability to identify die-cast cars. Participants viewed nine pictures of sedans, SUVs, and pickup trucks in colors like blue, red, and yellow on a tachistoscope for five seconds each. One of the nine vehicles had an X appear after presentation, indicating that this was the to-be-remembered target vehicle. After a 10 minute delay, participants viewed a lineup of vehicles, wherein the photographs were presented sequentially, and were asked to identify the target vehicle. The authors found that the participants identified the vehicle correctly 23.8% of the time. Interestingly, 15.87% of participants chose incorrect lures that did not match the target vehicle in terms of color or vehicle type. The authors noted that many participants made errors even though they had viewed the target vehicles under ideal circumstances (strong lighting, no part of vehicle obscured).

The Current Study

Given the dearth of research in psychology on people's knowledge of cars, the main purpose of our study was to obtain a baseline of knowledge about cars. Our aim was to study what cars people identify more easily and how well they know manufacturer symbols. We asked participants to identify top-selling vehicles like the Ford F-Series Truck, as well as lesser known vehicles like the Kia Amanti. We also asked participants to name the companies associated with manufacturer symbols like Toyota, Chevrolet, and Subaru. We hypothesized that top-selling cars and car companies' symbols would be more easily recognized. Further, we compared participants' accuracy in identifying vehicles in a free recall (open-ended questions) versus a recognition (multiple choice) questionnaire format. Recognition has repeatedly been demonstrated to be an easier memory task than recall because recognition requires only matching of the presented information to information stored in memory, while recall requires the person to initiate memory retrieval with no cue (Hollingworth, 1913; MacDougall, 1904). Thus, we hypothesized that participants in the recognition condition would be more accurate than participants in the recall condition.

Our secondary aims were to examine differences in accuracy based on gender and level of expertise. In the United States, men are more likely than women to register a vehicle (Truecar.com, 2010) so it is possible that men may be more accurate than women overall. However, women and men purchase different types of cars, so women may perform well when identifying certain types of cars. For example, Kia had the highest percentage of female registrants in 2010, followed by Suzuki, and then Mini. Men were more likely to register trucks and exotic cars like Ferrari, suggesting that they might do better at identifying the truck and coupe stimuli (Truecar.com, 2010). We also hypothesized that the car experts in the sample and those with more driving experience would be more accurate.

METHOD

Questionnaire

In the first part of the questionnaire, participants answered demographic questions regarding age, gender, race, major in school, types of cars they had driven, and how long they had been driving. We later noted whether the participants had ever owned one of the stimulus cars. We also asked participants whether they had a particular interest in cars (e.g., experience as a mechanic) and, if yes, to describe their interest. The second part of the questionnaire contained questions about vehicles, and the third part contained questions about manufacturer symbols. Half of the participants (49%) received a free recall questionnaire (i.e., fill-in-the-blank) which required them to look at a picture of a vehicle and recall the make and model (Part 2) and name the company behind the manufacturer symbol (Part 3). The remaining participants (51%) received the recognition questionnaire which required participants to look at a picture of a vehicle and identify the vehicle's make and model from four choices (Part 2) and identify the manufacturer symbol from four choices (Part 3).

Vehicles. We included 14 vehicles in Part 2: All were presented in black-and-white still photos with the manufacturer symbol blacked out. Each vehicle was presented with a view of the front, back, and side. Each view of the car was approximately 1 inch high by 4 inches long in size (total area of the three views of the car was approximately 3 inches by 4 inches), and there were two cars presented on each page. We chose a variety of cars, trucks, SUVs, and coupes that are available in the American market, including those that are sold in high numbers (e.g., Toyota Camry) and those that are less common (e.g., Suzuki Aerio, Table 1). Eleven of the cars were 2010 models, and three were 2007 models. We chose the 2007 models because we were looking for low-selling vehicles, and this was the last year that these models were produced. We included foreign and domestic cars, and we captured the images from internet sources like Toyota.com.

Manufacturer Symbols. The questionnaire contained 10 manufacturer symbols in black and white, and all were from companies that sell foreign and domestic cars in the U.S. (e.g., Chevrolet, Acura, Mazda). Each symbol was approximately 2 inches square and there were 6 symbols per page. Table 2 lists the symbols that were included in the questionnaire as well as the companies' sale figures in the U.S. in 2010.

Accuracy Measurement. For Part 2, participants in the free recall condition received accuracy scores of 0 (incorrect), partially correct (.5 = if they identified either the make or model), or completely correct (1 = identified the make and model). Participants in the recognition condition (Parts 2 and 3) and participants in the recall condition for Part 3 only received accuracy scores of 0 (incorrect) or 1 (correct). A research assistant coded the questionnaires, and the data were checked by the first author. For two of the stimuli, we accepted alternative answers. For the Chrysler Town and Country, the Dodge Caravan also was counted as correct. For the Mercury Monterey, the Ford Freestar was counted as correct. The alternatives were very closely related vehicles, with the main visible difference in the photographs being minor differences in the rear taillights.

Table 1

List of 2010 Cars Used as Stimuli and U.S. Sales Figures from 2010

2010	Make	Model	Sales
	Ford	F-Series	528,349[1]
	Chevrolet	Silverado	370,135[1]
	Toyota	Camry	327,804[1]
	Honda	Accord	311,381[1]
	Nissan	Altima	229,263[1]
	Chrysler	Town and Country	112,275[2]
	Mazda	3-Series Truck	106,353[2]
	Jeep	Grand Cherokee	84,635[2]
	Honda	Insight	20,962[2]
	Nissan	350Z	10,215[2]
	Kia	Amanti	281[3]
2007			
	Suzuki	Aerio	16,740[2]
	Buick	Rainier	4819[2]
	Mercury	Monterey	700[2]

Notes. Data were obtained from [1] from ChicagoTribune.com, [2] goodcarbadcar.net, and [3] PRnewswire.com. We accepted Dodge Caravan for Chrysler Town and Country and its sales figures were 103,323 for 2010. Combined, the sales for these two models were 215,598. We accepted Ford Freestar for Mercury Monterey and its sales figures were 2390 for 2007. Combined, the Mercury and Ford sales for these models were 3,090.

Table 2

List of Manufacturer Symbols Used as Stimuli and U.S. 2010 Sales Figures

Make	2010 Sales
Toyota	1,763,595
Chevrolet	1,563,881
Honda	1,230,480
Hyundai	538,228
Subaru	263,820
Mazda	229,566
Lexus	229,329
Mercedes Benz	224,947
Buick	155,389
Acura	133,606

Note. All sales data were obtained on goodcarbadcar.net.

Procedure and Participants

The University's Institutional Review Board approved all materials and procedures. Undergraduates signed up for a study titled "The Psychology of Vehicle Identifications" on sheets posted on a board in the Psychology building of a medium-sized liberal arts university in the southeastern United States. Participants took part in small groups (3-15) in classrooms. They signed consent forms, completed the questionnaire individually, and were given a verbal debriefing of the study's purpose. We counterbalanced the questionnaires so that the recall and recognition versions were evenly distributed among participants within each experimental session. The first page of the questionnaire was identical for both conditions to blind the experimenter to condition. At the end of the session, the experimenter thanked the participants and gave them course credit for their participation.

Participants ($N = 151$) ranged in age from 18 to 45 years (mean age = 19.26 years, $SD = 2.25$). There were 99 women (65.6%) and 52 men (34.4%), and self-identified race was reported as White (84.8%), Black (10.6%), or Other (4.6%). Most participants were first-year students (56%) or sophomores (33.3%) majoring in psychology (25.8%), majoring in another arts and science discipline (23.2%), or were undecided as to major (25.8%). All but two participants were residents of the United States. The two international student participants had been living in the U.S. for 6-10 months, and their responses were similar to American students' responses (and so their data were included with the rest of the sample). Participants had been driving an average of 3.58 years ($SD = 2.40$), and 83.4% stated that they regularly drive a car (the most common make being a Toyota, 15.2% of participants). Only 13.9% indicated that they had a special interest in cars and 13.9% had driven one of the stimulus cars.

RESULTS

Vehicles

We conducted a series of one-way Analyses of Variance (ANOVAs) with recall vs. recognition as the independent variable on participants' accuracy scores on the 14 vehicle questions. As we had hypothesized, participants were significantly more accurate in the recognition condition than in the recall condition for 11 of the 14 questions (Table 3). The largest effect size was in the Mercury Monterey question (partial eta-squared = .265), likely because very few participants in the free recall condition were accurate on this question. Another question with a comparatively larger effect size relative to the other questions was the Jeep Grand Cherokee question. This result was likely driven by the fact that 98.7% of participants in the recognition condition were correct. There were no significant differences between the recall and recognition conditions for three of the vehicles (Ford F-Series Truck, Honda Accord, and Mazda 3-Series Truck), but the trend was still for greater accuracy in the recognition condition over the recall condition (all $p > .05$).

Table 3

Means, Standard Deviations, and Univariate Test Results for Vehicle Accuracy Scores in Recall and Recognition Conditions

Car Make/Model	**Recall**		**Recognition**		**Univariate Results**	
	M	***SD***	***M***	***SD***	***F*(1, 149)**	**Partial η^2**
Kia Amanti	.01	.08	.17	.38	12.01***	.075
Ford F-Series Truck	.55	.43	.56	.50	n.s.	
Chrysler T & C	.37	.41	.62	.49	11.64***	.072
Jeep Grand Cherokee	.75	.32	.99	.11	36.68***	.198
Toyota Camry	.39	.42	.57	.50	5.67*	.037
Honda Accord	.26	.41	.39	.49	*n.s.*	
Nissan Altima	.32	.43	.52	.50	7.05**	.045
Buick Rainier	.03	.13	.23	.43	15.03***	.092
Nissan 350Z	.20	.37	.42	.50	8.89**	.056
Mazda 3-Series Truck	.01	.12	.06	.25	*n.s.*	
Honda Insight	.13	.28	.38	.49	14.68***	.090
Suzuki Aerio	.00	.00	.29	.45	29.21***	.164
Chevrolet Silverado	.21	.31	.51	.50	18.90***	.113
Mercury Monterey	.05	.15	.49	.50	53.74***	.265

Note. *** indicates $p < .001$, ** indicates $p < .01$, * indicates $p < .05$

We also noted the types of vehicles that were most often recognized or recalled, as well as those which proved more difficult (Table 4). Surprisingly, the stimulus vehicle that sold the most units in 2010 (the Ford F-Series Truck) was not the most widely recognized/ recalled vehicle. The vehicle with the greatest percentage of participants giving correct responses in the recognition condition was the Jeep Grand Cherokee (98.7% accuracy). The sole participant who was incorrect on this question chose the Dodge Journey. Turning to the recall condition, 58.1% were completely correct, 33.8% were partially correct, and 8.1% were incorrect on the Jeep question. An examination of the partially correct answers showed that most of this group either said “Jeep” alone and were unable to identify the specific model (20.3% of participants in the recall condition), or named another Jeep model like the Wrangler (31.15% in this condition).

Across conditions, participants had the most difficulty with the Mazda 3-Series Truck. It is interesting to note that in 2010 the Mazda 3-Series Truck outsold the Jeep Grand Cherokee by more than 20,000 units. However, only 6.5% were correct in the recognition condition (93.5% incorrect) and most of the incorrect participants chose the Toyota Tacoma (59.7%). In the recall condition, all but one participant were unable to identify the Mazda 3-Series Truck (98.6% incorrect). Our examination of the incorrect recall responses showed that most participants incorrectly wrote “Ford” alone or wrote “Ford F-150” (36.5% of participants in the recall condition included “Ford” in part of their answer).

Table 4

Percentage of Participants Coded as Incorrect, Partially Correct, and Correct on Vehicle Questions

Car Make/Model	Incorrect	Partially Correct	Correct
Jeep Grand Cherokee	**4.6%**	**16.6%**	**78.8%**
Ford F-Series Truck	38.4%	12.6%	49.0%
Chrysler Town & C	43.7%	12.6%	43.7%
Toyota Camry	45.7%	11.9%	42.4%
Nissan Altima	54.3%	7.3%	38.4%
Honda Accord	64.2%	6.0%	29.8%
Chevrolet Silverado	57.0%	13.9%	29.1%
Nissan 350Z	66.2%	5.3%	28.5%
Mercury Monterey	70.2%	4.6%	25.2%
Honda Insight	70.9%	7.3%	21.9%
Suzuki Aerio	85.4%	0.0%	14.6%
Buick Rainier	84.8%	3.3%	11.9%
Kia Amanti	90.1%	1.3%	8.6%
Mazda 3-Series Truck	**96.0%**	**0.0%**	**4.0%**

Note. Vehicles with most and least percentage of accurate responses are bolded.

To examine the impact that driving expertise had on accuracy, we ran a series of Spearman's correlations between accuracy on the Part 2 questions and length of driving experience. We did not use self-identified car expertise as a variable because there were too few participants who endorsed this option. Years of driving experience was significantly and positively correlated with four vehicle questions. Participants who had been driving for longer were significantly more accurate on the Ford F-Series Truck ($r = .27$, $p < .01$), Nissan Altima ($r = .26$, $p < .01$), Nissan 350Z ($r = .19$, $p < .05$), and Chevrolet Silverado ($r = .21$, $p < .05$) questions.

We had hypothesized that men would outperform women at recalling/recognizing the cars, and this hypothesis was partially supported. A series of one-way ANOVAs on vehicle question accuracy with gender as the independent variable found that men were more accurate on 8 of the 14 questions (Table 5). We hypothesized that women might perform better than men for some of the vehicles, most notably the Kia which had the largest number of female registrants in 2010 (Truecar.com, 2010). However, men were more accurate at identifying the Kia. We also hypothesized that men would be more accurate than women at identifying trucks and exotic cars because they are more likely to own such vehicles (Truecar.com, 2010). This hypothesis was partially supported in that men outperformed women in identifying one of the three trucks included in the list (Chevrolet Silverado). Interestingly, the largest effect (partial eta-squared = .124) was for the Nissan 350Z (a two-door coupe), which very few women answered correctly. While the 350Z is not an exotic car, it is a sports car and was one of only two coupes included on the list. There were no gender differences in accuracy on the remaining six questions (e.g., Ford F-Series Truck, Mazda 3-Series Truck, all $p > .05$).

Table 5

Means, Standard Deviations, and Univariate Test Results for Vehicle Accuracy Scores For Men and Women

Car Make/Model	**Men**		**Women**		**Univariate Results**	
	M	***SD***	***M***	***SD***	***F*(1, 149)**	**Partial η^2**
Kia Amanti	.16	.37	.06	.22	5.01*	.033
Ford F-Series Truck	.57	.50	.55	.45	*n.s.*	
Chrysler T & C	.69	.43	.40	.46	14.54***	.089
Jeep Grand Cherokee	.90	.24	.85	.28	*n.s.*	
Toyota Camry	.64	.45	.40	.46	9.81**	.062
Honda Accord	.47	.49	.25	.42	8.26**	.053
Nissan Altima	.49	.49	.38	.47	*n.s.*	
Buick Rainier	.28	.42	.06	.24	16.30***	.099
Nissan 350Z	.53	.50	.20	.38	21.02***	.124
Mazda 3-Series Truck	.04	.19	.04	.20	*n.s.*	
Honda Insight	.31	.42	.23	.41	*n.s.*	
Suzuki Aerio	.23	.43	.10	.30	4.69*	.027
Chevrolet Silverado	.46	.46	.31	.43	4.16*	.023
Mercury Monterey	.37	.47	.23	.41	*n.s.*	

Note. *** indicates $p < .001$, ** indicates $p < .01$, * indicates $p < .05$.

Manufacturer Symbols

To compare accuracy in the recall and recognition conditions, we ran a series of one-way ANOVAs (with recall vs. recognition as the independent variable) on answers to the manufacturer symbols questions. The hypothesis that participants in the recognition condition would outperform the recall condition was supported for six of the ten symbols questions (Table 6). There were no significant differences in accuracy on the remaining four questions (all $p > .05$).

Interestingly, participants performed quite well overall on the manufacturer symbols (Table 7). The hypothesis that there would be greater accuracy on symbols from companies with higher sales was partially supported. Collapsing across experimental conditions, the two questions with the largest percentage of participants answering correctly were Honda (98% of participants were accurate) and Lexus (89.4% were accurate). The Honda finding supports our hypothesis that a top-selling car company (over 1 million units sold in 2010) would be easily recognized. However, the Lexus was not as high a seller as other vehicles on the list (with just over 200,000 units sold in 2010).

Table 6

Means, Standard Deviations, and Univariate Test Results for Manufacturer Symbol Accuracy Scores For Recall and Recognition Conditions

Manufacturer Symbol	**Recall**		**Recognition**		**Univariate Results**	
	M	***SD***	***M***	***SD***	***F*(1, 149)**	**Partial η^2**
Chevrolet	.69	.47	.82	.39	*n.s.*	
Mercedes-Benz	.75	.43	.99	.11	20.80***	.123
Toyota	.81	.39	.94	.25	5.42*	.035
Honda	.99	.12	.97	.16	*n.s.*	
Hyundai	.61	.49	.82	.39	8.53**	.054
Acura	.55	.50	.88	.32	23.21***	.135
Buick	.43	.50	.73	.45	14.62***	.089
Subaru	.49	.50	.57	.50	*n.s.*	
Lexus	.88	.33	.91	.29	*n.s.*	
Mazda	.50	.50	.79	.41	15.40***	.094

Note. *** indicates $p < .001$, ** indicates $p < .01$, * indicates $p < .05$.

Table 7

Percentage of Participants Coded as Incorrect, Partially Correct, and Correct on Manufacturer Symbol Questions

Car Company	**Incorrect**	**Correct**
Honda	**2%**	**98%**
Lexus	10.6%	89.4%
Toyota	12.6%	87.4%
Mercedes Benz	13.2%	86.8%
Chevrolet	24.5%	75.5%
Acura	27.8%	72.2%
Hyundai	28.5%	71.5%
Mazda	35.1%	64.9%
Buick	41.7%	58.3%
Subaru	47.0%	53.0%

Note. Vehicles with most and least percentage of accurate responses are bolded.

The two car questions for which the smallest percentage of participants answered correctly were Subaru (53% accurate) and Buick (58.3% accurate), and the number of units sold of these cars was similar to that of the Lexus (both around 200,000 units). In our analysis of the incorrect responses for the Buick question we found that participants were fairly evenly split between the multiple choice options in the recognition condition. Participants also wrote a variety of responses for Buick in the free recall condition (e.g., Chrysler, Lincoln). For the Subaru question, incorrect participants were evenly split between the Suzuki and Kia lures in the recognition condition. There was a wide range of incorrect responses in the free recall condition, with none appearing more than four times (e.g., Kia, Saturn).

We also examined the relationship between years of driving experience and accuracy on the manufacturer symbols questions. Participants with more driving experience were significantly more likely to be accurate on the Hyundai ($r = .18$, $p < .05$), Buick ($r = .18$, $p < .05$), Subaru ($r = .21$, $p < .05$), and Mazda ($r = .22$, $p < .01$) questions. All other Spearman correlations were not significant (all $p > .05$). A series of ANOVAs on accuracy for the manufacturer symbols with gender as the independent variable showed that men and women performed similarly on all but one question ($p > .05$). Men ($M = .71$, $SD = .46$) were significantly more accurate than women ($M = .52$, $SD = .50$) on the Buick question, $F(1, 149) = 5.53$, $p < .05$, partial eta-squared = .036.

DISCUSSION

We conducted this study to determine how accurately people can identify a variety of vehicles and manufacturer symbols, and it serves as a starting point for future car studies. We found that generally participants had trouble identifying the makes and models of cars, with the exception of the Jeep Grand Cherokee. Participants in this study saw the vehicles in relatively ideal circumstances. There was no time pressure, and the photos were large and showed the car in three views. The job was made more difficult in that the manufacturer symbols were blacked out, so participants could not rely on the symbol as a cue to the make and model. We had hypothesized that top-selling vehicles would be more easily identified. The top-selling vehicle on the list was the Ford F-Series Truck (over 500,000 units sold in 2010). Almost half of the participants (49%) correctly identified it (and, of those, 61.6% were completely correct or partially correct). But the participants were much better at identifying the Jeep Grand Cherokee (78.8% overall accuracy, 95.4% were completely correct or partially correct). These results suggest that the Jeep is a well-recognized brand and that participants' accuracy is not necessarily related to the vehicle's high sales (it sold significantly less than the F-Series at 84,000 units). These results imply that if a crime is committed with the use of a Jeep Grand Cherokee, then it is likely that witnesses will do a good job of naming the make of the car (and possibly the model).

Participants had more difficulty with the Mazda 3-Series Truck (a moderate seller of over 100,000 units) and the Kia Amanti (a very low seller of 281 units). It is likely that had we included the symbols in the photographs, then participants would have been better able to name at least the make of the car. By blocking out the symbols, participants only knew they were looking at a truck or a sedan, but could give very little additional information. However, in Part 3 when participants saw the manufacturer symbols, they did quite well at naming the appropriate company. Almost all participants were able to identify the Honda symbol (98%), and the Lexus was the second most recognized symbol (89.4%). It is possible that participants did well here because the symbols are letters ("H" and "L") which may be easier to remember. Another possibility is that luxury brands like Lexus are more easily identified. For example, Mercedes was the fourth highest symbol in terms of accuracy in the list. Future studies should investigate accuracy rates for luxury and non-luxury vehicles. Of note, even the symbols that received the fewest correct responses were still recognized by more than half of the participants. Although the symbols were removed from the vehicle photos that the participants saw in Part 2, these results suggest that people do know the manufacturer symbols quite well and might do better at identifying the makes and models of vehicles if they were to see the symbols on the cars.

Another purpose of the current study was to examine differences in accuracy when participants completed recall versus recognition questionnaires. The results for the most part supported past research which showed the advantage of recognition over recall (Hollingworth, 1913; MacDougall, 1904) because giving participants options in a multiple-choice format improved their accuracy on many of the questions. This demonstrates that the cognitive processing necessary for car identification is analogous to the cognitive processing necessary identification of other information, and thus subject to the same influences of expertise and error that have been demonstrated for other types of identification.

Participants' years of driving experience also were related to the several of the dependent measures. Experience was found to be positively related to accuracy on four vehicle questions and four symbols questions. We also compared men and women on their accuracy at identifying vehicles and manufacturer symbols. While men had some advantage at identifying the makes and models of the vehicles in Part 2, they were only better than women on one of the symbols questions (the Buick). We can offer no clear explanations for the gender advantage of men on the Buick question because none of the men who answered this question correctly had themselves driven a Buick. However, the effect was small so replication is needed. The current sample was majority female because most psychology students at the university are female. In future research, it would be advantageous to try to even out the gender distribution and see what effect, if any, this might have on accuracy scores for men and women. Future studies should also include more vehicles that women tend to drive to see if they can then identify them. We had predicted that women might do well at identifying the Kia, but very few of the participants (both men and women) were able to name its make and model. Other cars that many women buy are the Mini Cooper and Mazda Miata (Truecar.com, 2010). This vehicle should be included in future studies to see if women do well at identifying it.

Future Research

Given the lack of research on vehicle identifications, much future research is needed. In the current study, we included 14 vehicles and 10 manufacturer symbols, and all the stimuli were black-and-white still photos. The choice of stimuli was driven in part by sales (top-sellers and low-sellers) and by the availability of useable photographs online. Future studies should include more makes and models from a variety of years. People's ability to remember vehicles and their color under differing levels of illumination is another possible avenue for future study (e.g., Smith, Vingrys, Maddocks, & Hely, 1994; Yarmey, 1986). Further, researchers need to include vehicles in mock crime experiments. There are numerous studies wherein researchers created mock crime videos and asked witnesses to describe the crime and culprit (e.g., Valentine & Maras, 2011; Wheatcroft, Wagstaff, & Kebbell, 2004). Careful research is needed on people's memory of the vehicles they have seen in mock crime videos. More research also is needed on how best to *ask* participants about their memories for vehicles. Previous researchers who have studied investigative interviewing with witnesses have suggested that starting with an open-ended "tell me everything you can remember about the car" is best (e.g., Fisher & Schreiber, 2007). However, it is not known whether it would be advantageous to show participants images of cars (e.g., generic pictures of sedans, SUVs, or trucks) or whether these images would contaminate memory.

Including people from the community who are older than the students in this sample would make for a more representative sample. Driving expertise did have some impact on accuracy in the current study, so it is likely that participants with much more driving experience (e.g., 20 years) would be more accurate than the average participant in this study (e.g., 3.5 years). Older participants also would have more experience with purchasing and renting cars. Another possible contributing factor to accuracy may be socioeconomic status (SES). Future studies on a community sample in which participants are asked about their SES would give more insight into a typical American's knowledge of cars and how well they might do at identifying vehicles involved in crimes. Another important avenue for future research would be to compare experts whose professions involve cars (e.g., mechanics and highway patrol officers) and those who are non-experts. Informal discussions between the authors and police officers suggest that they will do very well at identifying cars. One officer told us that he could identify a car's make at night just by seeing its headlights.

Comparisons between the current measure and other car expertise indexes as used in Gauthier, Curran, Curby, and Collins (2003) also would be beneficial. Scores on the current measure and expertise indexes could be used as predictors for participants' performance on identifying vehicles seen in mock crime videos. Researchers do not know whether participants who score highly on such questionnaires and who are more experienced drivers are able to translate their abilities into greater accuracy at identifying moving vehicles. Finally, this study also should be taken out of the American context. Americans' car knowledge could be compared to that of residents of other countries around the world.

Implications and Conclusion

This study's results have clear implications for the legal system. Under very good viewing conditions, people had trouble identifying the makes and models of vehicles. People who witness car accidents or who unknowingly witness the getaway car involved in a crime may have trouble describing the car, especially if the manufacturer symbol was obscured or seen from a distance. There are exceptions, however. Even without the symbol, the participants did a very good job at recognizing the Jeep Grand Cherokee. If the symbols on the vehicles are easily visible, then it is likely that participants will do quite well. These results relate to the marketing area as well because they suggest that the Jeep and Honda brands are very well known by undergraduates. Future research is needed to determine if this brand recognition extends to the non-student population.

The Kristen French case emphasizes the importance of vehicle identification to the legal system. How well would you do if you were asked to describe a vehicle that ran a red light on your drive home? People are likely to have trouble remembering relatively mundane events, especially as time passes (e.g., Cansino, 2009; Kvavilashvili, Mirani, Schlagman, Erksine, & Kornbrot, 2010). But there is hope in that there is a limited number of vehicles out there. We encourage citizens to learn car makes and models because it may help if people are witnesses to traffic accidents, unknowingly see the getaway car involved in a crime, or are asked to be on the lookout for vehicles involved in kidnappings (e.g., Amber Alert cases). While more research is needed on how best to interview witnesses about cars, learning more about cars may help prevent crime or capture those who commit crimes.

REFERENCES

Baltas, G., & Saridakis, C. (2010). Measuring brand equity in the car market: A hedonic price analysis. *Journal of the Operational Research Society, 61,* 284-293. doi:10.1057/jors.2008.159

Cansino, S. (2009). Episodic memory decay along the adult lifespan: A review of behavioral and neurophysiological evidence. *International Journal of Psychophysiology, 71,* 64-69. doi:10.1016/j.ijpsycho.2008.07.005

Department of Transportation (2011). Number of U.S. aircraft, vehicles, vessels, and other conveyances. Retrieved May 30, 2013 from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_11.html

Duffy, S. (2002) Closing the net: How they cracked the case. *CNN.com,* . Retrieved May 30, 2013 from http://archives.cnn.com/2002/US/South/10/24/sniper.case.cracked/

Federal Bureau of Investigation (2010). *Motor vehicle theft*. Retrieved May 30, 2013 from http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/property-crime/mvtheftmain

Fisher, R. P., & Schreiber, N. (2007). Interview protocols for improving eyewitness memory. In M. P. Toglia, J. D. Read, D. F. Ross, & R. C. L. Lindsay (Eds.), *The handbook of eyewitness psychology, Vol I: Memory for events* (pp. 53-80). Mahwah, NJ: Erlbaum.

Gauthier, I., Curran, T., Curby, K., & Collins, D. (2003). Perceptual interference supports a non-modular account of face processing. *Nature Neuroscience, 6,* 428-432. doi:10.1038/nn1029

Hollingworth, H. L. (1913). Characteristic differences between recall and recognition. *The American Journal of Psychology, 24*, 532-544.

Innocence Project (2014, September 27). Retrieved September 27, 2014 from http://www.innocenceproject.org/

Jeanes, W. (2011, June). Celebrating America's 125-year love affair with cars. *The Saturday Evening Post.*

Kvavilashvili, L., Mirani, J., Schlagman, S., Erksine, J. A. K., & Kornbrot, D. E. (2010). Effects of age on phenomenology and consistency of flashbulb memories of September 11 and a stated control event. *Psychology and Aging, 25,* 391-404. doi:10.1037/a0017532

McCrary, G. O. (2003). *The unknown darkness: Profiling the predators among us.* New York, NY: Harper Collins.

MacDougall, R. (1904). Recognition and recall. *The Journal of Philosophy, Psychology and Scientific Methods, 1*, 229-233.

R v. Bernardo (unreported, 1995). Ontario Court of Justice.

Rossion, B., & Curran, T. (2010). Visual expertise with pictures of cars correlates with RT magnitude of the car inversion effect. *Perception*, *39*, 173. doi:10.1068/p6270

Smith, G., Vingrys, A. J., Maddocks, J. D., & Hely, C. P. (1994). Color recognition and discrimination under full-moon light. *Applied Optics, 33,* 4741-4748. doi:10.1364/AO.33.004741

Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. *The Quarterly Journal of Experimental Psychology, 46*(2), 225-245. doi:10.1080/14640749308401045

Terech, A., Bucklin, R. E., & Morrison, D. G. (2008). Consideration, choice, and classifying loyalty. *Marketing Letters, 20,* 209-225. doi:10.1007/s11002-008-9065-y

Truecar.com (2010, June). Truecar.com examines gender differences in vehicle registrations; Reveals current discounts for vehicles most registered by females. Retrieved May 30, 2013 fromhttp://www.truecar.com/static/references/Gender_Snapshot_Release_June_2010.pdf

Valentine, T., & Maras, K. (2011). The effect of cross-examination on the accuracy of adult eyewitness testimony. *Applied Cognitive Psychology, 25,* 554-561. DOI: 10.1002/acp.1768

Vehicles sought in D.C. sniper hunt. (2002, October 13). *CNN.com*. Retrieved May 30, 2013 from http://archives.cnn.com/2002/US/South/10/12/shootings.probe/

Villegas, A. B., Sharps, M. J., & Satterthwaite, B., & Chisholm, S. (2005). Eyewitness identification of vehicles. *Forensic Examiner, 14*, 24-28.

Wheatcroft, J. M., Wagstaff, G. F., & Kebbell, M. R. (2004). The influence of courtroom questioning style on actual and perceived eyewitness confidence and accuracy. *Legal and Criminological Psychology, 9,* 83-101. doi:10.1348/135532504322776870s

Wells, G. L., Memon, A., & Penrod, S. D. (2006). Eyewitness evidence: Improving its probative value. *Psychological Science in the Public Interest, 7,* 45-75. doi:10.1111/j.1529-1006.2006.00027.x

Wells, G. L., Small, M., Penrod, S., Malpass, R. S., Fulero, S. M., & Brimacombe, C. A. E. (1998). Eyewitness identification procedures: Recommendations for lineups and photospreads. *Law and Human Behavior, 22,* 603-647. doi:10.1023/A:1025750605807

Yarmey, A. D. (1986). Verbal, visual, and voice identification of a rape suspect under different levels of illumination. *Journal of Applied Psychology, 71,* 363-370. doi:10.1037/0021-9010.71.3.363

Received: 2/2014
Accepted: 9/2014

Allison, M., Overman, A. A., Braun, M., Campbell, M., & Price, J.R. (2014). [Electronic Version]. Applied Psychology in Criminal Justice, 10(2), 83 -97.

ENDNOTES

1. We thank Elon University for its support of this project and Michael Jones for his help with data entry.