INVESTIGATING DIFFERENCES IN DRIVER ACCIDENT INVOLVEMENT:

THE INFLUENCE OF PERCEPTUAL MOTOR COMPETENCE, COMPETITIVE ATHLETICS, AND GENDER

Mary Jo Kane & Kim D. Pearce
Tucker Center for Research on
Girls & Women in Sport
University of Minnesota

Peter A. Hancock & Stephen F. Scallen
Human Factors Research Laboratory
University of Minnesota

Courtney B. Heniff
Center for Sport Psychology & Performance Excellence
University of North Texas

Technical Report Documentation Page

1. Report No. CTS 99-03	2.	3. Recipient's Accession No.	
4. Title and Subtitle Investigating Differences in Driver Accident Involvement: The Influence of Perceptual Motor Competence, Competitive Athletics, and Gender		5. Report Date April 1999 6.	
7. Author(s) Mary Jo Kane, Kim D. Pearce, Peter A. Hancock, Stephen F. Scallen, Courtney B. Heniff		8. Performing Organization Report No.	
9. Performing Organization Name and Address Tucker Center for Research on Girls and Women in Sport University of Minnesota 203 Cooke Hall, 1900 University Avenue SE Minneapolis, MN 55455		10. Project/Task/Work Unit No. 11. Contract (C) or Grant (G) No. (C) (G)	
12. Sponsoring Organization Name and Address Center for Transportation Studies ITS Institute Program 200 Transportation and Safety Building 511 Washington Avenue SE University of Minnesota, Minneapolis, MN 55455-0220		13. Type of Report and Period Covered Final Report 1997-1998 14. Sponsoring Agency Code	
15. Supplementary Notes			

16. Abstract (Limit: 200 words)

This report presents the results of a study to determine if skills developed in competitive athletics transfer to driving ability, and whether such transfer is mediated by gender. To test these questions, we compared the driving ability of male/female athletes and male/female nonathletes in high-demand, simulated driving situations. A front-projector simulator was used to create a virtual driving environment. A full-sized Honda Accord served as the simulation vehicle. Sensors in the vehicle measured participants' performance and behaviors under different following and braking conditions in eight experimental trials.

The findings of the study do not support the hypothesis that males and females differed significantly with respect to driving and braking performance; however, some results indicate a clear performance advantage for athletes over nonathletes. Furthermore, some descriptive data seem to indicate that the performance gap between female athletes and female nonathletes was wider than the performance gap between their male counterparts. Descriptive statistics for each performance measure are provided.

Finally, the report makes recommendations for research to further examine the nature of the links among gender, sport and driving performance, as well as recommendations for integrating activities that enhance perceptual motor skills into driver training programs.

17. Document Analysis/Descriptors Driver accident involvement Gender Perceptual motor competence	Human factors Athletics	18. Availability Statement No restrictions. Document available from: National Technical Information Services, Springfield, Virginia 22161	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages	22. Price

Investigating Differences in Driver Accident Involvement: The Influence of Perceptual Motor Competence, Competitive Athletics, and Gender

Final Report

Prepared by:

Mary Jo Kane, Ph.D.
Kim D. Pearce, M.S.R.A.

Tucker Center for Research on Girls & Women in Sport
University of Minnesota

Peter A. Hancock, Ph.D.
Stephen F. Scallen, Ph.D.

Human Factors Research Laboratory
University of Minnesota

Courtney B. Heniff, Ph.D.

Center for Sport Psychology & Performance Excellence
University of North Texas

August 1999

Published by

Intelligent Transportation Systems Institute of the
Center for Transportation Studies
200 Transportation and Safety Building
511 Washington Avenue SE
Minneapolis, MN 55455

CTS 99-03

TABLE OF CONTENTS

APPENDIX A

List of Tables

List of Figures

EXECUTIVE SUMMARY

RESEARCH ISSUE AND STATEMENT OF PROBLEM

Prior knowledge regarding sex-related differences in driver accident involvement suggest differential patterns with respect to decision-making strategies: females are significantly less likely to expose themselves to high-demand, high-stress driving conditions [1], possibly due to their deficiencies in high-level, perceptual motor skills [2]. What is unclear is whether females who possess a high degree of perceptual-motor competence (e.g., female athletes) can counter such deficiencies. The purpose of this study was to determine if competence in athletics—a demanding spatio-temporal activity—transfers to driving ability, and, if so, whether such transfer is mediated by gender to any significant degree.

To test these previously unanswered questions, we compared the driving ability of four experimental groups: 1) female athletes; 2) female nonathletes; 3) male athletes; and 4) male nonathletes. Standard psychomotor tests were administered using a front-projector simulator with 60 degrees of forward viewing area to create a virtual driving environment. A full-sized Honda Accord served as the simulation vehicle. Sensors in the vehicle measured participants' performance and behavior under different following and braking conditions in eight experimental trials. We hypothesized three significant outcomes: 1) athletes would outperform nonathletes; 2) within each of these experimental groups, there would be no difference between males and females; and 3) female athletes would outperform male nonathletes.

RESULTS

With respect to overall results, the findings of the study do not support the hypothesis that males and females differed significantly with respect to driving and braking performance. Results for time-to-contact (i.e., length of time for the participant's car to hit the lead vehicle), however, indicated a clear performance advantage for athletes over nonathletes. Despite little evidence that behavior (i.e., braking time) differed by athletic status, athletes were able to achieve better (longer) time-to-contact scores. Thus, it appeared that the advantage of athletic participation is not in the ability to behave (move limbs, react), but in the ability to produce desirable performance in context. Furthermore, some descriptive data seem to indicate that the performance gap between female athletes and female nonathletes was wider than the performance gap for their male counterparts. This was particularly evident for the following measures: closed-loop movement time (i.e., the interval between the moment the brake is actuated more than 5% and the moment of maximum brake position) and response time (i.e., the interval between lead car braking onset and the moment of maximum braking). (Note: statistical significance was never achieved, probably due to the variability of performance within groups.)

CONCLUSIONS AND RECOMMENDATIONS

These results suggest that athletic participation does provide an advantage in certain aspects of driving performance. Furthermore, the findings indicate that sports participation has the potential to provide a significantly greater effect for females in terms of improving driving performance. These patterns of findings suggest that an important segment of the driving population—females in general, and older females in particular—could increase their ability to avoid accidents by engaging in activities such as sports that improve perceptual-motor competence. Consequently, we propose the following recommendations for both scholars and practitioners:

- Expand the sample base to include the variable sport type in future research. It may be that particular types of sports (team vs. individual; an emphasis on fine vs. gross motor skills) mediate driver competence.

- Results suggest that the gap in performance differences was greater between female athletes versus female nonathletes than it was for male athletes versus male nonathletes. Future research should control more for the physical activity/sport background of nonathletes. It may be that due to socio-cultural differences, nonathletic males have much greater participation rates in sport activities and higher levels of competition than nonathletic females. This may explain performance differences more than gender.

- Develop and implement curricular materials in driver educational programs that enhance perceptual-motor competence (e.g., hazard identification).

- Modify existing exercise programs in order to increase retention of perceptual-motor skills (e.g., hand-eye coordination tasks) for elderly drivers.

- Advocate the inclusion of perceptual-motor tasks (e.g., training for practice in unusual driving circumstances) in the license renewal procedure, particularly for novice and elderly drivers.

CHAPTER 1
INTRODUCTION

BACKGROUND

While there are large and consistent gender differences in various forms of accident involvement [1], the pattern is highly complex. There is strong evidence suggesting that average gender differences exist in critical perceptual capabilities such as time-to-contact [3,4]. Accompanying such average differences, however, are large, individual differences such as performance capability. One domain where performance capability plays a critical role is competitive athletics. In fact, competitive athletics provide a rich and unexplored area for examining a variety of variables related to gender differences in driver accident involvement. Two salient questions that merit empirical investigation are: does competence in perceptual-motor skills (developed through sport participation) transfer to driving ability; and further, is such transfer mediated by gender?

Studies on gender-related differences in driver accident involvement reveal that females and males differ with respect to decision-making strategies: females are less likely to expose themselves to high-demand, high-stress driving circumstances [1]. Consequently, when faced with stressful, demanding situations, females may prove more vulnerable (i.e., at-risk) because of an average deficiency in high-level, perceptual-motor skills [2]. What is unclear is whether females who possess a high degree of perceptual-motor competence (i.e., female athletes) can counter such deficiencies.

In non-driving contexts, research findings indicate that female athletes respond significantly faster to game and nongame stimuli [5] and demonstrate increased accuracy in recalling visual display structures [6] when compared to nonathletic females. If such skills are transferable, participation in athletics may enhance females' ability to avoid vehicular accidents. Our central question became: does individual variability (i.e., gender differences), perceptual-motor competence (i.e., skill gained through sport) or an interaction of these two variables influence accident patterns?

RESEARCH OBJECTIVE

This study was designed to determine if skills developed in competitive athletics—a demanding, spatio-temporal activity—transfer to driving competency (i.e., a function of learned capabilities), and whether such a transfer is mediated by gender (i.e., a function of intrinsic capabilities). These empirical questions were addressed by examining the association between perceptual-motor competence and driving performance during a high-fidelity driving simulation. We compared the performance of individuals in high-demand driving conditions to determine if there is a transfer of skills from athletic participation to driving competency. Four experimental groups of age-matched individuals (50% males and 50% females) were divided by gender and perceptual-motor capabilities: Male and female students who have competed on a Division I university athletic team represented the high-competence groups, while students who have never competed in Division I athletics represented the low-competence groups.

Participants were evaluated on the basis of standard psychomotor tests (e.g., reaction time) by exposing them to 8 experimental driving trials (each on a two-lane, rural-like driving environment) requiring control of speed, steering, and lane position. This procedure is standard protocol in the academic body of knowledge under consideration.

We hypothesized three significant outcomes: 1) the high-competence group (athletes) would outperform the low-competence group (nonathletes); 2) within each competency group, there would be no differences between males and females; and 3) the high-competence group of female athletes would outperform the low-competence group of male nonathletes. Such findings would confirm competency (as partially gained through sport participation) as the primary source of driver ability rather than intrinsic differences due to gender alone. Finally, we sought to determine which aspect of competency is responsible for superior performance—perceptual/strategic skills or psychomotor skills.

REPORT ORGANIZATION

The remainder of this report is divided into three chapters. Chapter 2 describes the research methods, including the statistical analyses and study limitations. Chapter 3 describes the results and provides descriptive statistics for each performance measure. Chapter 4 contains the conclusions and recommendations for future research and protocol applications.

CHAPTER 2
METHODS

APPARATUS

Interactive driving scenarios were displayed in the Human Factors Research Laboratory's single-screen driving simulator. The front-projection simulator is a high-fidelity driving simulator that allows for 60 degrees of forward viewing area to immerse the subject in a virtual driving environment. Driving scenes are programmed with SGI Performer Graphics Libraries, displayed with an SGI Indigo2 and projected through an Electrohome ECP-3100® projector. Display resolution was 1024 X 768. A full-sized 1990 Accord served as the simulation vehicle (see Figure 2.1). The vehicle was equipped with sensors for gas, brake, and steering control, facilitating real-time driver input. A torque motor attached to the steering wheel provided steering force feedback to the driver.

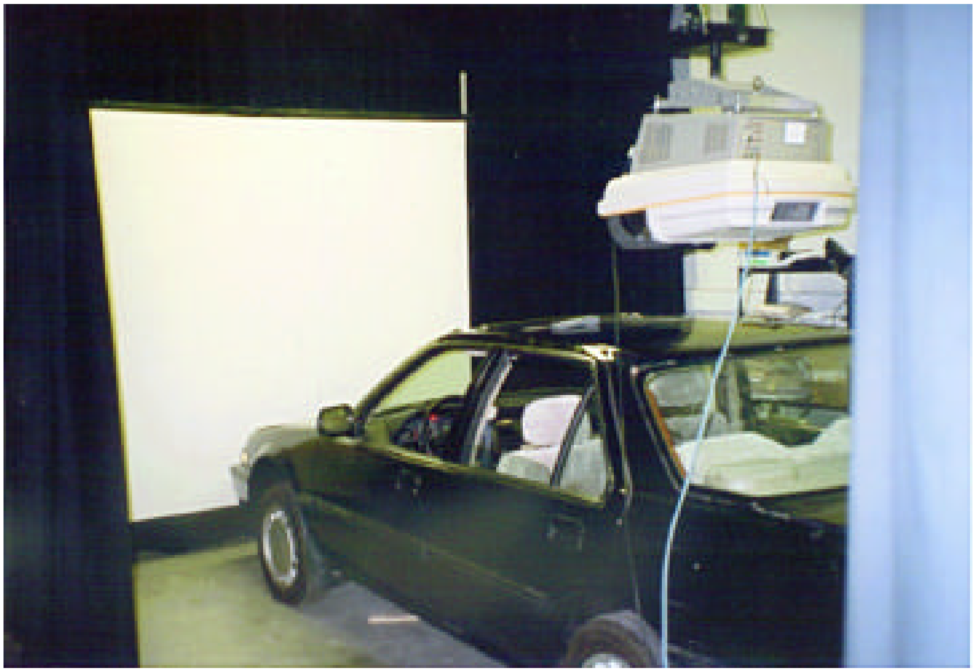

Figure 2.1. Human Factors Research Laboratory’s Front-Projection Driving Simulator

PARTICIPANTS

Participants were classified as “athlete” if they were currently participating on a Division I university athletic team. An overt attempt was made to recruit athletes who were participating in sports with strong closed-loop elements (i.e., sports such as baseball and tennis that require the participant to use feedback from the environment to moderate behavior in order to achieve a goal), versus open-loop elements (i.e., sports such as swimming and running that require the participant to execute a standardized action). Participants were classified as "nonathlete" if they had never participated in Division I athletics and were not currently participating in an organized sports team. Note that one nonathlete participant had limited exposure to an organized sports team (intramural soccer). Some nonathlete participants reported various degrees of activity in high school sports.

Twelve (12) males and twelve (12) females volunteered to participate in the study. Mean age for all subjects was 20.4 years with 4.7 years of driving experience. Mean age for males was 21 years with 5 years driving experience. Mean age for females was 19.8 years with 4.4 years of driving experience. Participant demographics, driving experience, and athletic status are detailed in Table 2.1. All subjects were licensed drivers and had normal or corrected-to-normal vision. Subjects were given $10 for participating in the hour-long experimental session.

Table 2.1. Subject Demographics, Driving Experience and Athletic Status.

Subj. #	**Age**	**Sex**	**Athletic Status**	**Years Driving**	**Division I Sports**	**H.S. Varsity Sports**	**Organized Sports**
1	20	f	nonathlete	6	no	no	no
2	24	m	nonathlete	9	no	no	no
3	18	f	nonathlete	2	no	no	no
4	21	f	nonathlete	6	no	no	no
5	20	m	nonathlete	6	no	no	no
6	19	m	nonathlete	4	no	yes	yes
7	21	f	nonathlete	6	no	yes	no
8	24	m	nonathlete	2	no	no	no
9	20	m	nonathlete	6	no	yes	no
10	23	m	nonathlete	4	no	no	no
11	24	f	athlete	7	yes	yes	-
12	21	f	athlete	6	yes	yes	-
13	19	f	athlete	3	yes	yes	-
14	18	f	athlete	3	yes	yes	-
15	19	f	athlete	4	yes	yes	-
16	18	f	athlete	3	yes	yes	-
17	19	f	athlete	4	yes	yes	-
18	18	m	athlete	3	yes	no (club)	-
19	18	m	athlete	3	yes	yes	-
20	20	m	athlete	5	yes	yes	-
21	22	m	athlete	6	yes	yes	-
22	22	m	athlete	7	yes	yes	-
23	20	f	nonathlete	3	no	no	no
24	22	m	athlete	5	yes	yes	-

DATA COLLECTION PROCEDURES

In accordance with university policy, all participants signed an informed consent form (see Appendix A) after reading a description of the experimental procedures and asking any clarifying questions. Participants then received practice-to-criteria training on the simulator controls. All subjects had to demonstrate control of vehicle speed, steering, and lane control in a practice driving scenario. Subsequent to training, subjects participated in the experimental trials.

The experimental scenario was a modified version of a braking scenario presented by Van Winsum and Brouwer [7] and Van Winsum and Heino [8]. Drivers controlled a vehicle on a two-lane road with 11.8-foot (3.6 meter) lanes and a 9.8-foot (3-meter) shoulder. The roadway was painted with a broken center line and a solid shoulder line. The peripheral environment contained some structures and non task-related signage, producing a rural-like driving environment. Subjects were instructed to accelerate the vehicle to a ‘safe and comfortable speed’ while maintaining lane position. Approximately .62 miles (1000 meters) into the drive, a second vehicle merged into the lane from a parked position on the shoulder. The second vehicle accelerated at 8.95 mph (4 m/sec^2) to achieve a target speed of either 50 mph (22.35 m/sec) or 40 mph (17.88 m/sec). Participants were instructed to approach the vehicle and maintain a “safe and comfortable” following distance. Participants were instructed not to pass the vehicle. At this point the experimental procedure differed.

In the “Preferred Time Headway” (THWpref) trial, participants were instructed to drive behind the lead vehicle and achieve a “safe and comfortable” distance (see Figure 2.2). Participants were instructed to maintain the constant distance for approximately five (5) minutes, after which the trial ended. In the “Braking Trials” subjects were instructed first to maintain the “safe and comfortable” distance. Prompted by the experimenter, the participants were requested to drive at a closer distance and maintain a new following distance. This continued until a time headway of 1.0 seconds was reached. At that moment the lead vehicle’s brake lights lit, and the vehicle decelerated at –6.71 mph (–3 m/sec^2) to half its original speed, either 25 mph (11.18 m/sec) or 20 mph (8.94 m/sec). The critical 1.0 time headway threshold was selected on the basis of extensive pilot testing with threshold values ranging from 0.6 to 1.2. The desire of the experimenter was to select a value that produced both open- and closed-loop movements (a ballistic limb movement from the gas to the brake, then moderated braking based on information available in the scene). Control trials were replicates of the “Braking Trials” except the lead car didn’t brake, regardless of the achieved time headway, or the lead car sped up at 1.0 time headway.

Figure 2.2. View of the Lead Vehicle.

Each participant drove eight (8) experimental trials. A summary of experimental trials is provided in Table 2.2.

Table 2.2. Summary of Trial Orders.

	Order 1				Order 2	
Trial	Type	Lead Vehicle Speed		Trial	Type	Lead Vehicle Speed
1	THWpref	50 mph (22.35 m/sec)		1	THWpref	50 mph
2	control-accel.	50 mph		2	control-accel.	40 mph
3	control-nothing	50 mph		3	control-nothing	40 mph
4	braking	50 mph		4	braking	40 mph
5	control-nothing	40 mph (17.88 m/sec)		5	control-nothing	50 mph
6	control-accel.	40 mph		6	control-accel.	50 mph
7	control-nothing	40 mph		7	control-nothing	50 mph
8	braking	40 mph		8	braking	50 mph

All subjects drove the “Preferred Time Headway” trial first. Orders 1 and 2 were represented equally across gender and athletic status. Inter-trial periods were approximately one minute. Subsequent to participation in the experimental trials, all participants were given a debriefing during which they were told in general terms the background, purpose and hypotheses of the investigation.

DEPENDENT MEASURES

The primary focus of this study was to evaluate participant performance and behavior under following and braking conditions. To support these foci, participant vehicle speed, lead car speed, accelerator actuation (percentage, 0-100), brake actuation (percentage, 0-100), and distance headway (bumper-to-bumper distance) were collected every second (1 Hz) during non-braking segments and 5 times every second (5 Hz) during braking segments. In post-processing, an additional measure, time headway (THW), was calculated by dividing the distance headway by the speed of the participant's vehicle. These data yielded the following information:

- **To** – time at the moment the lead car braked.
- **Tacc** – time at the moment the accelerator is released more than 5%.
- **Tbr** – time at the moment the brake is actuated more than 5%.
- **Tbrmax** – time at the moment of maximum braking.

Using the raw data as well as the identified moments of behavior, the following derived measures of performance and behavior were calculated for statistical analyses:

- **Preferred Time Headway (THWpref)** – the mean value for a 1-minute segment of the THWpref trial.
- **Reaction Time (RT)** – the interval between lead car braking onset and the moment the accelerator is released more than 5% (Tacc - To).
- **Open-Loop Movement Time (OLMT)** – the interval between the moment the accelerator is released more than 5% and the brake is actuated more than 5% (Tbr -To).
- **Closed-Loop Movement Time (CLMT)** – the interval between the moment the brake is actuated more than 5% and the moment of maximum brake position (Tbrmax - Tbr).
- **Total Movement Time (MT)** – OLMT + CLMT.
- **Response Time (RST)** – the interval between lead-car braking onset and the moment of maximum braking (Tbrmax - To).
- **Time-to-Contact at initial deceleration (TTCacc)** – the time-to-collision with the lead vehicle at the moment the accelerator is released more than 5%, calculated as THW/(difference in vehicle speeds), on Tacc.
- **Time-to-Contact at initial braking (TTCbr)** – the time-to-collision with the lead vehicle at the moment the brake is actuated more than 5%, calculated as THW/(difference in vehicle speeds), on Tbr.

- **Time-to-Contact at maximum brake (TTCbrmax)** – the time-to-collision with the lead vehicle at the maximum braking position, calculated as THW/(difference in vehicle speeds), on Tbrmax.

STATISTICAL ANALYSES

All measures were subjected to mixed-model between–within analyses of variance (ANOVAs). Participant gender (male, female) and athletic status (athlete, nonathlete) are the between subject factors. Lead vehicle speed is the repeated factor. Unless otherwise stated, reported degrees of freedom and probabilities for repeated measure effects and associated interactions were adjusted based on the Greenhouse-Geisser epsilon when deemed necessary by a significant Mauchly sphericity statistic. Where appropriate, follow-up tests were conducted using the Tukey comparison, unless otherwise indicated. A traditional level of significance ($p<.05$) is adopted for all parametric testing.

STUDY LIMITATIONS

It should be noted that one limitation of this experiment was the inability of the statistical model to handle missing cells in the repetition factor. Missing cells were produced when, for example, subjects did not have the accelerator sufficiently actuated at the moment the lead car began braking. In this situation, the data could not detail a reaction time. The number of times this specific situation occurred was surprisingly high (7 times) and severely limited the statistical analyses by reducing an already low sample size. Another limitation was the difficulty in applying the desired (strict) athletic status criteria. Some “athletes” were participating in primarily open-loop sports (e.g., swimming), while some “nonathletes” had some varsity high school sport experience. Due to the small sample size (in part due to the difficult screening criteria) and expected difficulties with missing cells (e.g., no RT can be calculated when the accelerator is not actuated at To), descriptive data will be provided.

CHAPTER 3
RESULTS

PREFERRED TIME HEADWAY

Measures of THWpref were calculated and subjected to the designed analyses. Analyses indicated no main effects or interactions. Descriptive statistics are located in Table 3.1.

Table 3.1. Descriptive Statistics for Preferred Time Headway.

	SEX	STATUS	Mean	Std. Deviation	N
THWPREF	f	a	3.729	3.632	7
		na	3.267	2.667	5
		Total	3.537	3.137	12
	m	a	2.129	0.512	6
		na	2.525	1.936	6
		Total	2.327	1.366	12
	Total	a	2.991	2.719	13
		na	2.862	2.207	11
		Total	2.932	2.445	24

RESPONSE TIME (AND PARTITIONS)

Measures of reaction time (RT), open-loop movement times (OLMT), closed-loop movement times (CLMT), total movement times (MT), and total response times (RST) were calculated and subjected to the designed analyses. Analyses of RT indicated no main effects or interactions. Descriptive statistics for RT are located in Table 3.2. Analyses of OLMT indicated no main effects or interactions. Descriptive statistics for OLMT are located in Table 3.3. Analyses of CLMT indicated a main effect for lead vehicle speed (F(1,20)=6.989,p<.05), see Figure 3.1. Descriptive statistics for CLMT are located in Table 3.4. Analyses of MT indicated no main effects or interactions. Descriptive statistics for MT are located in Table 3.5. Analyses of RSP indicated a main effect for lead vehicle speed (F(1,19)=9.738,p<.01), see Figure 3.2. Descriptive statistics for RSP are located in Table 3.6

Table 3.2. Descriptive Statistics for Reaction Times.

	SEX	STATUS	Mean	Std. Deviation	N
RT50	f	a	0.564	0.297	7
		na	0.384	0.301	2
		Total	0.524	0.289	9
	m	a	0.515	0.321	3
		na	0.744	0.424	6
		Total	0.667	0.389	9
	Total	a	0.549	0.287	10
		na	0.654	0.411	8
		Total	0.596	0.341	18
RT40	f	a	0.531	0.125	7
		na	0.498	0.048	2
		Total	0.524	0.110	9
	m	a	0.555	0.187	3
		na	0.577	0.225	6
		Total	0.569	0.201	9
	Total	a	0.538	0.135	10
		na	0.557	0.194	8
		Total	0.547	0.159	18

Table 3.3. Descriptive Statistics for Open-Loop Movement Times.

	SEX	STATUS	Mean	Std. Deviation	N
OL50	f	a	0.601	0.161	7
		na	0.718	0.226	2
		Total	0.627	0.169	9
	m	a	0.692	0.398	3
		na	0.614	0.286	6
		Total	0.640	0.304	9
	Total	a	0.628	0.233	10
		na	0.640	0.261	8
		Total	0.634	0.239	18
OL40	f	a	0.596	0.092	7
		na	0.516	0.276	2
		Total	0.578	0.131	9
	m	a	0.645	0.192	3
		na	0.748	0.259	6
		Total	0.714	0.232	9
	Total	a	0.611	0.120	10
		na	0.690	0.265	8
		Total	0.646	0.195	18

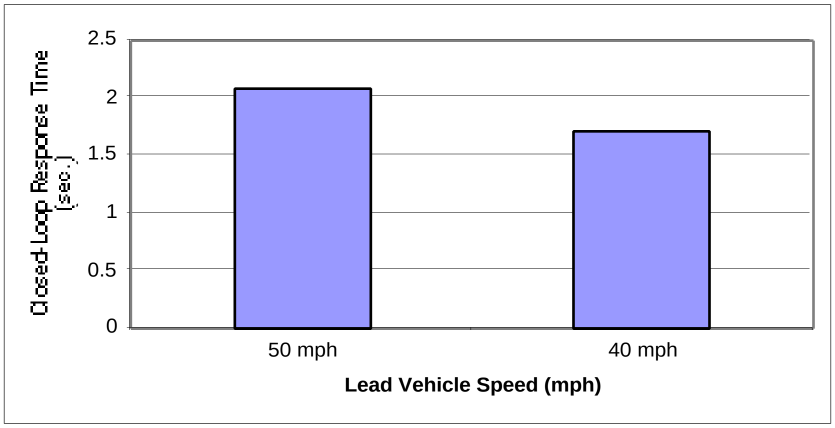

Figure 3.1. Closed-Loop Response Times at 40 and 50 mph (17.88 and 22.35 m/sec).

Table 3.4. Descriptive Statistics for Closed-Loop Movement Times.

	SEX	STATUS	Mean	Std. Deviation	N
CL50	f	a	1.894	0.449	7
		na	2.459	0.774	5
		Total	2.130	0.642	12
	m	a	1.917	0.795	6
		na	2.059	0.515	6
		Total	1.988	0.643	12
	Total	a	1.905	0.604	13
		na	2.241	0.645	11
		Total	2.059	0.633	24
CL40	f	a	1.450	0.366	7
		na	1.981	0.148	5
		Total	1.671	0.395	12
	m	a	1.735	0.596	6
		na	1.651	0.518	6
		Total	1.693	0.534	12
	Total	a	1.582	0.486	13
		na	1.801	0.415	11
		Total	1.682	0.459	24

Table 3.5. Descriptive Statistics for Total Movement Time.

	SEX	STATUS	Mean	Std. Deviation	N
MT50	f	a	2.496	0.502	7
		na	2.954	1.377	2
		Total	2.597	0.684	9
	m	a	2.360	1.379	3
		na	2.673	0.566	6
		Total	2.569	0.837	9
	Total	a	2.455	0.771	10
		na	2.743	0.719	8
		Total	2.583	0.741	18
MT40	f	a	2.046	0.378	7
		na	2.421	0.426	2
		Total	2.130	0.396	9
	m	a	2.004	0.654	3
		na	2.399	0.657	6
		Total	2.268	0.645	9
	Total	a	2.034	0.436	10
		na	2.405	0.579	8
		Total	2.199	0.524	18

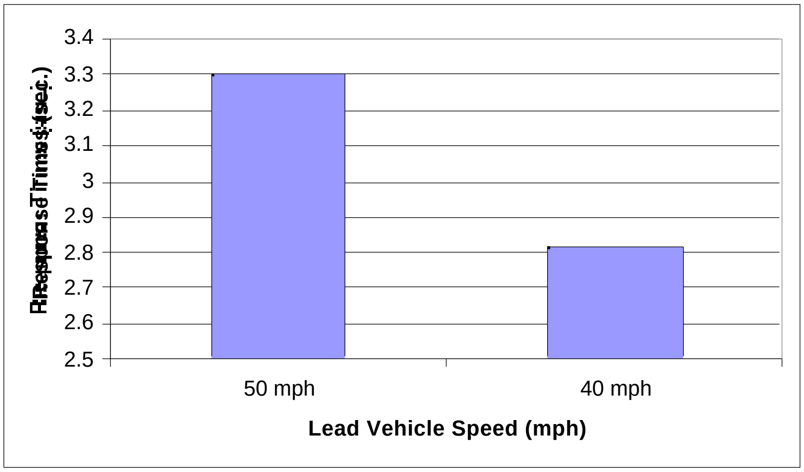

Figure 3.2. Response Times at 40 and 50 mph (17.88 and 22.35 m/sec).

Table 3.6. Descriptive Statistics for Response Times.

	SEX	STATUS	Mean	Std. Deviation	N
RST50	f	a	3.060	0.483	7
		na	3.636	0.764	5
		Total	3.300	0.654	12
	m	a	3.126	1.120	6
		na	3.417	0.315	6
		Total	3.271	0.799	12
	Total	a	3.090	0.800	13
		na	3.516	0.544	11
		Total	3.285	0.714	24
RST40	f	a	2.578	0.428	7
		na	2.919	0.286	5
		Total	2.720	0.401	12
	m	a	2.799	0.675	6
		na	2.976	0.781	6
		Total	2.887	0.702	12
	Total	a	2.680	0.543	13
		na	2.950	0.582	11
		Total	2.804	0.566	24

TIME-TO-CONTACT

Measures of time-to-contact at Tacc (TTCacc), time-to-contact at Tbr (TTCbr), and time-to-contact at Tbrmax (TTCbrmax) were computed and subjected to the designed analyses. Analyses of TTCacc indicated no significant effects. However, when gender was removed from the model, analyses indicated a significant status effect (F(1,16)=5.524,p<.05), see Figure 3.3. Descriptive statistics for TTCacc are located in Table 3.7. Analyses of TTCbr indicated a main effect for athletic status (F(1,20)=7.699,p<.05), see Figure 3.4. Descriptive statistics for TTCbr can be located in Table 3.8. Analyses of TTCbrmax indicated no main effects or interactions. Descriptive statistics for TTCbrmax can be located in Table 3.9.

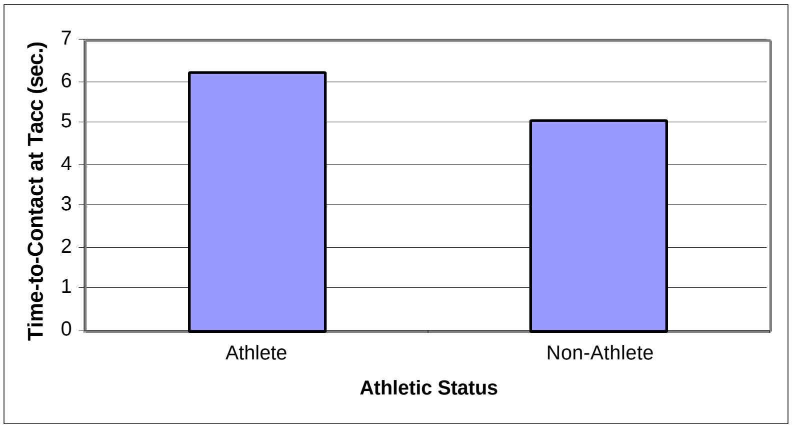

Figure 3.3. Time-to-Contact at Tacc for Athletes and Nonathletes.

Table 3.7. Descriptive Statistics for Time-to-Contact at Tacc.

	SEX	STATUS	Mean	Std. Deviation	N
TTCACC50	f	a	6.135	1.236	7
		na	4.726	0.319	2
		Total	5.821	1.243	9
	m	a	6.338	1.735	3
		na	4.840	1.424	6
		Total	5.339	1.607	9
	Total	a	6.196	1.303	10
		na	4.811	1.211	8
		Total	5.580	1.415	18
TTCACC40	f	a	6.472	1.535	7
		na	4.607	1.273	2
		Total	6.058	1.627	9
	m	a	5.707	1.497	3
		na	5.540	1.318	6
		Total	5.596	1.286	9
	Total	a	6.243	1.485	10
		na	5.307	1.288	8
		Total	5.827	1.442	18

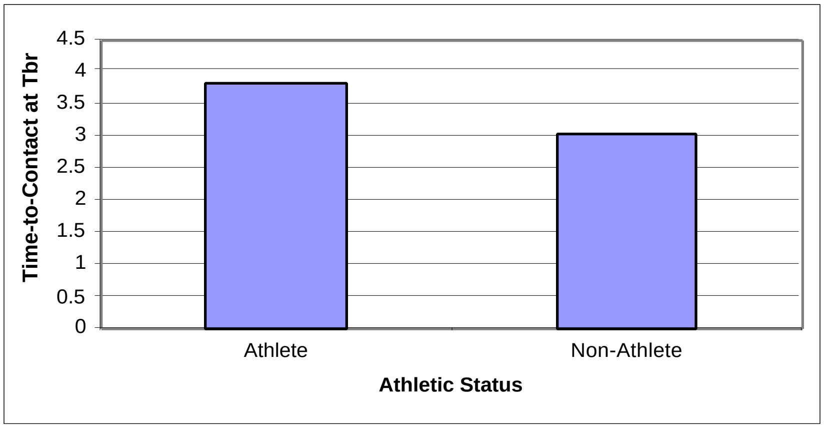

Figure 3.4. Time-to-Contact at Tbr for Athletes and Nonathletes.

Table 3.8. Descriptive Statistics for Time-to-Contact at Tbr.

	STATUS	SEX	Mean	Std. Deviation	N
TTCBR50	a	f	3.815	0.758	7
		m	4.058	1.274	6
		Total	3.927	0.990	13
	na	f	3.266	0.915	5
		m	2.953	0.664	6
		Total	3.095	0.763	11
	Total	f	3.586	0.835	12
		m	3.505	1.127	12
		Total	3.546	0.971	24
TTCBR40	a	f	3.712	1.013	7
		m	3.837	0.993	6
		Total	3.770	0.963	13
	na	f	2.923	0.643	5
		m	2.992	1.019	6
		Total	2.961	0.828	11
	Total	f	3.383	0.936	12
		m	3.414	1.056	12
		Total	3.399	0.976	24

Table 3.9. Descriptive Statistics for Time-to-Contact at Tbrmax.

	STATUS	SEX	Mean	Std. Deviation	N
TTCbrmax50	a	f	15.974	30.654	7
		m	2.721	2.100	6
		Total	9.857	22.780	13
	na	f	2.583	5.823	5
		m	1.898	1.376	6
		Total	2.209	3.826	11
	Total	f	10.395	23.925	12
		m	2.309	1.747	12
		Total	6.352	17.096	24
TTCbrmax40	a	f	5.164	3.206	7
		m	4.596	1.903	6
		Total	4.902	2.595	13
	na	f	3.039	1.515	5
		m	-3.202	13.496	6
		Total	-0.365	10.130	11
	Total	f	4.279	2.764	12
		m	0.697	10.051	12
		Total	2.488	7.437	24

CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The results of the study do not support the assertion that males and females differed significantly with respect to driving and braking performance. In addition, the data showed no inherent bias based on either gender or athletic status with respect to preferred time headway. The same was true for behaviors associated with ballistic aspects of behavior (RT, OLMT).

In spite of these findings, athletic status was an important factor in the results for TTC (length of time for the participant's car to hit the lead vehicle): TTC scores indicated a clear performance advantage for athletes over nonathletes. Despite little evidence that behavior differed (i.e., RT, CLMT, OLMT, MT, RST) by athletic status, athletes were able to achieve better (longer) TTC scores. Thus, it appeared that the advantage of athletic participation is not in the ability to behave (move limbs, react), but in the ability to produce desirable performance in context. Furthermore, some descriptive data seem to indicate that the performance gap between female athletes and female nonathletes was wider than the performance gap for their male counterparts. For example, the difference in CLMT scores between female athletes and nonathletes was four (4) times greater than the difference between male athletes and nonathletes at 50 mph (22.35 m/sec), and six (6) times greater at 40 mph (17.88 m/sec) (see Tables 3.4). Similarly, the difference in RST scores between female athletes and nonathletes was twice the difference between male athletes and nonathletes at either speed (see Table 3.6). (Note: statistical significance was never achieved, probably due to the variability of performance within groups.)

For all subjects, effects for speed in closed-loop behaviors and total response times indicated longer closed-loop movement times and response times under higher speeds, probably due to the fact that the two vehicles were farther apart at the higher speed. This is indicative of a poor driving strategy. Despite differences in distance, time-headway was kept constant, thus the longer CLMTs and RSTs under the higher speed actually reduced the separation between vehicles.

RECOMMENDATIONS

These results suggest that athletic participation does provide an advantage in certain aspects of driving performance. Furthermore, the findings indicate that sports participation has the potential to provide a significantly greater effect for females in terms of improving driving performance. These patterns of findings suggest that an important segment of the driving population—females in general, and older females in particular—could increase their ability to avoid accidents by engaging in activities such as sports that improve perceptual-motor competence. Consequently, we propose the following recommendations for both scholars and practitioners:

- Expand the sample base to include the variable sport type in future research. It may be that particular types of sports (team vs. individual; an emphasis on fine vs. gross motor skills) mediate driver competence.

- Results suggest that the gap in performance differences was greater between female athletes versus female nonathletes than it was for male athletes versus male nonathletes. Future research should control more for the physical activity/sport background of nonathletes. It may be that due to socio-cultural differences, nonathletic males have much greater participation rates in sport activities and higher levels of competition than nonathletic females. This may explain performance differences more than gender.

- Develop and implement curricular materials in driver educational programs that enhance perceptual-motor competence (e.g., hazard identification).

- Modify existing exercise programs in order to increase retention of perceptual-motor skills (e.g., hand-eye coordination tasks) for elderly drivers.

- Advocate the inclusion of perceptual-motor tasks (e.g., training for practice in unusual driving circumstances) in the license renewal procedure, particularly for novice and elderly drivers.

REFERENCES

1. Evans, L. E., Traffic Safety and the Driver, New York: Van Nostrand Reinhold, 1991.

2. Thomas, J.R., French, K.E., “Gender Differences Across Age in Motor Performance: A Meta-Analysis,” Psychological Bulletin, Vol. 98, No. 2, 1985, pp. 260-282.

3. Hancock, P.A., Manser, M.P, “Time-to-Contact: More than Tau Alone,” Ecological Psychology, Vol. 9, 1997, pp. 265-297.

4. Manser, M.P., Hancock, P.A., “Influence of Approach on Estimates of Time-to-Contact,” Ecological Psychology, Vol. 8, No. (1), 1996, pp. 71-99.

5. Allard, F., Starks, J.L., “Perception in Sport: Volleyball,” Journal of Sport Psychology, Vol. 2, 1980, pp. 22-33.

6. Borgeaud, P., Abernethy, B., “Skilled Perception in Volleyball Defense,” Journal of Sport Psychology, Vol. 9, 1987, pp. 400-406.

7. Van Winsum, W., Brouwer, W., “Time Headway in Car Following and Operational Performance During Unexpected Braking,” Perceptual and Motor Skills, Vol. 84, 1997, pp. 1247-1257.

8. Van Winsum, W., Heino, A., “Choice of Time-Headway in Car-Following and the Role of Time-to-Collision Information in Braking,” Ergonomics, Vol. 39, No. 4, 1996, pp. 579-592.

APPENDIX A

CONSENT FORM

CONSENT FORM

Investigating Differences in Driver Accident Involvement

You are invited to be in a research study investigating the human perceptual system. You were selected as a possible participant because you are between the ages of 18 and 25, and possess no apparent limitations. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Drs. Mary Jo Kane, Shelly Shaffer, and Peter Hancock of the Department of Kinesiology at the University of Minnesota.

Background Information: The purpose of this study is to determine your ability to quickly and safely navigate through various city streets. In addition, the experimenters are examining whether participant sex affects the ability to quickly react to events occurring in the environment.

Procedures: If you agree to be in this study, we would ask you to do the following things. You will be asked to be seated in a car several feet away from a curved wall. Computer-generated driving scenarios will be presented on the walls in front and behind you. The scenarios will depict a two lane, two way street in different parts of the city. You will be asked to navigate the street as quickly and safely as possible. You will have control of the gas, braking, and steering of the vehicle. We will present three practice trials to you and then present twenty experimental trials. The entire experiment will last approximately 45 minutes. If at any time during the experiment you decide not to continue for any reason, please feel free to notify the experimenter and s/he will stop the experiment.

Risks and Benefits of Being in the Study: There are no risks associated with this study. You will receive a ten dollar ($10) cash payment for your participation in this study. Payment will occur at the conclusion of the research session before you leave the Human Factors Research Laboratory. Minimum conditions which need to be met for you to receive payment is that the research session be initiated successfully and completed successfully. Successful initiation consists of either finishing the experiment completely, your terminating the experiment for any reason at any time, or by having the experimenter terminate the experiment for any reason.

Confidentiality: The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. The research records will be kept in a locked file; only the researchers will have access to the records.

Voluntary Nature of the Study: Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to withdraw at any time without affecting those relationships

Contacts and Questions: The researchers conducting this study are Drs. Mary Jo Kane, Peter Hancock and Shelly Shaffer. You may ask any questions you have now. If you have questions later, you may contact us at the Human Factors Research Laboratory, 1901 Fourth Street SE, University of Minnesota, Minneapolis, MN 55455. Phone: (612) 626-7521.

You will be given a copy of this form for your records.
The copy of this form will be attached to the debriefing packet you will receive when the experiment is finished.

Statement of Consent: I have read the above information. I have asked questions and have received answers. I consent to participate in this study.

Signature______________________________________ Date________________

Signature of Investigator__________________________ Date________________