

APPENDIX A. RESULTS OF PILOT TESTING

Table A-1. Average viewing angles

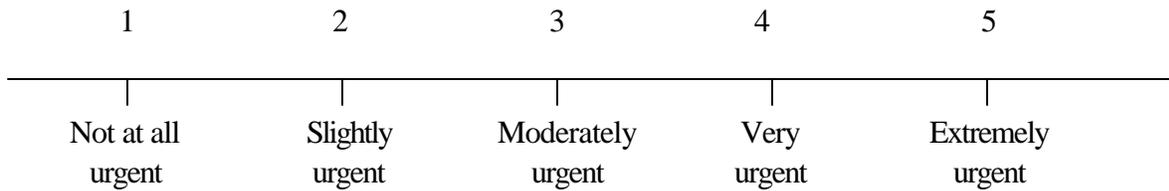
Frequency	Degrees		
	Left	Mid line	Right
1Hz	85.81	43.25	85.44
3 Hz	85.38	43.25	85.13
4Hz	85.25	40.63	84.56
7Hz	83.06	37.5	81.31

Table A-2. Average urgency ratings

Frequency	Urgency Ratings
1Hz	2.5
3 Hz	3.65
4Hz	4
7Hz	4.5

Figure A-1. Urgency rating scale

How urgent does this signal appear?



APPENDIX B. POST DRIVE QUESTIONNAIRE FOR SUBJECTS EXPOSED TO THE STROBE CONDITION

**VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Virginia Tech Transportation Institute**

Post-Drive Questionnaire (STP)

This questionnaire is designed to find out how you and others feel about the experiment. The information that you provide will help researchers to better understand how people feel about the concept of a strobe as a warning signal. To ensure that this questionnaire is useful, it is important that you answer honestly. There are no right or wrong answers to these questions and your responses to these questions will be treated with anonymity.

Participant number _____

Date/Time _____

1. Which of the following statements best describes your feelings?

- A. I felt very endangered throughout the experiment
- B. I felt very endangered at certain points in the experiment
- C. I felt slight endangerment throughout the experiment
- D. I felt slight endangerment at certain points in the experiment
- E. I felt no danger at all throughout the experiment

If you felt that your safety was endangered, how would you change the experiment to better facilitate safety?

2. When you first saw the stopped vehicle, describe your reaction in as much detail as possible (When did you decide to react? What did you do to try and avoid a collision?)

3. When you tried to avoid the stopped vehicle, how realistic was your reaction? (Did you react as you would have reacted in an actual traffic situation?)

1.	2.	3.	4.	5.
Not at all realistic	Slightly realistic	Moderately realistic	Very realistic	Extremely realistic

Please explain your answer

4. If you felt your reaction was not realistic, what would you have done differently? (for example, reacted earlier or later, swerved instead of braked, or braked instead of swerved)

5. On a scale of 1-5, how distracted were you immediately prior to the presentation of the stopped vehicle?

1.	2.	3.	4.	5.
Not at all distracted	Slightly distracted	Moderately distracted	Very distracted	Extremely distracted

6. What factors do you feel contributed to your level of distraction?

7. What first alerted you to the presence of the stopped vehicle?

8. Have you experienced strobe lights before in transportation? (e.g. traffic lights, on signs, vehicles) Briefly explain where you have seen them, if at all.

9. Which statement best describes how frequently you have seen strobe signals during driving?

- A. Very Frequently, every day
- B. Frequently, more than once a week
- C. Infrequently, a few times per month
- D. Very infrequently, a few times per year

10. When you experience strobe signs in transportation, in general what message do you think is conveyed by this type of signal?

11. The purpose of the strobe is to alert drivers to the presence of a vehicle at a dangerously unsafe distance up ahead. Is this how you perceived the signal?

12. How effective would you rate the strobe, as an imminent rear warning signal?

1.	2.	3.	4.	5.
Not at all effective	Slightly effective	Moderately effective	Very effective	Extremely effective

13. What one word would best describe your reaction when you first saw the strobe?

14. How surprised were you at seeing the stopped vehicle?

1.	2.	3.	4.	5.
Not at all surprised	Slightly Surprised	Moderately surprised	Very surprised	Extremely surprised

15. Do you have any comments or suggestions on how the design of the imminent rear warning signal could be made more effective?

If so, please describe the changes you would make to one or more of the following

Flash rate _____

Intensity _____

Signal size _____

Signal color _____

Location (where on the vehicle do you think is the best position to locate the signal?) If you have any suggestions, mark on the photograph below where you think is the best positioning for the signal)



15. If you have any other comments or ideas about the usefulness of a strobe as a rear warning signal, please feel free to describe them here

Thank you very much for your help. Have a great day!

**APPENDIX C. POST DRIVE QUESTIONNAIRE FOR SUBJECTS EXPOSED TO THE
NO STROBE CONDITION**

**VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Virginia Tech Transportation Institute**

Post-Drive Questionnaire (STNP)

This questionnaire is designed to find out how you and others feel about the experiment. The information that you provide will help researchers to better understand how people feel about the concept of a strobe as a warning signal. To ensure that this questionnaire is useful, it is important that you answer honestly. There are no right or wrong answers to these questions and your responses to these questions will be treated with anonymity.

Participant number _____

Date/Time _____

1. Which of the following statements best describes your feelings?

- A. I felt very endangered throughout the experiment
- B. I felt very endangered at certain points in the experiment
- C. I felt slight endangerment throughout the experiment
- D. I felt slight endangerment at certain points in the experiment
- E. I felt no danger at all throughout the experiment

If you felt that your safety was endangered, how would you change the experiment to better facilitate safety?

2. When you first saw the stopped vehicle, describe your reaction in as much detail as possible (When did you decide to react? What did you do to try and avoid a collision?)

3. When you tried to avoid the stopped vehicle, how realistic was your reaction? (Did you react as you would have reacted in an actual traffic situation?)

1.	2.	3.	4.	5.
Not at all realistic	Slightly realistic	Moderately realistic	Very realistic	Extremely realistic

Please explain your answer

4. If you felt your reaction was not realistic, what would you have done differently? (for example, reacted earlier or later, swerved instead of braked, or braked instead of swerved)

5. On a scale of 1-5, how distracted were you immediately prior to the presentation of the stopped vehicle?

1.	2.	3.	4.	5.
Not at all distracted	Slightly distracted	Moderately distracted	Very distracted	Extremely distracted

6. What factors do you feel contributed to your level of distraction?

7. What first alerted you to the presence of the stopped vehicle?

8. Do you think that some kind of warning alerting you to the presence of the stopped vehicle would have changed your reaction? Explain.

9. Have you experienced strobe lights before in transportation? (e.g. traffic lights, on signs, vehicles) Briefly explain where you have seen them, if at all.

10. Which statement best describes how frequently you have seen strobe signals during driving?

- A. Very Frequently, every day
- B. Frequently, more than once a week
- C. Infrequently, a few times per month
- D. Very infrequently, a few times per year

11. When you experience strobe signs in transportation, in general what message do you think is conveyed by this type of signal?

12. What one word would best describe your reaction when you first saw the stopped vehicle

13. How surprised were you at seeing the stopped vehicle?

1.	2.	3.	4.	5.
Not at all surprised	Slightly Surprised	Moderately surprised	Very surprised	Extremely surprised

14. Do you have any comments or suggestions on how the design of an imminent rear warning signal would look if it were to be effective?

If so, please describe the design recommendations you would make

Flash rate _____

Intensity _____

Signal size _____

Signal color _____

Location (where on the vehicle do you think is the best position to locate the signal?) If you have any suggestions, mark on the photograph below where you think is the best positioning for the signal)



14. If you have any other comments or ideas about the usefulness of a rear warning signal, please feel free to describe them here

Thank you very much for your help. Have a great day!

APPENDIX D. POWER ANALYSIS

Predicted Mean (baseline) = 1.5 seconds, Lerner (1993).

Predicted Mean (treatment) = 1.2 seconds, Sivak et al., (1982).

Standard Deviation = 0.4 seconds.

α (probability of Type 1 error) = 0.1

β (probability of Type 2 error) = 0.2

Sample sizes for testing $H_0: \mu_1 - \mu_2 = D_0$, Independent samples.

$$n = 2\sigma^2 \frac{(Z_{\alpha} + Z_{\beta})^2}{\Delta^2};$$

$$n = 2 \times 0.4^2 \frac{(1.28 + 0.84)^2}{(0.3)^2};$$

$n = 15.98$; therefore use a minimum of 16 subjects in each condition

$16 \times 2 = 32$ participants in total.

APPENDIX E. DEMOGRAPHIC AND HEALTH SCREENING QUESTIONNAIRE

**VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Virginia Tech Transportation Institute**

Driver Screening and Demographic Questionnaire

Note to Researcher:

Initial contact between drivers and researchers may take place over the phone. If this is the case, read the following Introductory Statement, followed by the questionnaire. Regardless of how contact is made, this questionnaire must be administered before a decision is made regarding suitability for this study.

Introductory Statement:

Use the following script as a guideline in the screening interview.

Hello, my name is Lisa Schreiner and I'm a researcher with Virginia Tech's Transportation Institute in Blacksburg, VA could I speak with _____. I understand you may be interested in participating in one of our driving studies. We are currently running an on-road study investigating driver's perceptions and behavior while driving at various car-following distances. This study will involve you driving a car along a closed test track. The entire experiment should last approximately 60 minutes. Does this sound like something you may want to do?

If they say no, ask them if they would like us to keep them on the potential driver list for future studies.

If they say yes continue

First, to see if you are eligible to take part, I would like to ask you several questions, it will only take 5 minutes of your time.

Questions

1. Do you have a valid driver's license? (*Exclude if no*)

Yes _____ No _____

2. Have you participated in one of our studies before? If yes ask them what this study was about and when it occurred. (*Exclude if they have taken part in a similar study*)

3. How often do you drive each week?

Every day _____ At least 2 times a week _____ Less than 2 times a week _____

4. Approximately how many miles do you drive annually? _____

5. How old are you? _____

6. Gender? _____

7. How tall are you? _____

8. How much do you weigh? _____

9. How long have you held your drivers' license? _____

10. What type of car do you currently drive? _____

11. Are you able to drive an automatic transmission without special equipment?

Yes _____ No _____

12. Have you had any moving violations in the past 3 years?

Yes _____ No _____

If so, please explain

13. Have you been involved in any accidents within the past 3 years?

Yes _____ No _____

If so, please explain

Because of pre-existing health conditions some people are not eligible for participation in this study. I need to ask you several health-related questions before you can be scheduled for a study session. Your response is voluntary and all responses are treated with anonymity.

Do you have a history of any of the following?.

- Do you suffer from a heart condition such as disturbance of the heart rhythm or the experience of a heart attack? If yes, please describe.

(Exclude if there has been a heart attack within the past 6 months, or if there is a history of ventricular flutter or fibrillation, or systole requiring cardioversion. Potential participants with atrial fibrillation may be acceptable, given that their heart rhythm is now stable following medical treatment or pacemaker implants.)

- Have you suffered brain damage from a stroke, tumor, head injury, or infection? If yes, what are the resulting effects? Do you have visual loss, blurring or double vision; weakness, numbness or funny feelings in the arms, legs or face; trouble swallowing, slurred speech; no coordination or loss of control; trouble walking; trouble thinking, remembering, talking or understanding?

(Exclude if there has been a stroke within the past 3 months, there is an active tumor, or if there are lingering effects.)

- Have you been diagnosed with a serious or terminal illness? If yes, is the condition still active? Are there any lingering effects? If yes do you care to describe?

(Exclude if there is any current serious condition)

- Have you ever been diagnosed with seizures or epilepsy? If yes, how frequently and what type?

(Exclude if there has been a seizure within the past 2 months)

- Do you suffer from a respiratory disorder such as asthma or chronic bronchitis? If yes, please describe.

(Exclude if disorder results in obvious or continuous shortness of breath or if the participant requires chronic medical therapy such as theophylline, inhalers, steroid medications, and especially oxygen therapy.)

- Do you suffer from motion sickness? If yes on what mode of transportation and what are the conditions (e.g. rough sea, back seat, etc.) What symptoms did you experience? How old were you when this occurred?

(Exclude if sickness occurs often, occurs to mild to moderate conditions, or results in severe symptoms.)

- Do you suffer from inner ear, dizziness, vertigo or balance problems? If yes please describe. Do you have maniere's disease?

(Exclude if there is any recent history of inner ear, dizziness, vertigo or balance problems)

- Do you have diabetes? Have you been diagnosed with hypoglycemia? If yes, do you take insulin or any other medication for blood sugar?

(Exclude if insulin is taken)

- Do you have migraine or tension headaches? How often and when was the last headache? Are you currently taking medication for these headaches? If so, what are you taking?

(Exclude if headaches are chronic or if they are taking regular medication for migraine)

- Are you currently taking any medications on a regular basis?

(Exclude if medication is for motion sickness, psychiatric disorder, or any other conditions mentioned above that indicates a problem mentioned above that may have been incorrectly denied previously).

- Are you or is there a possibility that you are currently pregnant?

(Exclude if there is a possibility of pregnancy)

- Do you have normal or corrected to normal hearing and vision?

Yes _____ No _____

If yes, please explain.

I would like to take your phone number or phone numbers where you can be reached and hours/days when it's best to reach you.

Name _____

Phone Numbers _____

Best Time to Call _____

If the participant is eligible schedule and state the following

You will have the following responsibilities:

- 1) To be physically free from any illegal substances (alcohol, drugs, etc.) while driving.
- 2) To be free of any medication that might cause drowsiness 24 hours prior to the test
- 3) To follow the experimental procedures as well as you can
- 4) To inform the experimenter if you incur difficulties of any type.

Summary Criteria For Participation:

Must hold a valid driver's license.

Have at least 2 years driving experience.

Must be 25-30, or over 60 years of age.

Must drive at least 2 times a week.

Cannot have 2 or more moving violations within the past 12 months.

Cannot have any at fault accidents involving injuries within the past 2 years.

Must have normal (or corrected to normal) hearing and vision.

Must be able to drive an automatic transmission without special equipment.

Cannot have a history of heart condition or prior heart attack, lingering effects of brain damage from stroke, tumor, head injury, or infection, epileptic seizures within 12 months, respiratory disorders, motion sickness, inner ear problems, dizziness, vertigo, balance problems, diabetes for which insulin is required, chronic migraine or tension headaches.

Must not be pregnant.

Cannot currently be taking any substances that may interfere with driving ability (cause drowsiness or impair motor abilities).

5. Are you taking any drugs of any kind other than the ones listed above?

YES

NO

If so please list other drugs currently being taken

6. Are you pregnant?

YES

NO

7. Have you ever had whiplash?

YES

NO

8. Have you ever suffered from a concussion?

YES

NO

If so, how many and how did they happen?

Signature _____

Date _____

APPENDIX G. INFORMED CONSENT FORM

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Virginia Tech Transportation Institute

Informed Consent for Participants of Investigative Projects

<u>Title of Project:</u>	An Investigation of Comfort Ratings at Specified Headway Distances.
<u>Principal Investigators:</u>	Dr. T. A. Dingus, Professor, ISE; Director of the Virginia Tech Transportation Institute Dr. S. E. Lee, Research Scientist, Virginia Tech Transportation Institute Lisa Schreiner, Graduate Research Assistant, ISE
<u>Faculty Advisor:</u>	Dr. T. A. Dingus, Professor, ISE; Director of the Virginia Tech Transportation Institute

I. The Purpose of the Research/Project

You are invited to participate in a study designed to evaluate comfort levels experienced while following a vehicle at various distances. The experiment will take place at the Smart Road (a controlled, closed driving environment) at the Virginia Tech Transportation Institute. There are 32 participants of various ages, who are expected to take part in this study.

II. Procedures

You will be driving, with an experimenter beside you, on a closed, controlled road for approximately an hour. While you are driving, you will be asked to maintain a certain distance from the vehicle in front by monitoring a "headway detection display" (mounted on the dash). This display receives information from a sensor installed on the front bumper of your vehicle and provides you with information concerning the distance between you and the vehicle in front. You will be asked to maintain a set of "headways" and asked every five minutes how comfortable you feel following the vehicle in front at that distance. Throughout the course, the lead vehicle may change lanes every so often, when this happens you will be expected to remain in your own lane. This is needed to reconfigure the equipment and maintain a realistic driving environment, but please maintain a speed as close as possible to 25 miles per hour while continuing to follow the vehicle in the front. The session is expected to last approximately one hour. You will then be paid for your participation.

This experiment will consist of five experimental stages:

1. Introductory stage

This stage consists of preliminaries. You will be asked to read the informed consent form. Once you have signed this form, a simple vision test will be given and we will also ask to see your driver's license. Once you have completed this stage we will go on to stage 2.

2. Familiarization with the test vehicle

While the instrumented vehicle is parked you will be shown how to operate the vehicle (for example, lights, mirror adjustments, windshield wipers, etc.) as this may be different from your personal vehicle. You will then be asked to set each control to optimize your comfort and driving performance. The headway display will be shown and explained to you as well as the

method and timing of experimenter questions about your comfort ratings. This stage should take approximately 10 minutes.

3. Familiarization with experimental conditions

You will be asked to drive around the test track once or twice while following the lead vehicle so that you get used to maintaining a headway distance as the vehicle in front makes lane changes. Only when you are comfortable with the conditions of the experiment will the experiment begin.

4. Driving the test track

As you follow the vehicle in front maintaining a speed of 25 mph and a required headway distance, you will be asked about your comfort rating at that distance every 5 minutes. During the course of driving the test track you will be asked to drive at various "headway distances" from the vehicle ahead. Also expect lane changes from the vehicle in front every now and then. Detailed instructions on your car following task will be provided by the experimenter, after you have acclimatized to driving the vehicle.

5. Debriefing and Payment

After completing the experiment, you will be asked your opinion about the usefulness of the headway display and your comfort levels at the range of distances from the lead vehicle. You will then be paid for your participation. It is expected that the complete session will last approximately 1 hour.

III. Risks

The tests described here are believed to pose no more than minimal risk to your health or well-being. In order to minimize any risks associated with driving around the test track, you will be required to maintain a low speed of 25 miles per hour throughout the session. If at any point in the session the experimenter believes that continuing the session would endanger you or the equipment, she will stop the testing.

IV. Benefits of the Project

Your participation in this study will provide useful information about car-following behavior and comfort. While there are no direct benefits of participating in this study (apart from payment) you may find the experiment interesting. No guarantee of benefits has been made to encourage you to participate. To avoid biasing other potential participants however, you are requested not to discuss this study with anyone for at least 8 months after participation.

V. Extent of Anonymity and Confidentiality

The results obtained from this study will be kept completely anonymous. Your name will not appear on data derived from your session. Only a number will differentiate your data from others who take part in the study. This number, and not your name, will also be used in subsequent data analyses and reports.

VI. Compensation

You will be paid \$25 to compensate for the time that you spend participating in this study.

VII. Freedom to Withdraw

You are free to withdraw at any time without penalty. If you choose to withdraw from this study you will be compensated for your time up until that point.

VIII. Approval of Research

This research project has been approved by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University.

IX. Participant's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

- 1) I should not participate in this study if I do not have a valid driver's license or if I am not in good health.
- 2) I should notify the experimenter at any time if I do not want to continue my participation.
- 3) I should operate the instrumented vehicle in a safe and responsible manner.
- 4) I should answer all questions truthfully.

X. Participant's Permission

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

Signature	Date
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Should I have any questions about this research project or its conduct, I may contact:

Lisa Cooper, Experimenter 231-1521	Dr. Thomas A. Dingus, Principal Investigator 231-1502
Tom Hurd, Director of Sponsored Programs	231-5281

APPENDIX H. INSTRUCTIONS

You will be driving, with an experimenter beside you, on a closed, controlled road for approximately an hour. While you are driving, you will be asked to maintain a certain distance from the vehicle in front by monitoring this "headway detection display" (show display mounted on the dash). This display receives information from a sensor installed on the front bumper of your vehicle and provides you with information concerning the distance between you and the vehicle in front. It is very important that you try and remain centered behind the vehicle in front so that the display provides an accurate reading.

You will be asked to maintain a number of set distances from the vehicle in front with the aid of this display, for example, 72 feet, 48 feet etc (I will indicate to you when you should change this distance). Try as much as possible to maintain this distance within a 4-foot range above or below this distance (e.g. if you are asked to maintain a distance of 72 feet from the vehicle in front, try and keep the distance within a range of 68 – 76 feet)

As you go round the Smart Road you will also be asked every so often how comfortable you feel following the vehicle in front at that distance (show comfort scale). A rating of 1 indicates that you feel very uncomfortable with your distance behind the van, whereas a rating of 5 indicates that you feel very comfortable with your distance from the vehicle in front. (Read the ratings and associated meanings of 2, 3, 4.)

Throughout the course, the lead vehicle may change lanes every so often. This is needed to reconfigure the equipment and maintain a realistic driving environment. Also to enable us to maintain a speed of 25 miles per hour on the straight portions of the road (for safety reasons), we will ask that you change gear from "drive" to second at certain points on the road. I will remind you during the session when you need to do this.

The session is expected to last approximately one hour. You will then be paid for your participation.

Note to experimenter:

1. Ensure the driver has seat belts buckled
2. Ensure driver has headrest in position
3. Ensure that the driver has all mirrors positioned in appropriate places
4. Ensure the driver is comfortable
5. Go on 1 practice circuit, then if the driver feels comfortable begin the experiment

APPENDIX I. DRIVER'S COMFORT RATING SCALE

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY Virginia Tech Transportation Institute

Driver's Comfort Rating Scale

The participant is asked every 3 minutes how they rate their comfort at the required following distance. The participant is asked to provide feedback in the form of a five point rating scale, as follows:

1	2	3	4	5
Very Uncomfortable	Uncomfortable	Neither Comfortable nor Uncomfortable	Comfortable	Very Comfortable

A rating of 1 means that the participant is very uncomfortable driving at a particular following distance to the vehicle in front. A rating of 3 means that the participant is neither comfortable or uncomfortable driving at a particular following distance and 5 indicates that the participant is very comfortable following at this distance. Subjects may use any number from 1-5 to describe their comfort levels.

APPENDIX J. DEBRIEFING AND NEW INFORMED CONSENT

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY:

Virginia Tech Transportation Institute (ISE)

Debriefing and Informed Consent for Participants of Investigative Projects

Title of the Project: An Investigation of the Effectiveness of a Strobe Light as an Imminent Rear Warning Signal

Investigators: Dr. T.A Dingus, Dr. S. E. Lee, Lisa Schreiner

The Purpose of this Research

The true purpose of this research is to evaluate an imminent rear warning signal. To do this, we needed to ensure that you did not expect a situation where you had to brake suddenly. If you expected to brake at any moment this would have affected your reaction to the situation. There was no “correct” or “incorrect” information in the data that you provided. We needed to compare your response to others who (were/were not) presented with a warning signal. All precautions were taken to ensure your complete safety throughout this session and during the presentation of the scenario. We would like to thank you for your participation in this study, as the results may contribute to future improvements of rear signaling and collision avoidance systems. We would also like to ask that you do not talk about the details of this study to others for at least 8 months after your participation as this may invalidate future data that may be collected.

We again assure you that all data will be treated with complete confidentiality. Shortly after participating, your name will be separated from the data. A coding scheme will be employed to identify the data by subject number only (e.g., Subject No. 3).

I hereby acknowledge the above and give my voluntary consent for my data to be used in this project.

Participant's Signature

Date