Department of Transportation
National Highway Traffic Safety Administration
Supporting Statements: Part B
Distraction: Portable Electronic Device Interfaces
OMB Control Number: 2127- (New or assigned number)

Abstract:

The National Highway Traffic Safety Administration (NHTSA) is proposing a new information collection consisting of a single, one-time experimental research study that involves voluntary participation from members of the public. The purpose of this research is to evaluate how safely drivers can interact with smartphone integration systems that allow access to smartphone applications through the vehicle's built-in display screen. Data collection will occur in two parts. Part I consists of an evaluation method called an "occlusion study" at Westat facilities in the Washington D.C. area (n =56). Part II consists of a closed-course track (CCT) evaluation conducted at Utah Motorsports Campus near Salt Lake City (n=72). The primary characteristic of eligible participants is the use of Android Auto (AA) or Apple CarPlay (ACP) while driving. Data collected will include eye tracking measurements, vehicle performance metrics, task completion times, error rates, and participant demographics. The collected information will be analyzed by Westat and Red Scientific on behalf of NHTSA, with summarized findings provided to NHTSA through detailed research reports. The study procedures will be reviewed and approved by the Westat Institutional Review Board (IRB) before any data collection begins.

Part I will follow the procedures for occlusion testing as outlined in the 2013 NHTSA Driver Distraction Guidelines for Task Acceptance Testing and will take place in stationary vehicles. In this part, 24 participants per system (across up to 3 vehicles, for a total of up to 56 participants, in a mixed-factorial design) will perform 6-9 standardized non-driving tasks (e.g., entering a destination in GPS, placing a food order using an app, finding a specific playlist) while wearing occlusion goggles, which are special electronic goggles that mimic on-road and off-road glances.

In Part II, a closed-course track (CCT) evaluation will be conducted at the Utah Motorsports Campus near Salt Lake City with 72 participants. In this part, 24 participants per system will perform a subset of standardized tasks from Part I, while operating vehicles equipped with Android Auto, Apple CarPlay, and original equipment manufacturer interfaces on a 0.84-mile track. Objective measures of driving performance – including eye-tracking data, vehicle kinematics, and task completion times – will be collected to quantify the impact of each interface on driver workload and safety. This real-world driving component will allow for validation of the findings from the controlled occlusion testing and provide critical insights into the potential for distraction and impaired driving performance during typical on-road scenarios.

Data collection will begin after receiving approval of this ICR and will be performed as needed to obtain the target number of valid participants. A literature review and technology scan report, as well as a final report will also be conducted as part of this project and details of the findings provided to NHTSA, with eventual publication in the National Transportation Library for public access. The final report will consist of the critical information gathered from the literature review and technology scan, as well as the methods, results, and implications of this information collection. The overall intent of this report will share information as to whether these interfaces meet NHTSA's guidelines for minimizing driver distraction and their effects on driving safety.

B. JUSTIFICATION

B.1 Describe the potential respondent universe and any sampling or other respondent selection to be used.

No statistical methods will be used in selecting study participants. The respondent universe consists of the average U.S. driver who regularly uses Android Auto or Apple CarPlay and can safely follow the study protocol. Participants will be recruited from the Washington, D.C. area for Part I and the Salt Lake City, Utah area for Part II with demographic characteristics balanced among groups. Part II will have more study restrictions due to the CCT study design to ensure participant and researcher safety. To participate individuals must meet the following criteria for both studies:

1. Must be at least 18 years old for Part I and 21 years old for Part II
2. Regularly use either Android Auto (AA) or Apple CarPlay (ACP) when driving
3. Do not regularly drive one of the vehicles chosen for testing
4. Have a valid driver's license
5. Drive at least 3000 miles per year
6. Have normal or corrected-to-normal vision
7. Have normal or corrected-to-normal hearing
8. Fluent in reading and speaking in English
9. Be in general good health

Additional Requirements for Part II:

10. The ability to abstain from alcohol, marijuana, and illicit substances for the 12 hours prior to session
11. No use of sedative or psychotropic medications (antidepressants, anti-anxiety medications, stimulants, antipsychotics, or mood stabilizers)
12. Have no more than two at-fault accidents in the past 2 years
13. Do not wear corrective lenses while driving (contacts are allowed)
14. Do not require the assistance of special driving equipment
15. No medical conditions that might impact driving (i.e., heart condition, back or neck pain, recent back or neck pain treatment, disorders, disability or seizures)
16. No false eyelashes or mascara.

For Part I, participants will be recruited through Westat intranet and social media posts as needed. We are targeting 56 participants and apply a 5% attrition rate to ensure enough participants are recruited, resulting in 59 participants being scheduled for a session. For Part II, we are targeting 72 participants on a closed course track (CCT). Due to the cost of renting track time, we will utilize an overbooking strategy, where 144 participants are recruited, and 2 participants are scheduled for the same track time. If both participants arrive, one participant is

compensated and sent home. We utilize this strategy because it is cheaper to recruit an additional 72 participants than to miss even one test track session. Additionally, we will follow the recruiting criteria outlined in the NHTSA Visual-Manual Driver Distraction Guidelines to ensure a representative population of the U.S. driving population is recruited.

B.2 Describe the procedures for the collection of information.

Part I (Occlusion Study) Protocol

Part I of this research, referred to as Occlusion Testing, is a new information collection request to evaluate how smartphone mirroring interfaces, namely Android Auto (AA) and Apple CarPlay (ACP) compare with legacy Original Equipment Manufacturer (OEM) vehicle interfaces in terms of driver distraction. This study will follow the protocol for Occlusion Testing outlined in the NHTSA Visual-Manual Driver Distraction Guidelines as well as the referenced International Standard ISO 16673:2007(E) for Occlusion Testing. NHTSA Visual-Manual Driver Distraction guidelines specify there must be 5 trials per task.

Introduction and Familiarization: Upon arrival, participants of Part I will be consented for the study. The experimenter will then explain how many tasks the participant will complete (e.g., 7 tasks, 8 tasks) based on the systems (AA + OEM, ACP + OEM, OEMs only) they will be using. They will also be told to perform five replications of each task for each of the systems they will be assessing. The order of the systems and tasks will be counterbalanced. Then, the participants and experimenter will sit in the pre-selected vehicle. Participants will be instructed to adjust the seat to a comfortable position and fasten their seatbelt.

Occlusion Goggle Training: Next, participants will complete training using the occlusion goggles. The researcher will introduce the occlusion goggles and demonstrate how they work. While holding the goggles, the researcher will activate them and show the participant what they look like from an observer's and user's perspective. This explanation will include how the goggles mimic visual behavior while driving. The open periods represent glances toward a device they interact with, and the closed periods represent glances toward the roadway when they cannot see the device. The participant will put on the goggles to experience the goggles' opening and closing. The experimenter will answer any questions as the goggles are active and will ask the participant to state when they are comfortable with the operation of the goggles and are ready to move on.

Study Protocol and Procedures: Before participants complete the tasks, the experimenter will provide a general overview of the protocol, where participants will be trained on how to perform a task and then will be asked to complete the task with the occlusion goggles on. The experimenter will also explain that for each task, they will verbally provide the task instructions and the target (e.g., song title, POI, etc.) and that the target will also be displayed near the interface that will be used to assist with recall.

The experimenter will provide these instructions verbally to the participants and then request that the participants verbally state when they are ready for the task to begin. The experimenter will also inform the participants that they can request that the task instructions be repeated as many times as necessary. The task instructions will be provided while the goggles are closed, and the task will begin once the participant verbally states, “I am ready.” The experimenter will start the goggles, opening, and closing until the participant completes the task. The participants will be instructed to verbally state “Done” when the task is successfully completed. This will trigger the experimenter to stop the cycling of the goggles. The participants will also be told that the trial will be considered invalid and removed if they say they are done when they are not. The researcher will also explain the reasons for a trial being deemed invalid. These reasons are:

- Refusal to complete a trial
- Stating a trial is done when it is not
- Not able to successfully complete a trial, judged by the experimenter
- Not attempting to perform the trial as instructed
- An error is made

After explaining the overall protocol, the experimenter will provide a brief overview of the interface, showing the starting point for the task and general interface layout. Next, the experimenter will demonstrate the protocol through a practice task, where the experimenter will provide a task prompt and demonstrate the tasks before having the participant perform the task without the occlusion goggles and then with the occlusion goggles.

Pretraining Task Error Documentation: Before task training, participants will attempt to perform each task once before the occlusion training. These trials will be used to evaluate errors and the recovery steps; thus, the participant will not receive feedback. Since the participants will still need to be trained on the tasks, it is more likely that errors will occur during this period before training. These tasks will also be video recorded so, if necessary, the recordings can be used to verify or complete documentation of any errors.

Test Trials: The occlusion evaluation procedure includes task training, followed by the test trials. Each portion of the procedure is outlined in the sections below.

Comprehensive training will be provided for each task performed across each interface. Without the goggles, the experimenter will demonstrate how each task is performed while explaining each step. The experimenter will answer any questions posed by the participant. The participant will then be allowed to practice the same task as many times as needed to become proficient and comfortable performing the task. They will be instructed to state when they are comfortable performing the task. Once the participant states that they are comfortable with the task, the occlusion goggles will be provided so they can practice while the occlusion goggles are active. The researcher will disinfect the goggles between each participant and whenever a participant requests to do so. The experimenter will “close” the goggles, provide the task instructions, and ask if the participant is ready to perform the task. Once the participant indicates that they are

prepared, the experimenter will activate the occlusion goggles. The goggles will cycle until the participant indicates the task is complete. The experimenter will then reset the device being evaluated and the goggles. The participant will be prompted to continue practicing until ready to move to the test trial. Once the participant states that they are prepared and have successfully completed the practice task at least two times with the occlusion goggles on, the test trials will begin.

Participants will perform five replications for each task, as outlined in the NHTSA Distraction Guidelines (NHTSA, 2013). The replications within each task will have the same instructions, but each will have different targets to select (e.g., select the same artist and album but select a different song). The participant will be requested to put the goggles on if they are not already on, and the experimenter will close the goggles. The experimenter will place a label with the target identified adjacent to the interface being evaluated. The experimenter will then read the task instructions to the participant. Once the participant states "Ready," the experimenter will start the goggles and watch as the participant performs the task. The experimenter will not interject or coach the participant during their performance, but guidance will be provided after the task is completed if errors are performed. The experimenter will stop the goggles once the participant states they are "Done" with the task. The goggles will stop in the open state. This sequence will continue until the necessary replications for a task are completed. At this point, the training on the next task will begin. Participants will complete all tasks across the system before moving onto another system.

Debriefing: After completing all tasks across each assigned system, participants will receive an honorarium of $120.

Part II (Closed Course Track Study) Protocol

Part II is a closed-course track (CCT) performance evaluation designed to quantify the safety-relevant impacts of using interface applications while driving. The study examines a subset of tasks and vehicles identified in the occlusion study, focusing on metrics related to visual attention and cognitive workload. Each experimental session will last 3.5 hours, with an additional 10-minute buffer period. Participants will evaluate three interfaces (OEM, AA, and ACP) while performing four standardized tasks. Interface presentation will follow a Latin square counterbalancing design, creating six possible sequences distributed evenly across participants. Task order within each interface block will also be counterbalanced to control for learning effects.

Introduction: The session begins at the staging area. Upon arrival, participants will receive a comprehensive introduction to the research team and study overview. The researcher will provide a detailed explanation of the study's purpose and structure, emphasizing that participants will evaluate different in-vehicle interfaces while driving along the CCT. Following this introduction, participants will review and sign informed consent documents that will detail their

rights as research participants, potential risks and benefits, confidentiality protections, and compensation arrangements. A comprehensive safety briefing will follow, covering terms of participation, safe driving speeds, proper equipment handling, emergency procedures, communication protocols, and the right to discontinue participation. During this period, participants will be fitted with the eye tracking equipment and tactile detection response task (TDRT) setup, including tactile motor and response switch placement. All data collection systems will undergo thorough calibration during this phase.

Familiarization Drive: Before beginning any tasks, participants will first undergo route familiarization. From the passenger seat, the researcher will guide participants, as they operate the vehicle, through a complete familiarization drive of the 0.84-mile route in both directions. This practice drive will serve multiple crucial purposes: participants will become comfortable with the test vehicle's handling characteristics, establish appropriate traveling speeds, identify safe areas for task initiation, and understand CCT safety considerations. The researcher will demonstrate proper driving procedures, and when and where to stop. Only after participants demonstrate comfortable handling of the vehicle and route familiarity will they proceed to the experimental tasks.

Interface Orientation and Task Training: After the familiarization drive, participants will receive approximately 10 minutes of interface orientation, encompassing interface introduction, basic navigation training, and general practice. The remaining 40 minutes will be divided into four 10-minute task completion segments. Each task segment will begin with task-specific training while the vehicle is parked in the staging area. The researcher will provide detailed instruction and practice opportunities using practice tasks that will mirror the structure of those evaluated in the occlusion study, but with different specific targets. For instance, if the task set includes music selection tasks, participants might practice with sequences like selecting a favorites playlist and playing the third song, changing to FM radio station 98.7, and returning to the playlist to skip forward two songs. Participants will learn to indicate task initiation with "starting" and completion with "done." To ensure proficiency, participants will need to successfully complete three consecutive practice tasks without error and verbally confirm their comfort before proceeding to the driving portion. The four tasks will be finalized near the start of the study due to the rapidly changing capabilities of both AA and ACP but may include setting a navigation destination, text messaging, playing a music playlist and viewing a calendar event. All tasks will be counterbalanced.

Task Data Collection Drives: Once trained to proficiency, participants will drive a single leg of the course during which time they will be asked to complete variations of the trained task. Exemplary tasks will be completed sequentially while participants drive the route segment with new task variations being provided as each variation is completed.

Participants will complete the NASA-TLX after each task for the OEM, ACP, and AA interfaces. Thus, the TLX will be administered 12 times, 4 times per interface. This will allow us to gain insight into workload. The NASA-TLX will be administered while the vehicle is parked and just after each set of tasks are completed, ensuring that ratings reflect the workload experienced in the just-completed set of tasks.

This second block (ACP) will maintain identical formatting to the first block, beginning with 10 minutes of training followed by the same four 10-minute task/study drive segments. All training procedures, practice requirements, and in-vehicle protocols will remain consistent with the previous block to ensure comparative data quality. Following completion of the ACP tasks, participants will again complete the NASA-TLX assessment before instructions for the next interface are given.

This final interface block (AA) will follow the same format as the previous two, with 10 minutes of interface orientation and four 10-minute task segments. All procedures, timings, and protocols will remain consistent across all three interface blocks to maintain experimental control and data compatibility. At the end of the AA tasks, participants will again complete the NASA-TLX before any subsequent instructions or activities, ensuring that each set of tasks is followed by a workload assessment.

Debriefing: A final debriefing will allow participants to ask any final questions and researchers will verify that all data from the Red Scientific logger, eye tracking system, TDRT, and critical event response task has been properly recorded and stored. The session will conclude with participant compensation of $120.

A buffer will be built into the schedule to accommodate task completion variance, transition periods, unexpected delays, and additional breaks as needed. This buffer will ensure that timing delays in one session do not cascade into subsequent sessions.

B.3 Describe methods to maximize response rates.

Participation in the study is voluntary. Response rates will be maximized by initially contacting only individuals who have previously expressed interest in driving research. Respondents will receive no payment or gift for completion of the online eligibility questionnaire. Depending on whether participants are recruited for Part I or Part II, participants will receive a competitive honorarium that encourages participation without becoming coercive. Participant time will be compensated based on an hourly rate. Once scheduled, participants will be offered ~$60 per hour as compensation for completing Part I and ~ $34 per hour for Part II. These rates of pay are comparable to their respective local area average hourly rate and were chosen based on our experience. Anything less than these values would likely result in failure to recruit enough

participants to provide adequate statistical power. In addition to compensation, several methods will be used to maximize response rates, including:

- Completing recruiting and screening electronically for respondent convenience.
- Sending a visit confirmation email including the scheduled date and time, directions, pertinent study information, and a contact email address and phone number in case of cancellation or questions.
- Sending reminder emails within 24 hours of the scheduled session to boost show rate and minimize scheduling misunderstandings or forgetfulness.

B.4 Describe any tests of procedures or methods to be undertaken.

The online format for the eligibility screening has been used since 2017 in industry- and government-funded trials and was based on phone-screening procedures used for well over a decade. The occlusion goggles, physiological sensors and tactile detection response task (TDRT), have all been extensively used in prior data collections. Workflows have been established to improve data collection and data handling processes. Additionally, a series of small pilot studies (totaling nine or fewer participants) will be conducted to assist in refining study scenarios, tasks, validating workflow, data collection procedures, and data quality.

Occlusion data will be collected using the occlusion goggles from Red Scientific to assess whether these tasks meet NHTSA distraction guidelines. Eye-tracking data will be gathered using the Pupil Labs Neon, a portable eye-tracker worn like glasses that records pupil data, as well as gaze metrics (e.g., eyes off road time, define dwell times, fixation locations and counts, transitions patterns to regions of interest). TDRT data will also be collected using Red Scientific's TDRT machine.

Researchers anticipate cleaning and analyzing the data using the R statistical software program. For Part I, researchers anticipate using descriptive statistics to determine if the total shutter open time (TSOT) captured from Occlusion Testing meets the pass/fail criteria for the assessed tasks per NHTSA distraction guidelines. Pass/fail criteria is defined by NHTSA as TSOT less than or equal to 12 seconds. Based on this pass/fail criterion, tasks will be chosen for Part II. Linear Mixed Effects Models (LMMs) will be used to analyze the nested data structure, with subject specified as a random effect and interface type, task type, and interaction as fixed effects. Separate LMMs will be conducted for the following continuous response variables: (1) cognitive workload measures (e.g., DRT reaction times, critical event response times); (2) visual behavior measures (e.g., total eyes-off-road time, mean glance duration, glance frequency counts, percentage of time eyes remain on road); (3) vehicle control performance measures (e.g., mean lane position, lane position variability, mean speed, speed variability, time-to-line crossing); (4) task performance measures (e.g., total task completion time, error-free task completion time, task completion time with errors, time spend in error recovery).

These methods will help understand interface efficiency and workload support. Subjective workload assessments (e.g., NASA-TLX) will be analyzed using non-parametric tests. Additionally, consideration will be given to normalizing ratings within participants (e.g., converting to z-scores using each participant's grand mean TLX rating across components) to compare perceived workload across system interfaces and tasks, further contributing to the understanding of cognitive demands.

Safety-critical events, such as lane departures, extreme speed variations, missed light bar responses, or other missed critical event responses, will be analyzed to address their context and frequency. The error recovery process will be evaluated by categorizing error types and recovery strategies.

B.5 Provide the name and telephone number of individuals consulted on statistical aspects of the design.

- Jeffrey Dressel, Ph.D., Research Psychologist, National Highway Traffic Safety Administration, Office of Vehicle Safety Research, Human Factors/Engineering Integration Division NSR-310, 202-493-0492
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