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Appendices for Technical Report 2013-17A

The Effects of a Production Level "Voice-Command" Interface on Driver Behavior: Reported Workload, Physiology, Visual Attention, and Driving Performance

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Note: These appendices were developed as part of an integrated technical report and should be considered as part of a single document for citation purposes even if the main body of the report and the appendices appear as separate files due to size considerations when supplied in electronic form.

APPENDIX A: GLANCE-TO-DEVICE ANALYSIS

Introduction

NHTSA's visual-manual distraction guidelines define an off-road glance as any glance "away from the forward roadway" (Section VI.F.1, p. 273). This includes glances to the vehicle's mirrors. NHTSA's rationale for classifying mirror glances as "off-road" comes from the assumption that, "Due to the [simulated] driving scenario [described in the guidelines], eye glances to the side of the roadway or to the vehicle's mirrors are expected to be minimal" (Section VI.F.1, p. 273). However, NHTSA's recommended *simulated* driving scenario may not always reflect a *realistic* driving scenario, where glances to the mirrors are often necessary and more frequent.

Since this experimental design utilized an on-road driving protocol, and not a simulator, glances to the mirrors are likely to be substantially more frequent than NHTSA's guidelines might suggest. Therefore, the following section re-analyzes the glance metrics from the Primary Analysis, but considers only glances to the in-vehicle device, rather than the broader category of all off-road glances. It is important to note that is approach is consistent with methods proposed by The Alliance (2006).

Methods

The methodology is the same as described in Primary Analysis Methods. However, off-road glance metrics in this section consider only glances to the in-vehicle device (glances to the mirrors and other non-device areas are not considered). Measures that would not be affected by the change in glance classification are not considered here. These include: self-reported task difficulty, heart rate, skin conductance, driving behavior metrics, task completion time, task completion ability, and orienting response data. Only glance-relevant data are presented.

Results

A summary table for the Glance-to-Device analysis appears on the next page.

Selected Glance Metrics Summary Table (Glance-to-Device Analysis)

If one were to apply NHTSA distraction cutpoints to participants in the younger, older, and overall cohort, the table below (**Table A-1)** shows the percentage who would meet each of the criteria if a glance-to-device analysis is used instead of glances-off-the-forward-roadway. Entries for cases where less than 85% of a group meet a threshold are bolded and shown in red.

Task	Age Group	Long Duration Glances	Mean Glance Duration	Total To-Device Glance Time
Nav Cancel	Younger	100.00%	100.00%	100.00%
	Older	100.00%	100.00%	91.30%
	(all)	100.00%	100.00%	96.20%
Nav Entry	Younger	100.00%	100.00%	**26.70%**
	Older	100.00%	100.00%	**26.10%**
	(all)	100.00%	100.00%	**26.40%**
Radio Manual Easy	Younger	90.00%	96.70%	100.00%
	Older	**82.60%**	100.00%	91.30%
	(all)	86.80%	98.10%	96.20%
Radio Manual Hard	Younger	96.70%	100.00%	**73.30%**
	Older	87.00%	100.00%	**8.70%**
	(all)	92.50%	100.00%	**45.30%**
Radio Voice Easy	Younger	100.00%	100.00%	100.00%
	Older	100.00%	100.00%	**82.60%**
	(all)	100.00%	100.00%	92.50%
Radio Voice Hard	Younger	100.00%	100.00%	96.70%
	Older	100.00%	100.00%	**78.30%**
	(all)	100.00%	100.00%	88.70%
Song Select	Younger	96.70%	100.00%	86.70%
	Older	95.70%	100.00%	**60.90%**
	(all)	96.20%	100.00%	**75.50%**
Song Fail	Younger	93.30%	100.00%	**30.00%**
	Older	100.00%	100.00%	**60.90%**
	(all)	96.20%	100.00%	**43.40%**
Phone	Younger	100.00%	100.00%	96.70%
	Older	100.00%	100.00%	**72.70%**
	(all)	100.00%	100.00%	86.50%

Mean Glance-to-Device Duration

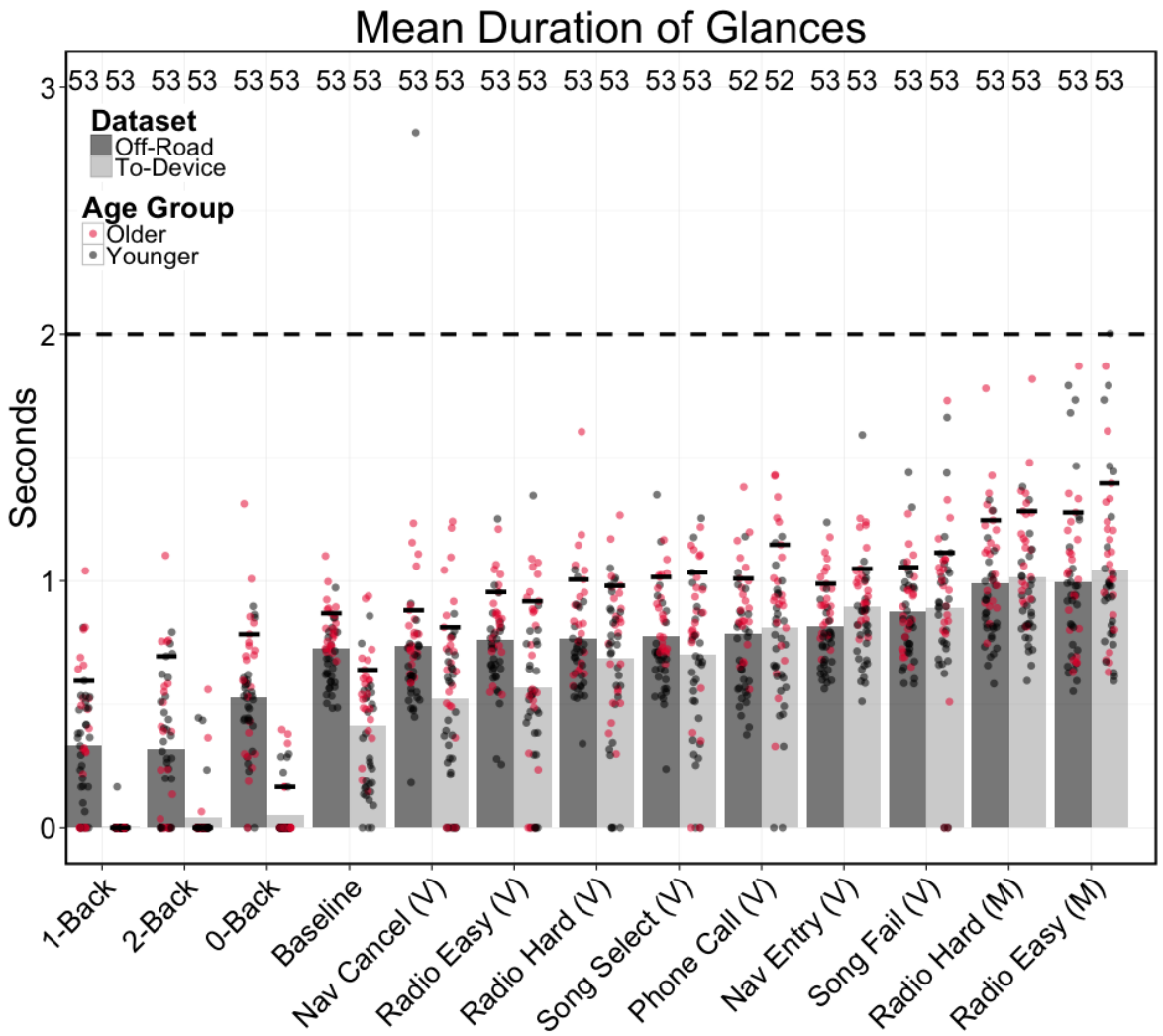


Figure A-1: Mean duration of to-device glances.

These plots present the data from the off-road analysis (dark bars, replicated from the data shown in the previous section) alongside data from a to-device analysis. The mean duration of to-device glance is almost always kept to less than 2.0 seconds. Note the nearly complete absence of to-device glances during the N-Back tasks, as these tasks did not utilize the in-vehicle device.

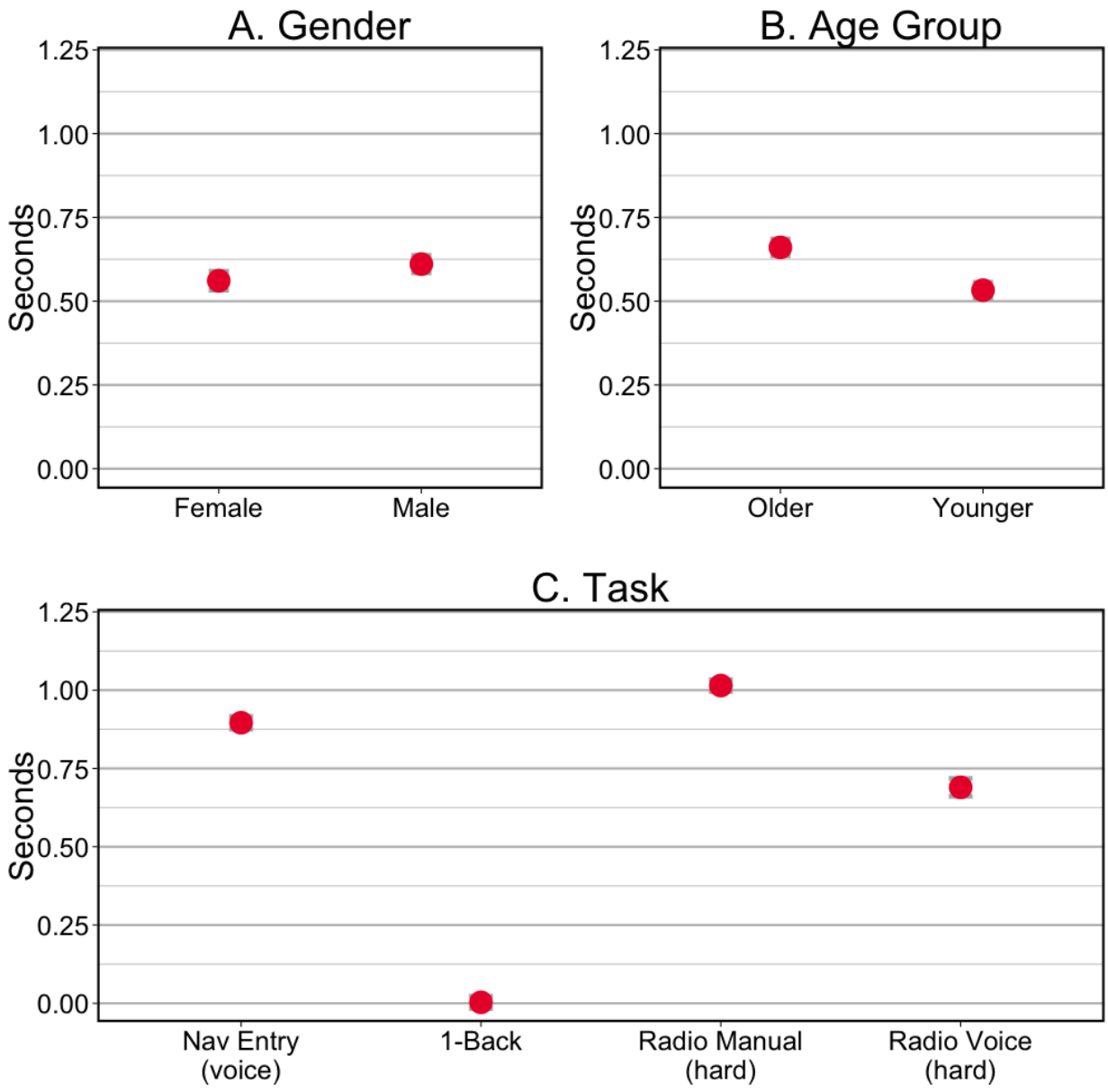


Figure A-2: Statistical summary plot for mean duration of to-device glances.

Mean glance duration was not significantly affected by gender ($p = .099$). However, age group significantly affected mean glance duration ($p = .001$), as did comparisons between the radio tasks, and a comparison between the radio manual task and navigation entry task ($p < .001$ for both).

Percentage of Long Duration (> 2s) Glances

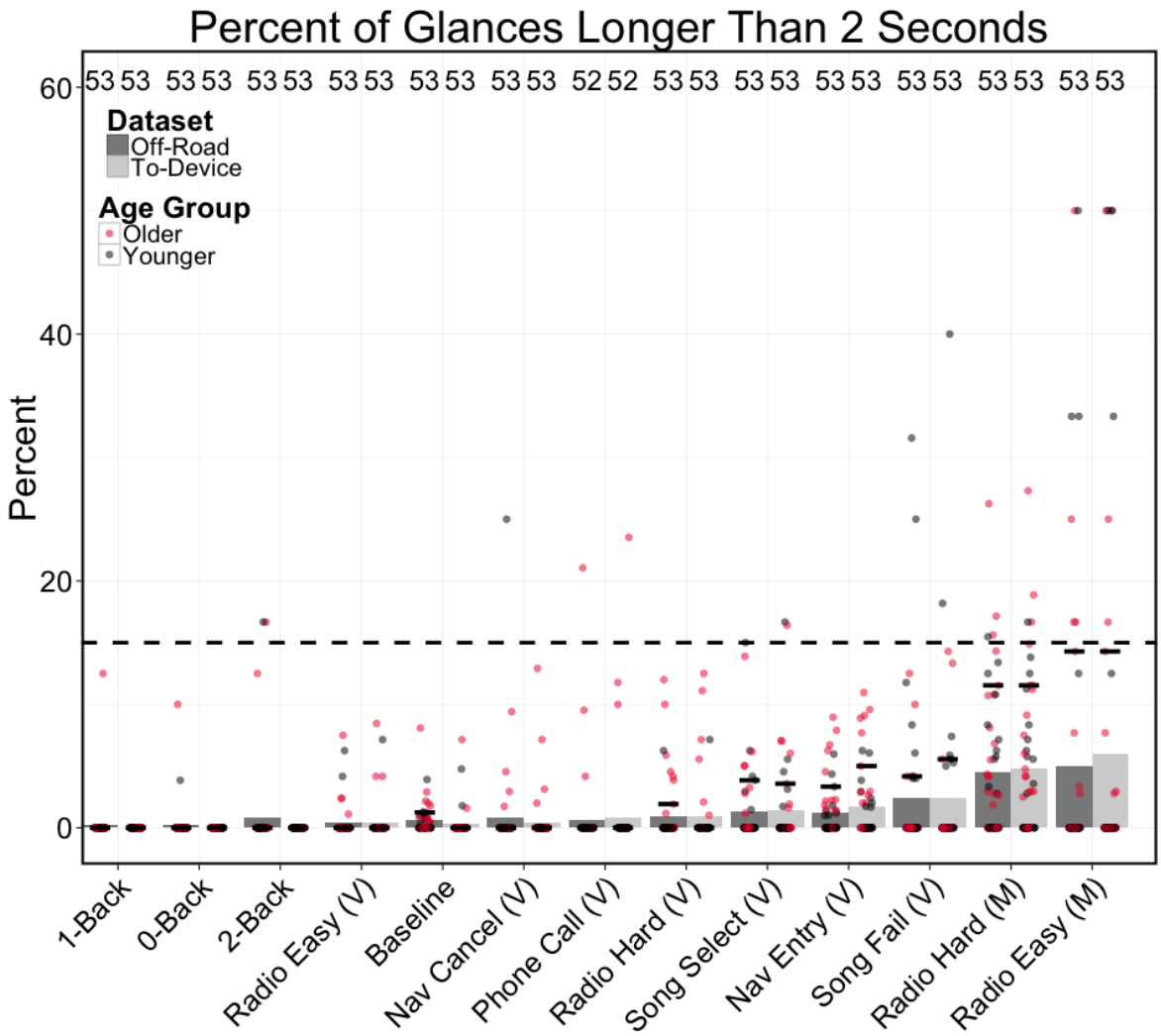


Figure A-3: Percentage of glances greater than 2 seconds towards the in-vehicle device.

Note that long glance rates for the Radio Manual Easy task (Radio Easy M) may be inflated due to the task's relatively brief duration. Although this task's mean glance rate skews fairly large, its 85th percentile is still below the NHTSA criterion line for our sample.

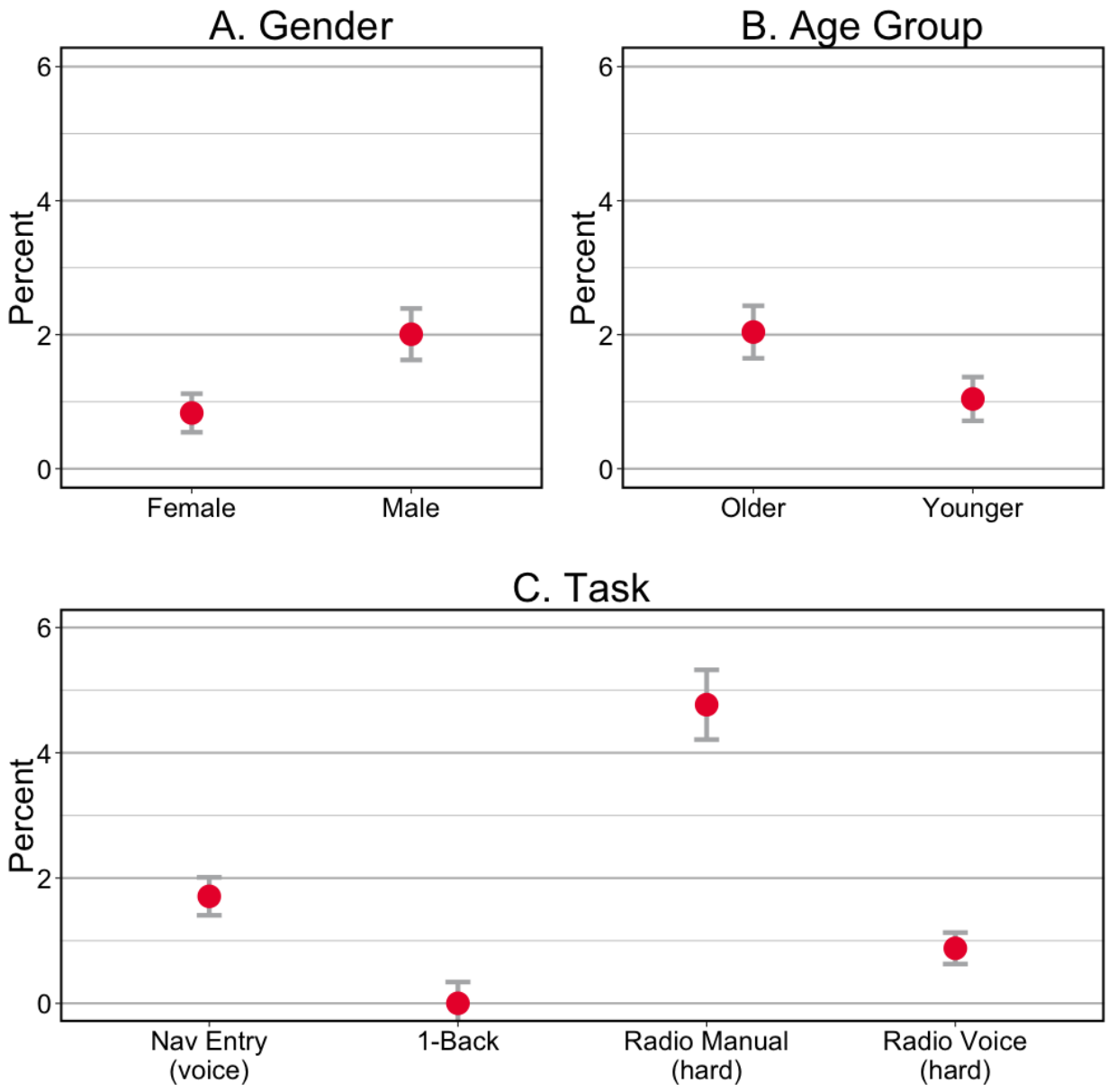


Figure A-4: Statistical summary plots for percentage of glances longer than 2 seconds to the in-vehicle device.

Male participants had a significantly higher proportion of long glances compared to females ($p = .049$). Older participants had a significantly higher proportion of long glances compared to younger participants ($p = .020$). Lastly, the percentage of glances longer than 2 seconds varied significantly between radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both). This may be because the task was relatively brief and was typically performed in

a single motion (turning a dial to the correct station), necessitating a low number of glances overall.

Total To-Device Glance Time

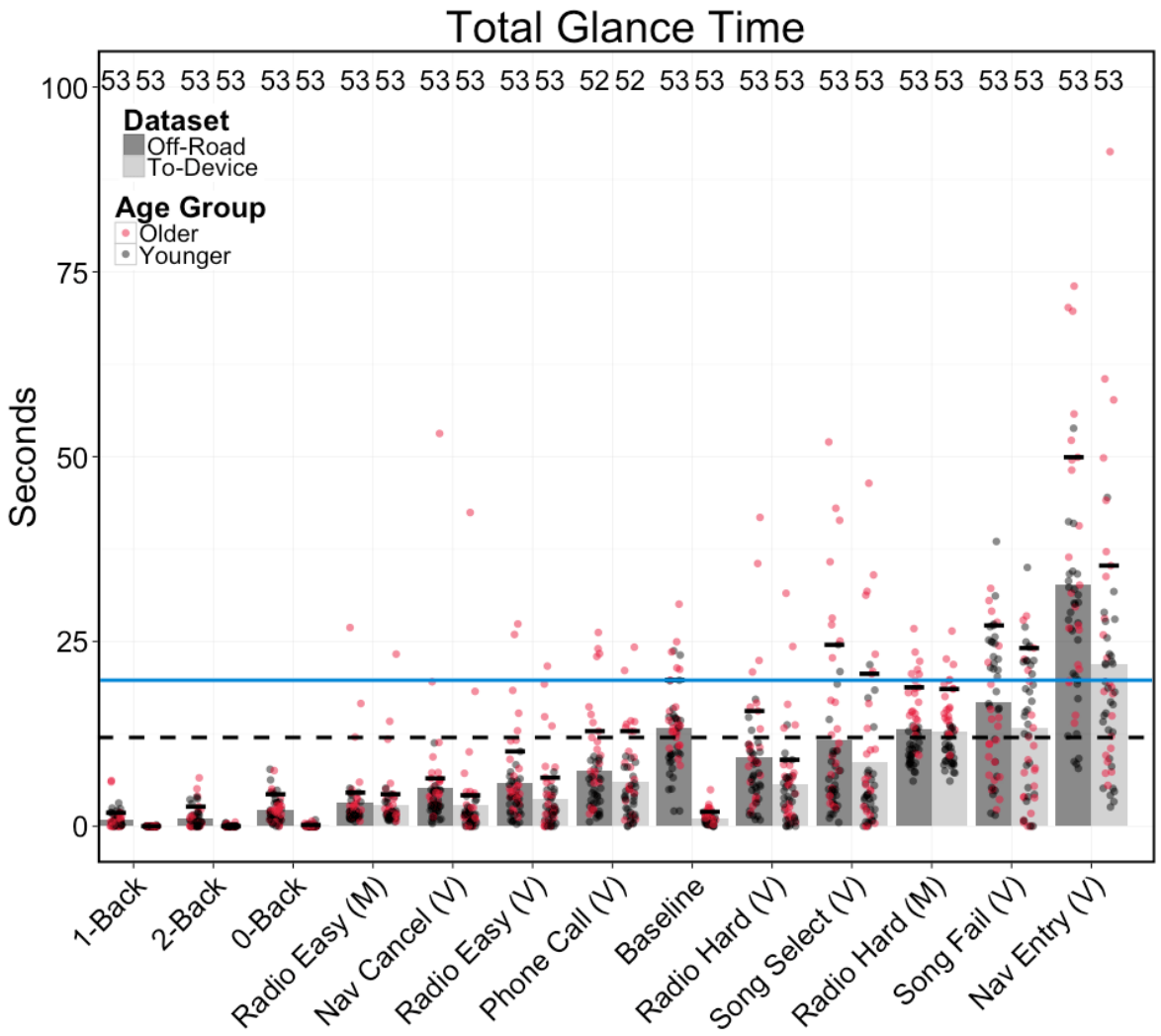


Figure A-5: Total time spent glancing to the in-vehicle device. One outlier data point on the Nav Entry task is excluded from view to aide plot readability. The blue horizontal line represents The Alliance's criterion for total glance time (criterion 2.1 A), which is 20 seconds.

The dark gray bars are reproduced from the plots in the Primary Analysis, and visualize the total time spent glancing off-road. In contrast, the light gray bars represent the time spent glancing only to the in-vehicle device. This gives a sense of what proportion of all glances are directed toward the device interface. For example, almost no glances are directed to the device during the N-Back tasks and baseline periods, whereas the Navigation Entry task requires a substantial amount of glance time to the device. For the Radio Manual Hard task, nearly all off-road glances are glances to the device itself. Note also that the change of glance criteria affects this samples' ability to meet guidelines if they are applied to it. For example, the verbal Radio

Hard task meets the 12 second criterion if a glance-to-device metric is used, but does not if the eyes-off-the-forward-roadway metric is applied. It can be observed that the manual Radio Hard task studied here meets The Alliance 20 second criterion (2.1 A) level, but does not meet the NHTSA 12 second criterion regardless of whether the eyes-off-road or glance-to-device metrics are used. Note again that this sample does not fully conform to NHTSA's recommend age distribution.

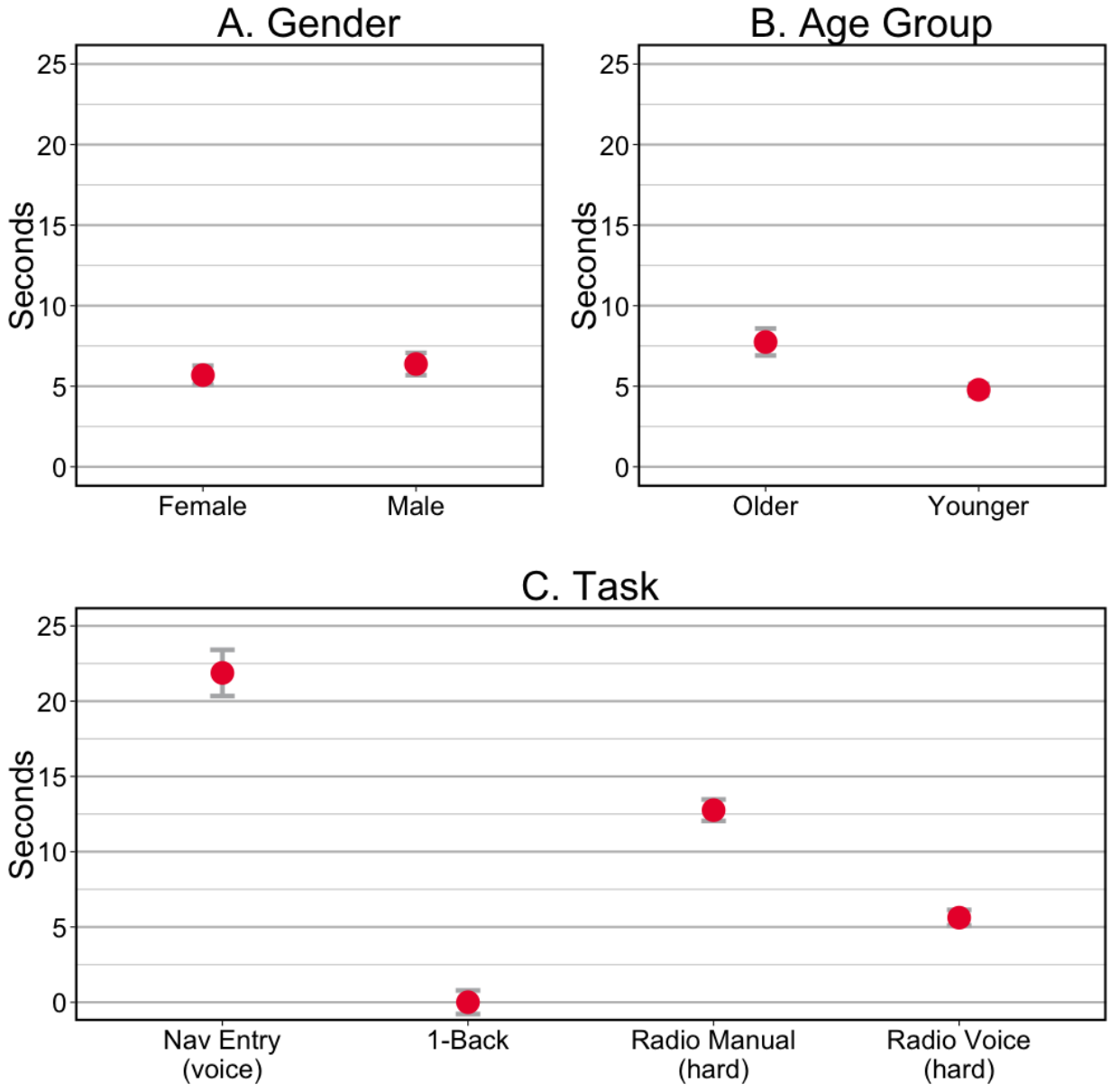


Figure A-6: Statistical summary plots for to-device glance time.

Gender did not significantly impact glance time ($p = .462$). Age group significantly affected glance time ($p = .002$), with older participants spending more time glancing at the device. Total glance time differed significantly between the radio tasks and the radio manual and navigation entry tasks ($p < .001$ for both). Almost no time is spent looking at the device during the 1-Back task, particularly in contrast to the Navigation Entry task, which required a long total glance time.

Number of To-Device Glances

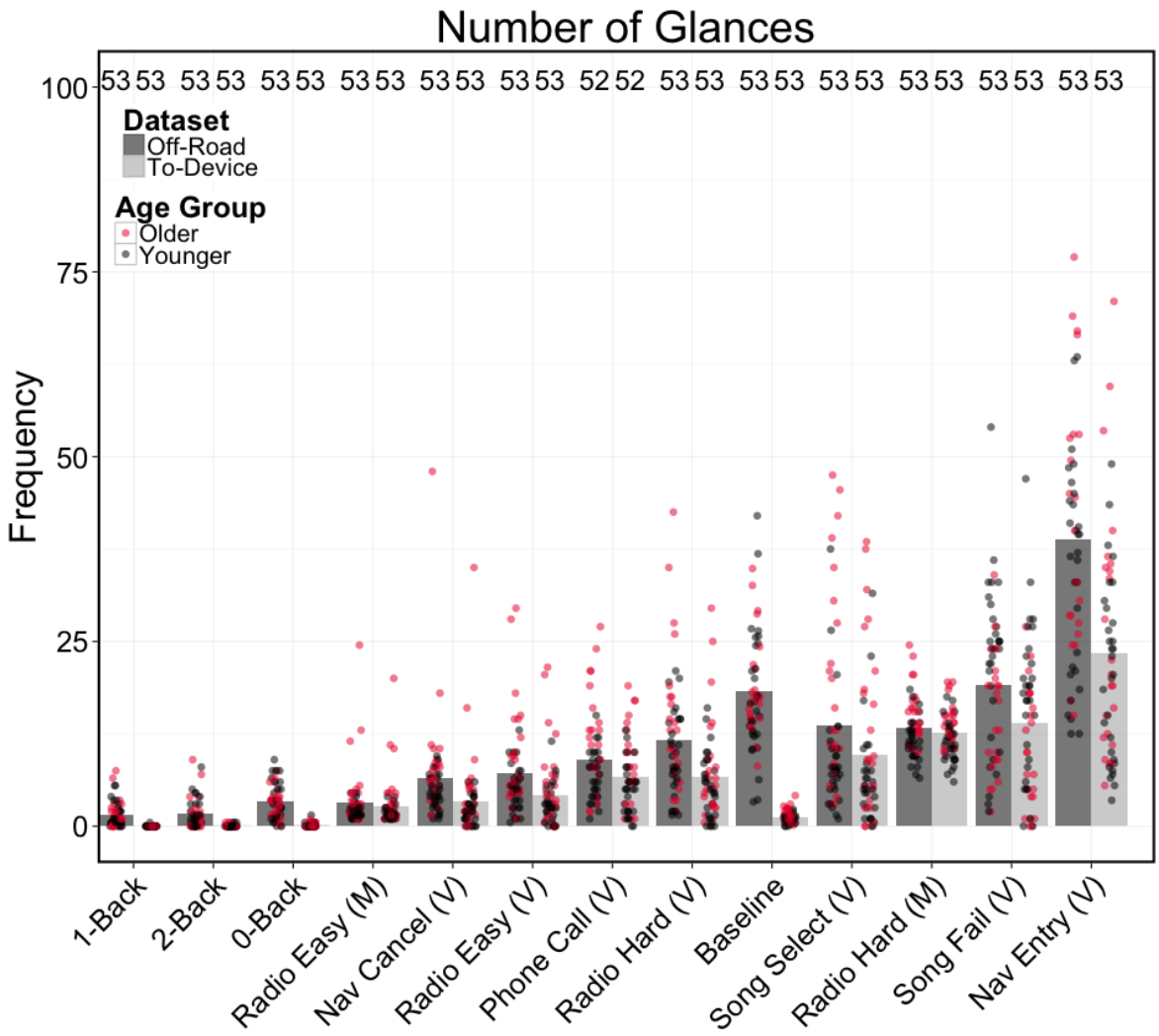


Figure A-7: Number of glances to the device for each task. . One outlier data point on the Nav Entry task is excluded from view to aide plot readability.

These data are similar to the total glance time metric discussed earlier.

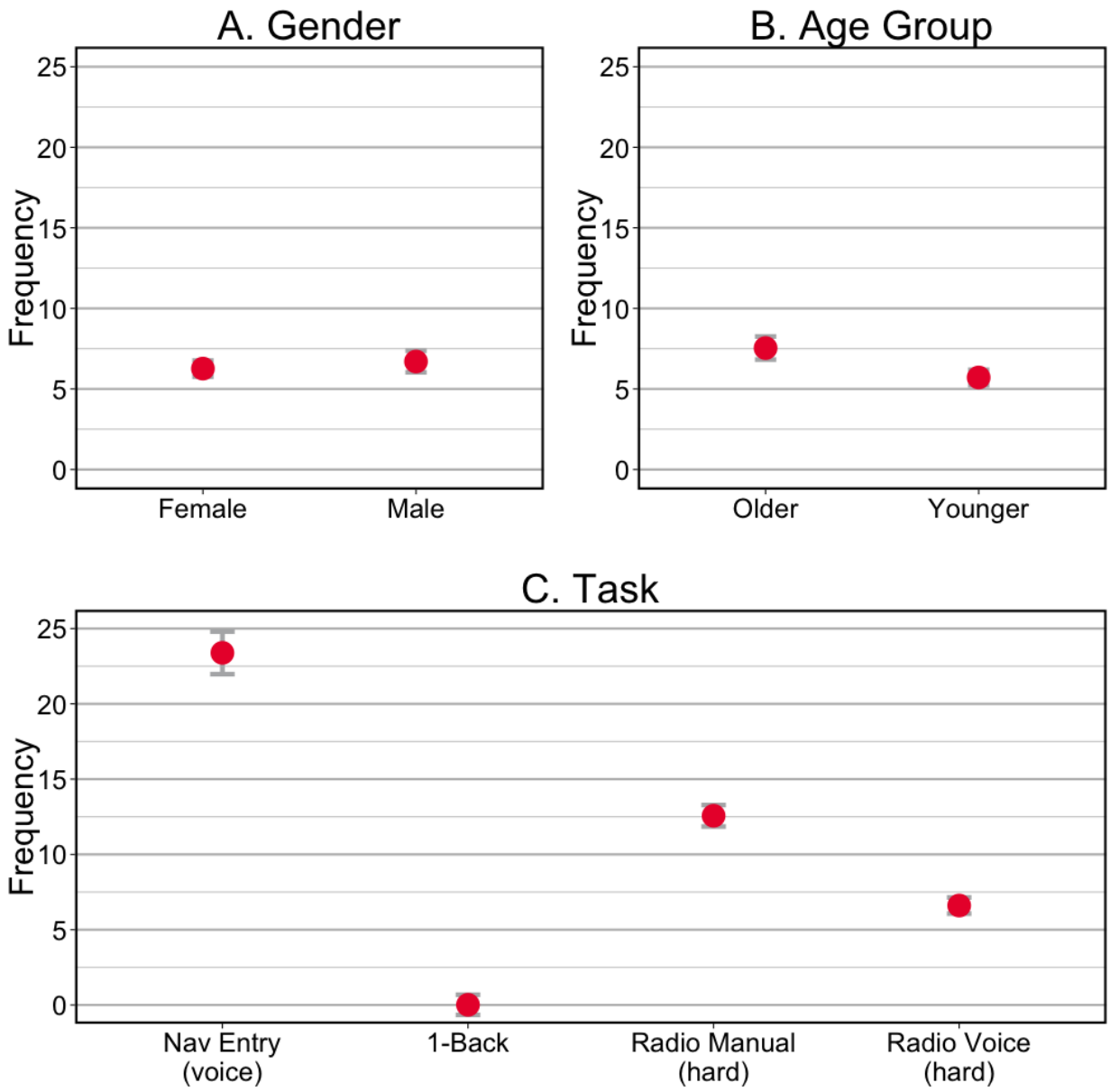
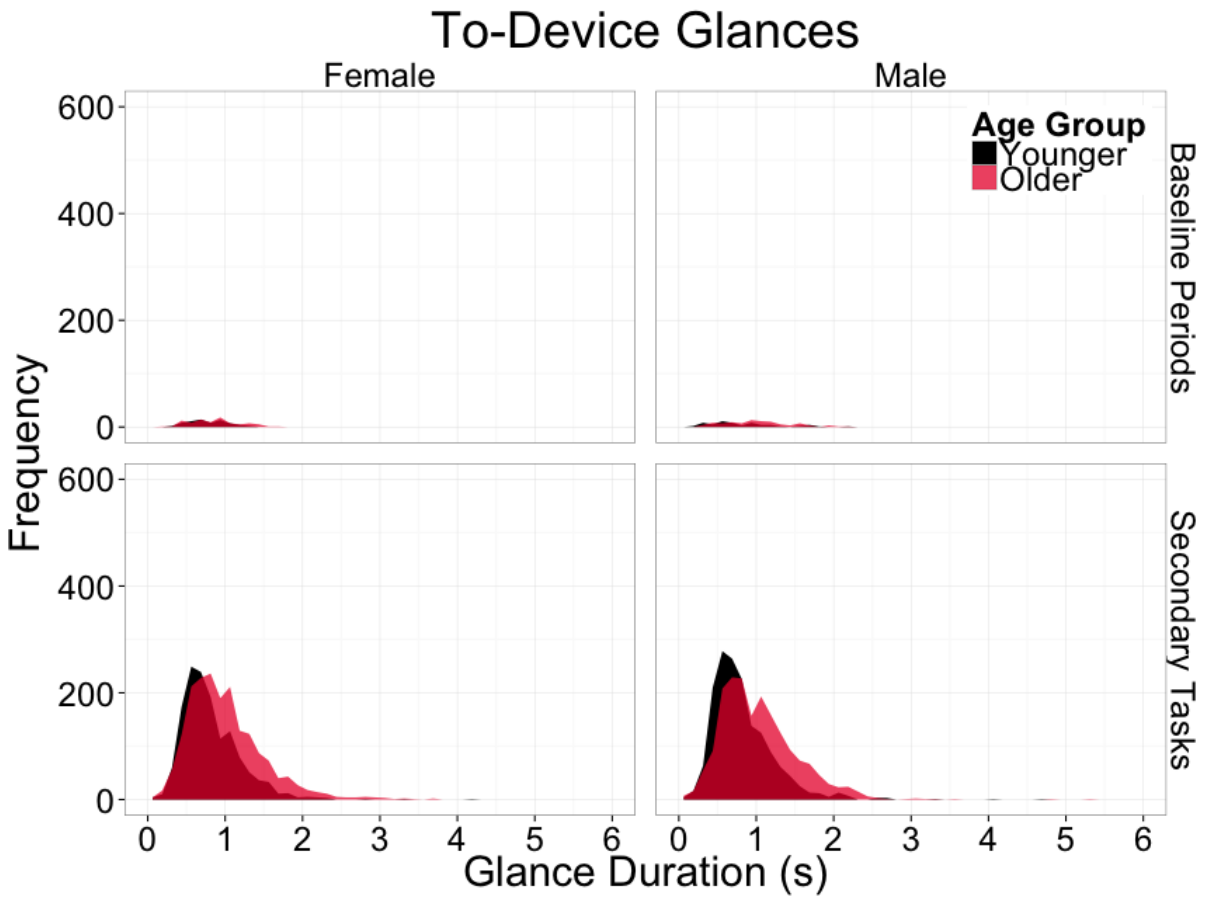


Figure A-8: Statistical summary plots for number of glances to the in-vehicle device.

Gender did not significantly affect the number of glances to the device ($p = .866$). Age group was a significant factor ($p = .041$), with older participants making slightly more glances to the device overall. The number of glances required between the radio tasks and between the navigation entry and radio manual task were significantly different ($p < .001$ for both).

Glance Duration Analysis

Distributions of glances to the in-vehicle device are shown in **Figure A-9**. As would be expected, few glances were made to the device during the baseline driving periods (upper graphs) in comparison to the secondary task periods (lower graphs).



Effect of Task Completion Time

Figure A-10 presents correlation plots between total task completion time and total device glance time for the hard radio tuning task (manual and voice), as well as the Navigation Entry task. As in the Primary Analysis, correlations are quite strong across tasks (Pearson R > 0.65 for all three tasks, all p < .001). This suggests that during task periods, most glances away from the forward roadway were made to the device.

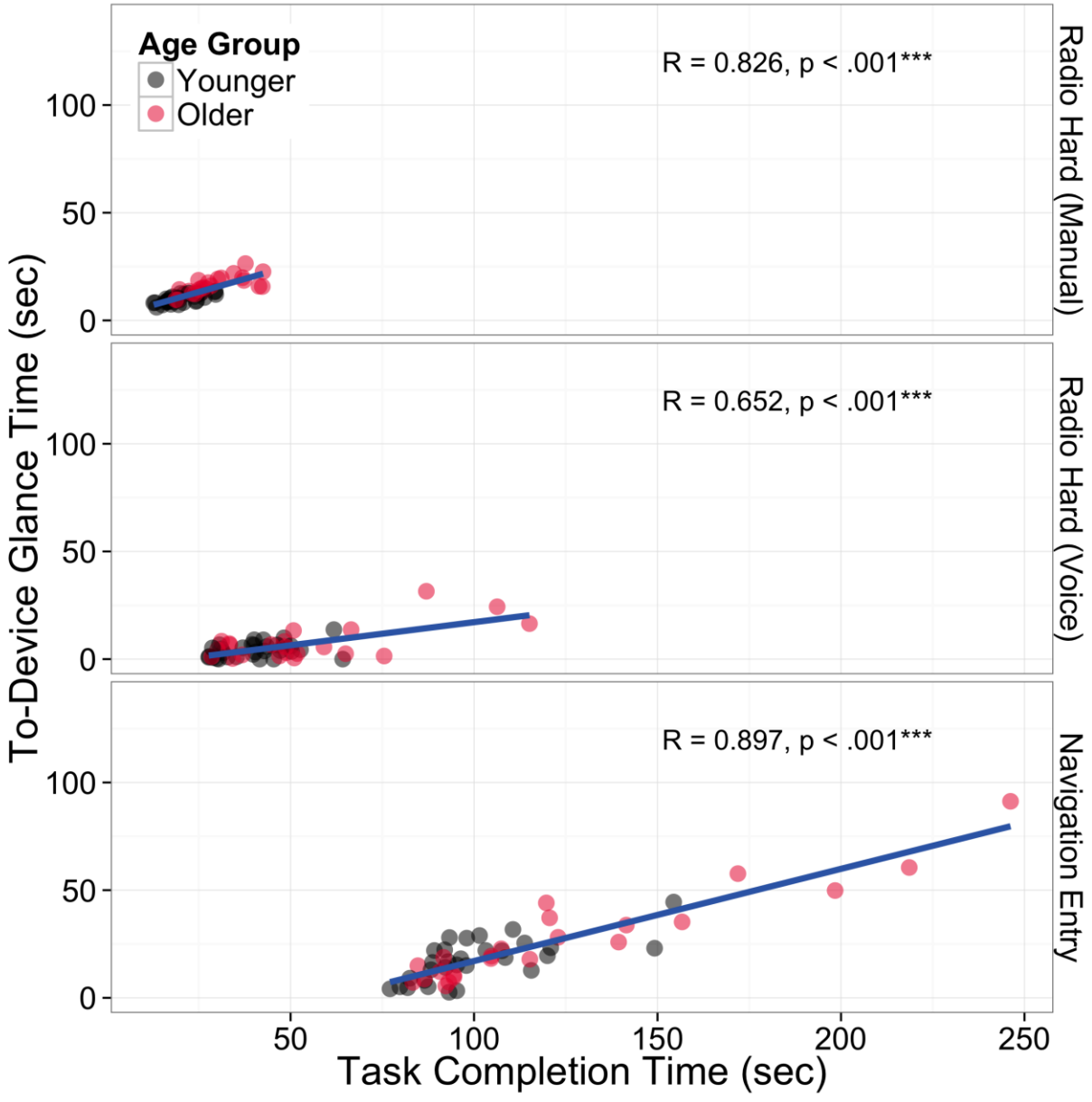


Figure A-10: Device glance time vs. task completion time for three tasks.

APPENDIX B: ERROR-FREE TASK ANALYSIS

Introduction

NHTSA's (2013) guidelines on visual-manual distraction state that only data from "error-free" test trials should be used when determining whether a task meets the visual-manual safety criteria. An error occurs whenever the participant backtracks through the steps of the task, deletes previously entered information, or fails to complete the task (Section VI.H.1-2, p. 277-278).

In many real-world driving scenarios (new car purchase, rental car, borrowing a friend's car), drivers are likely to be confronted by unfamiliar (and sometimes questionably implemented) interfaces that may result in errors while performing a task. For this reason, we included all task trials in the Primary Analysis, as long as relevant data were available. However, it is instructive examine only trials that meet NHTSA's definition of "error-free", to investigate how the subset of best-case task performance scenarios compare to the overall dataset.

Methods

The methodology is the same as described in *Primary Data Analysis - Methods*. In this section, a subset of the primary dataset is considered: only task trials that were completed "error-free", per NHTSA's guidelines. Each individual task performance was rated on an eight-point scale (see Appendix G for rating data and guidelines). Only cases that achieved the highest rating on both trials are considered in this analysis (in other words, the participant performed the task perfectly on both replications). To achieve the highest rating, the participant must have successfully complete the task without backtracking through the task steps or deleting previously entered information, and without additional prompting or help from the research assistant.

It should be noted that the definition of "error-free" used here could be considered "generous" to the device interface under evaluation. Following NHTSA's guidelines, the first on-road trial could be considered a "practice" trial and the second as the "evaluation" trial. The analysis presented here only includes cases where the participant was error-free on both the first (practice) trail and the second (evaluation) trial.

This section omits the "Glance Distribution Analysis". Since younger participants completed many more tasks without error than older participants, a specific comparison of glance frequencies between the age groups would be highly distorted.

Results

As in Appendix A, the plots below present two datasets side-by-side: the data from the Primary Analysis in dark gray, and the error-free data in light gray. Since the light gray bars represent only cases where error-free performance was obtained for both the first and second trials, sample size varies between tasks, depending on how many participants were able to achieve overall error-free performance (sample sizes shown for each column at the top of figures).

Self-Reported Workload

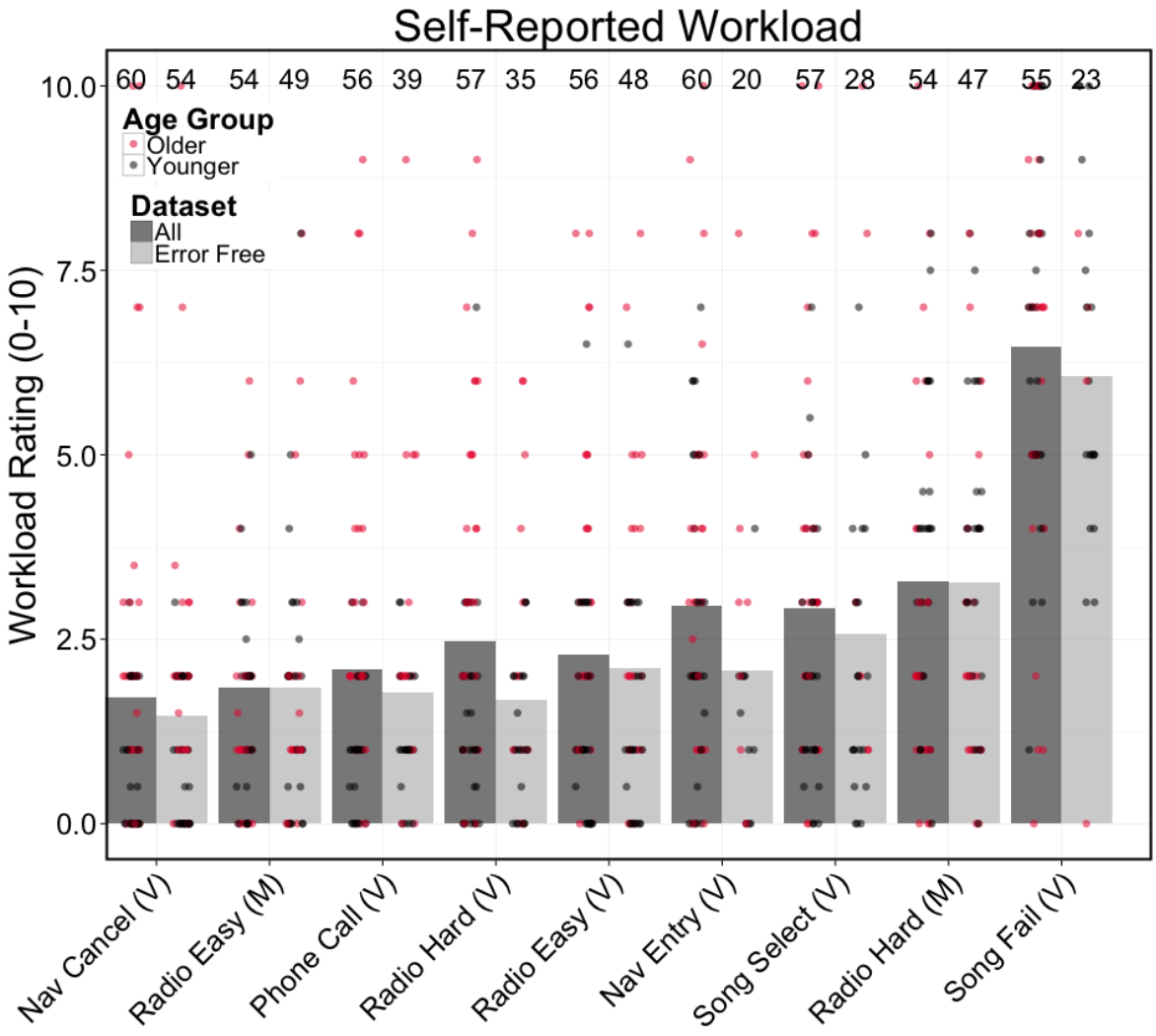


Figure B-1: Self-reported workload for each task regardless of performance (dark gray) and for cases where participant performance was error free across both trials (light gray).

The mean workload rating changes little between the primary and error-free samples. Note that few participants were able to complete the Navigation Entry, Song Fail, and Song Select tasks without some level of difficulty or error.

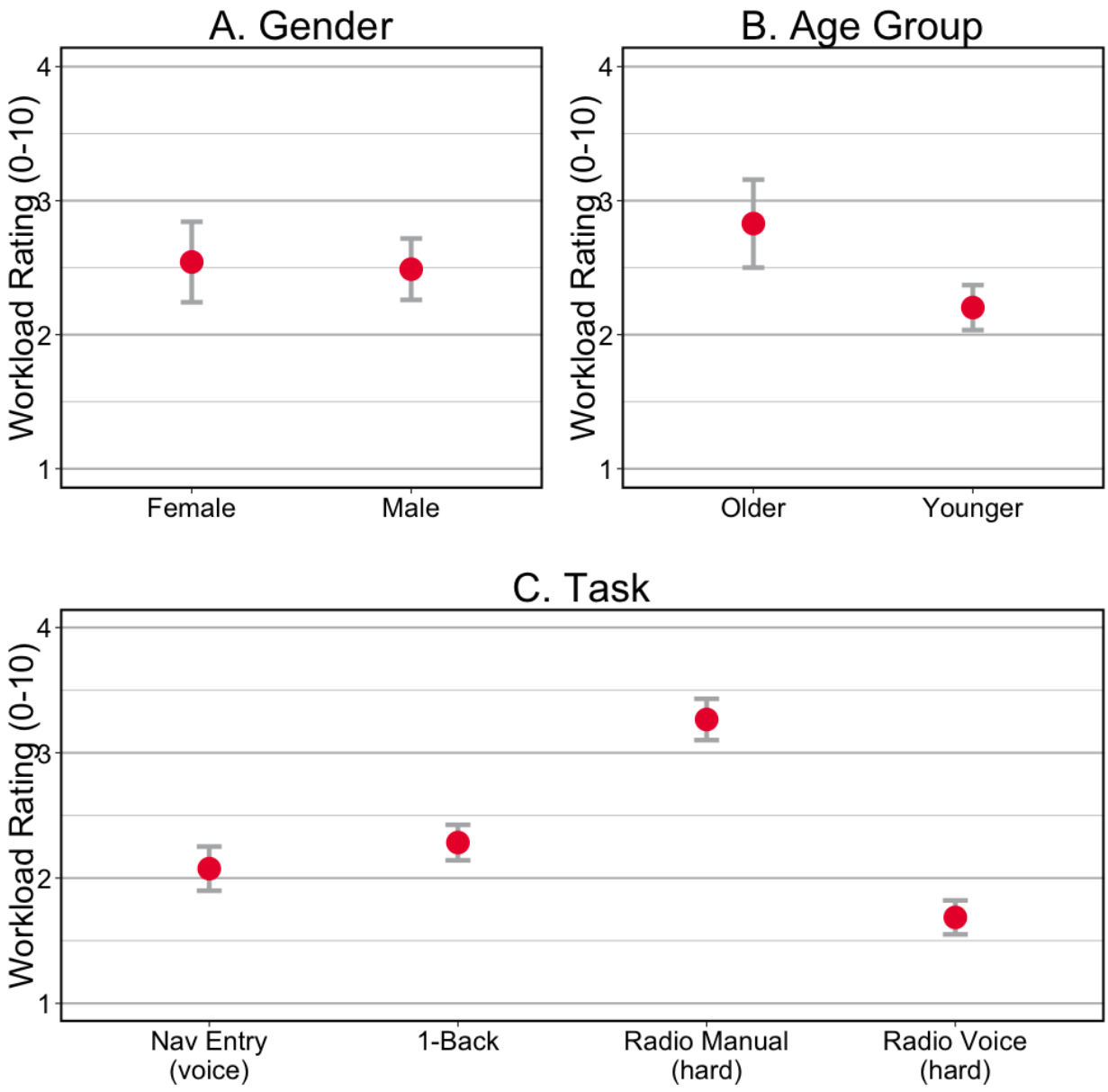


Figure B-2: Statistical summary plots for self-reported workload among the error-free sample.

Neither gender nor age group significantly affected workload ratings ($p = .733$ and $p = .359$, respectively). Workload ratings did differ between the two radio tasks ($p = .002$) and between the radio manual and navigation entry tasks ($p = .019$).

Total Completion Time

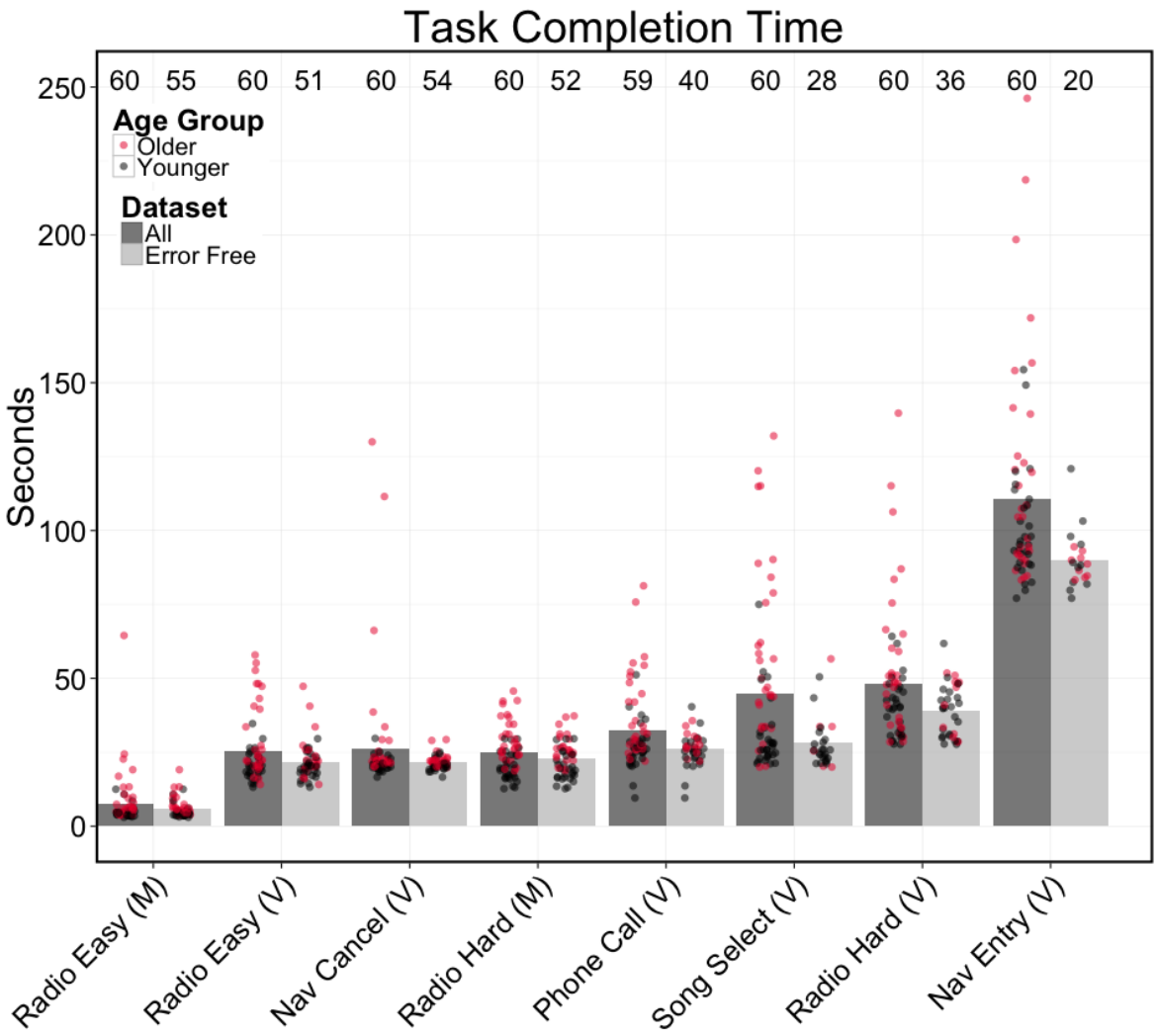


Figure B-3: Task completion time for error-free cases (light gray).

As would be expected, restricting the analysis to error-free trials does result in a reduction in task completion time values. However, it does not substantially change the relative pattern of across tasks.

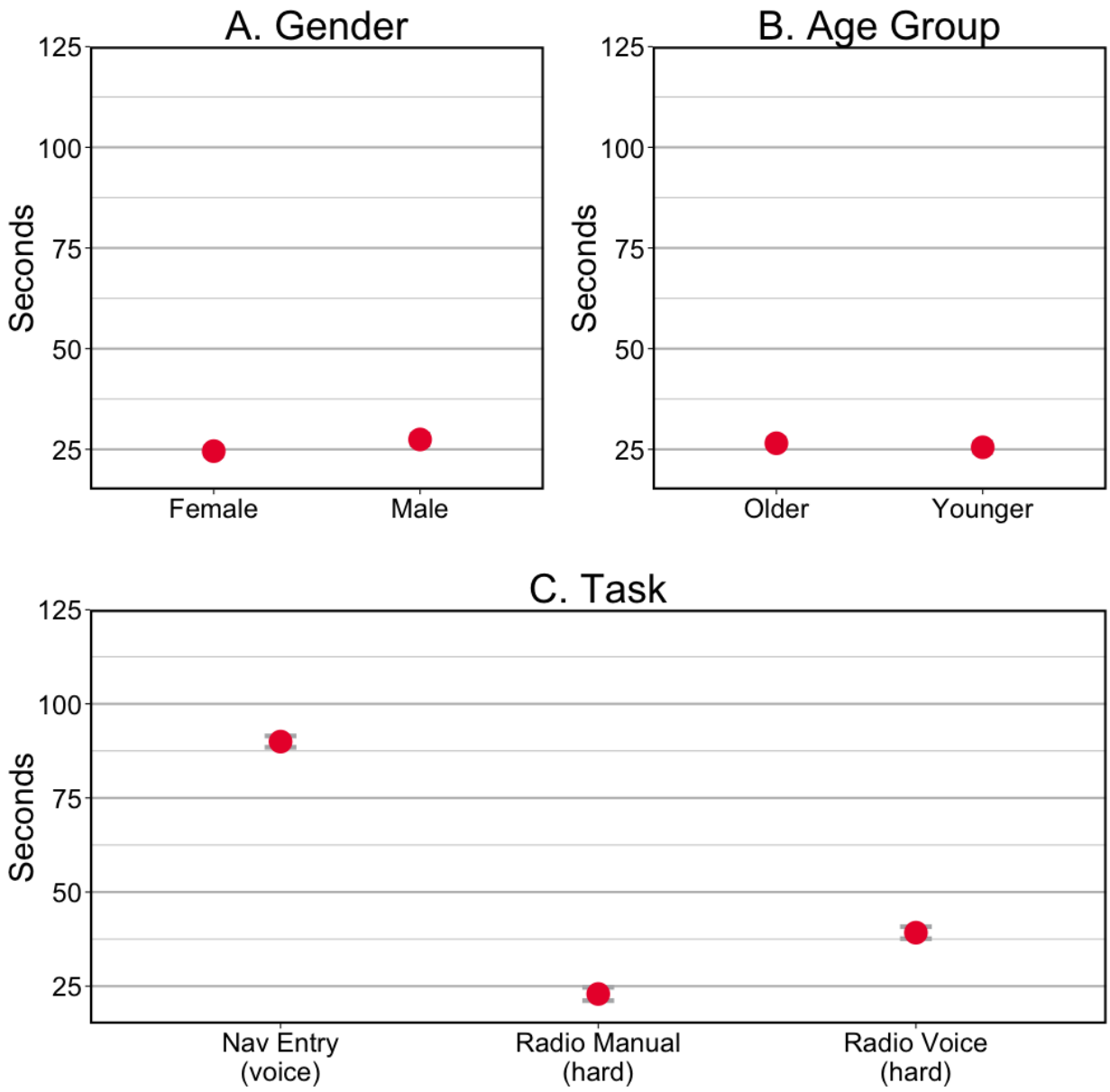


Figure B-4: Statistical summary plots for task completion time for error-free cases.

Completion time was not significantly affected by gender ($p = .100$). There was no effect of age group ($p = .582$), with older participants taking slightly longer to complete tasks. Task completion time differed significantly between the radio tasks ($p < .001$) and between the navigation entry and radio manual tasks ($p < .001$).

Heart Rate

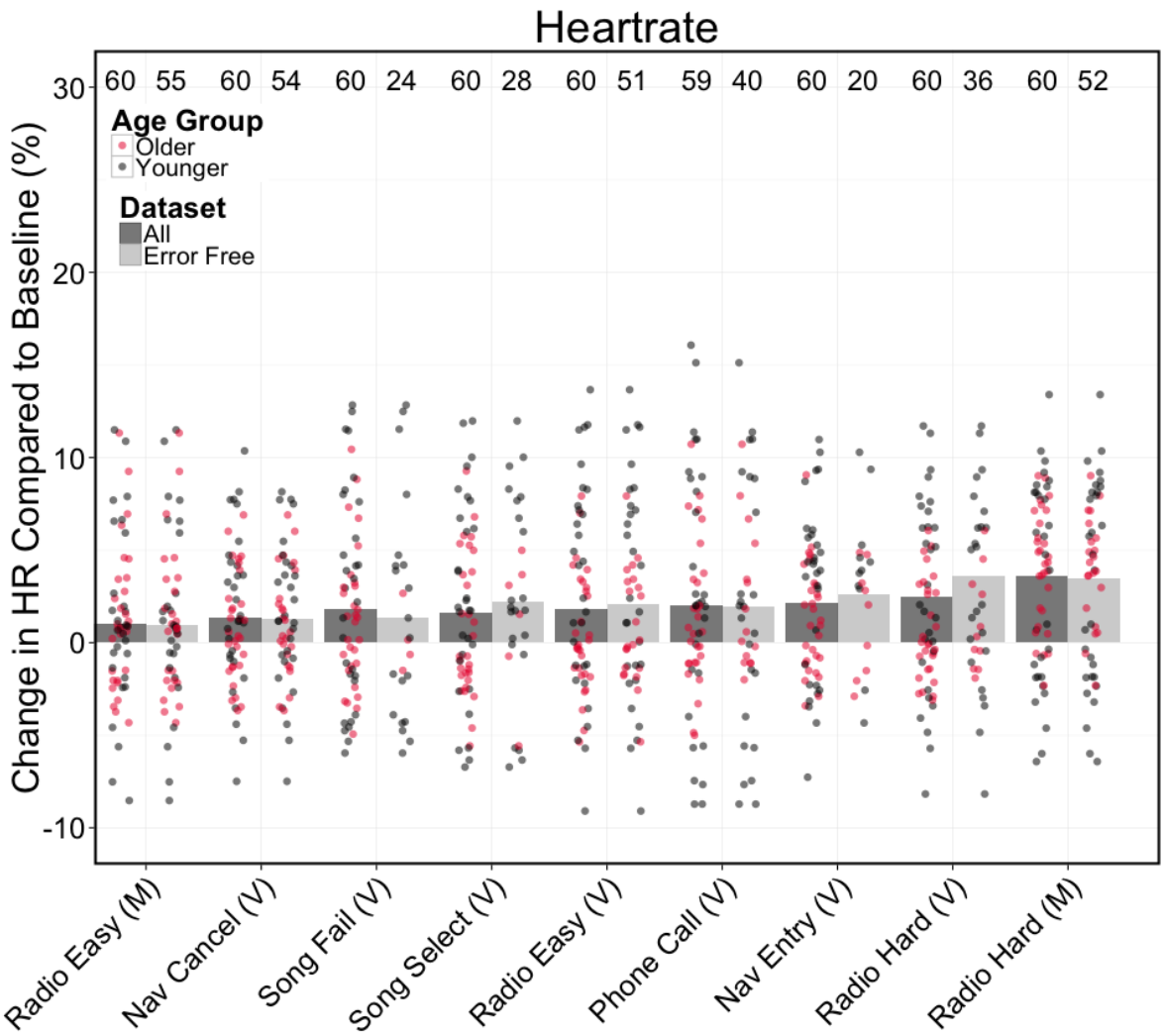


Figure B-5: Heart rate change data relative to an averaged baseline period of single-task driving for error-free cases (light gray).

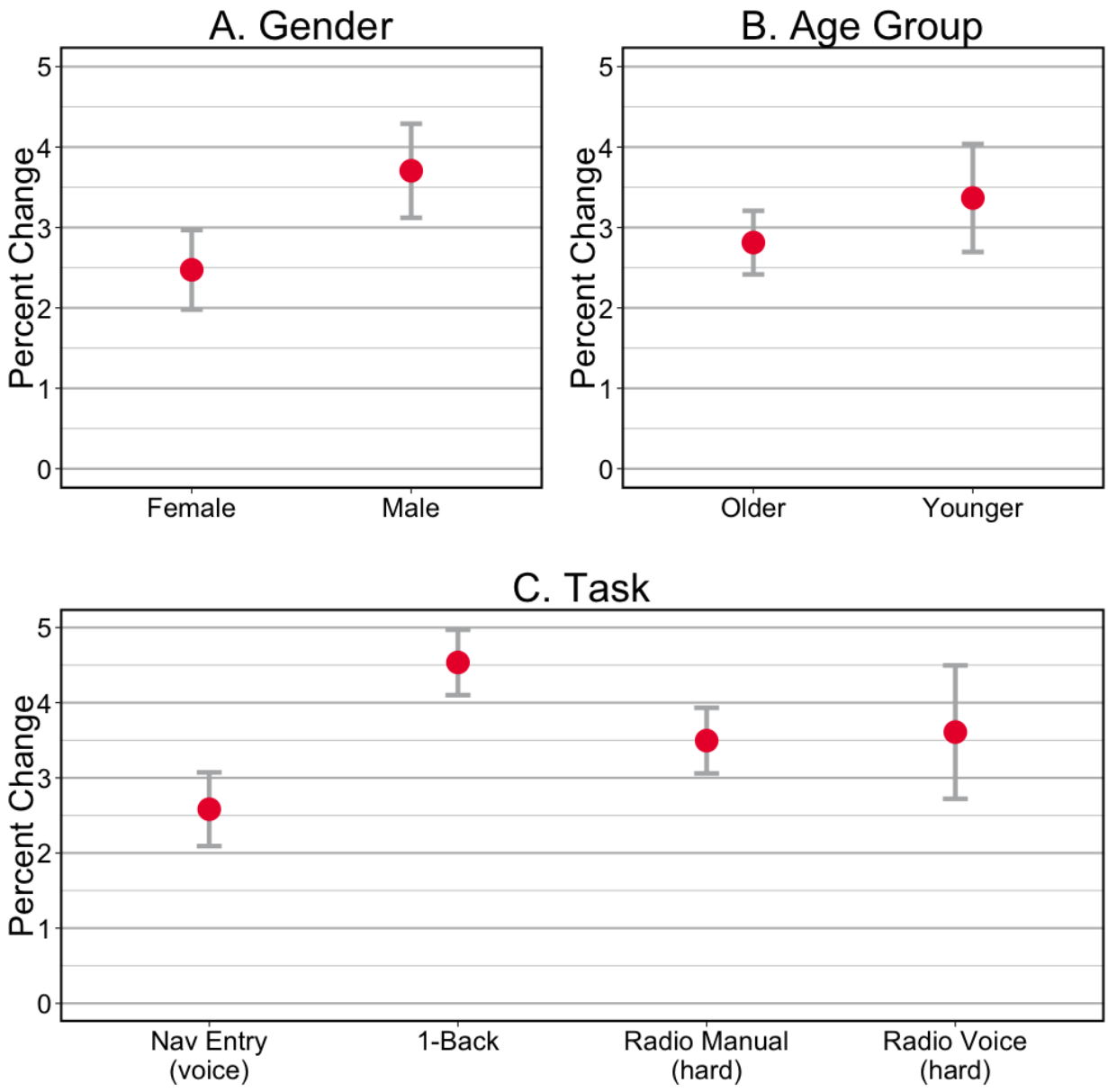


Figure B-6: Statistical summary plots for changes in heart rate relative to an averaged baseline period of single-task driving for error-free cases.

There was no significant effect of gender or age group ($p = .123$ and $p = .797$, respectively). There were no significant differences between the radio tasks ($p = .710$) or between the radio manual and navigation entry tasks ($p = .212$).

Skin Conductance (SCL)

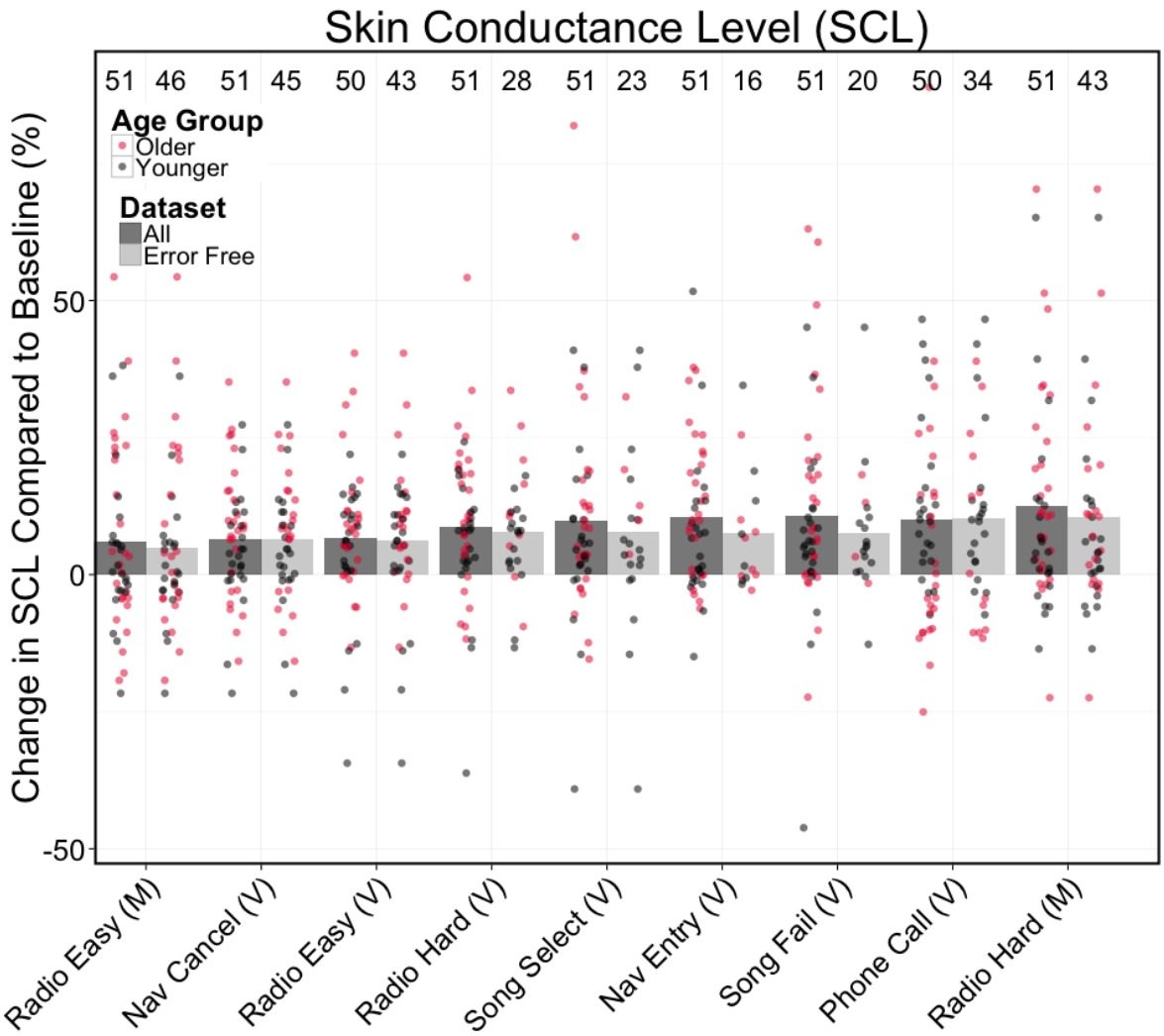


Figure B-7: Changes in skin conductance levels (SCL) relative to an averaged baseline period of single-task driving for error free cases (light gray).

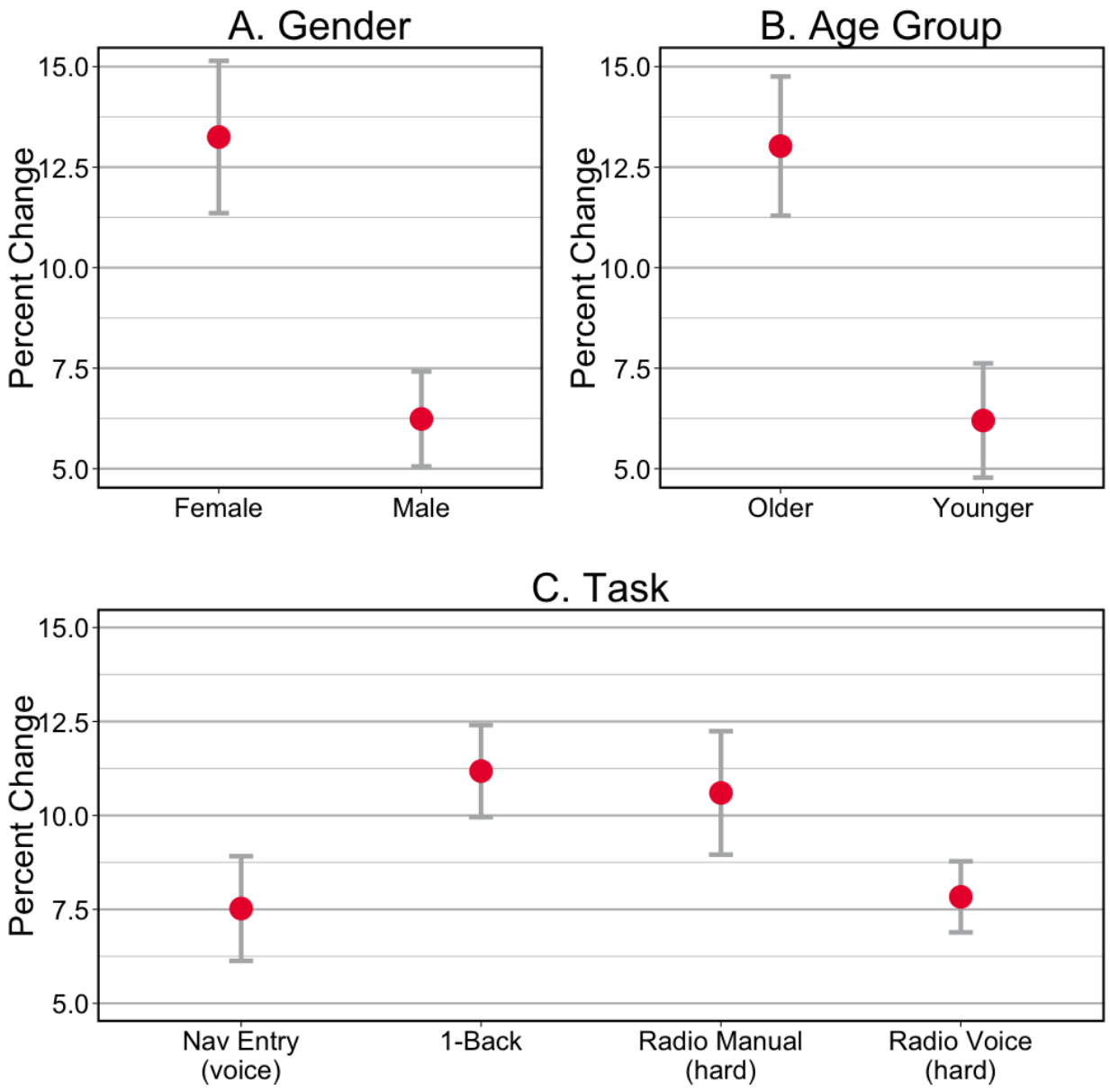


Figure B-8: Statistical summary plots for SCL changes relative to an averaged baseline period of single-task driving during error-free cases.

SCL changes differed significantly by gender ($p = .007$), with women showing elevated changes in SCL compared to men. SCL also differed significantly by age group, with older participants showing elevated changes compared to younger ($p = .002$). SCL changes did not differ significantly between the radio tasks ($p = .861$) or between the radio manual and navigation entry tasks ($p = .855$).

Mean Velocity

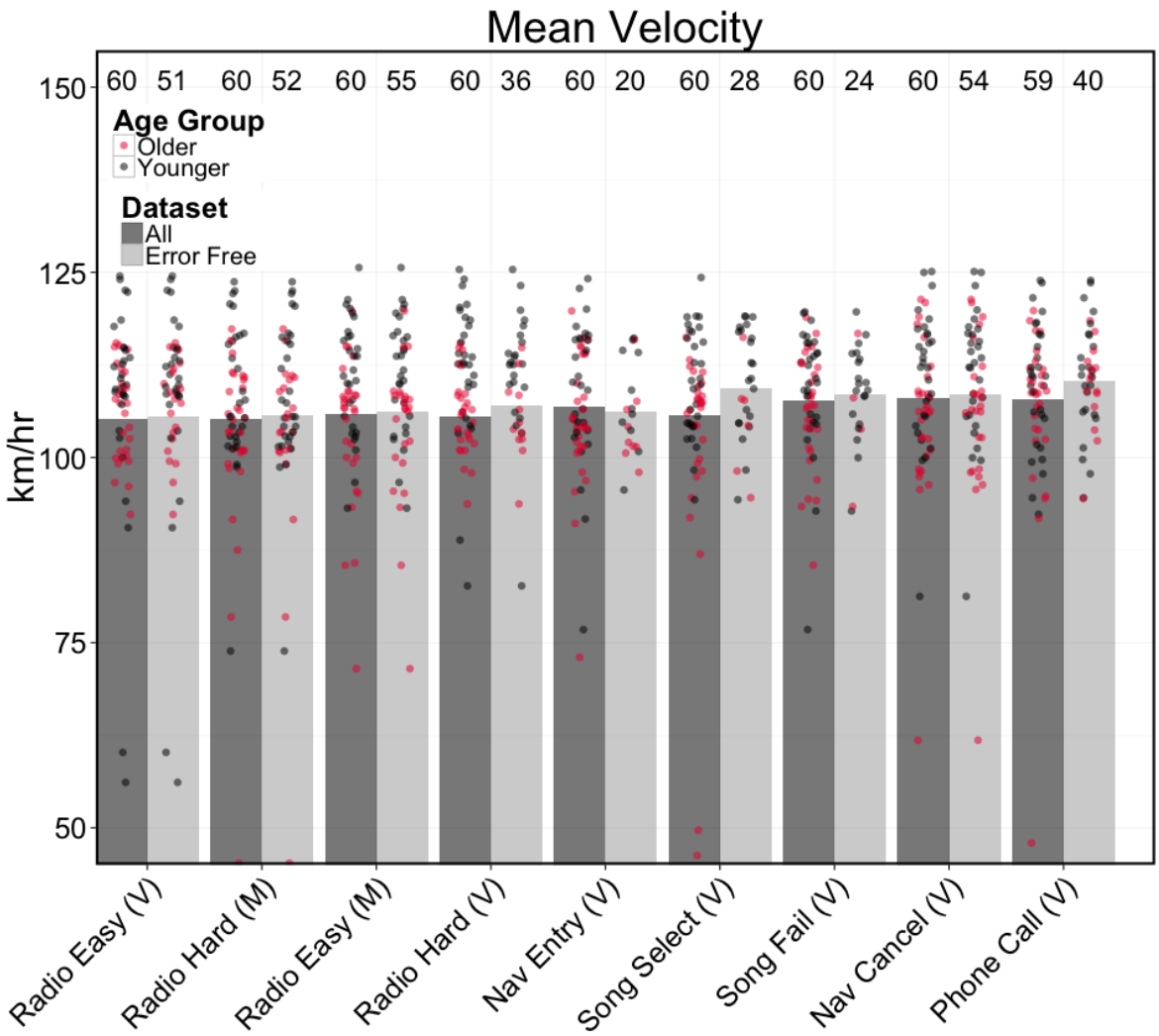


Figure B-9: Mean vehicle velocity during error-free cases (light gray).

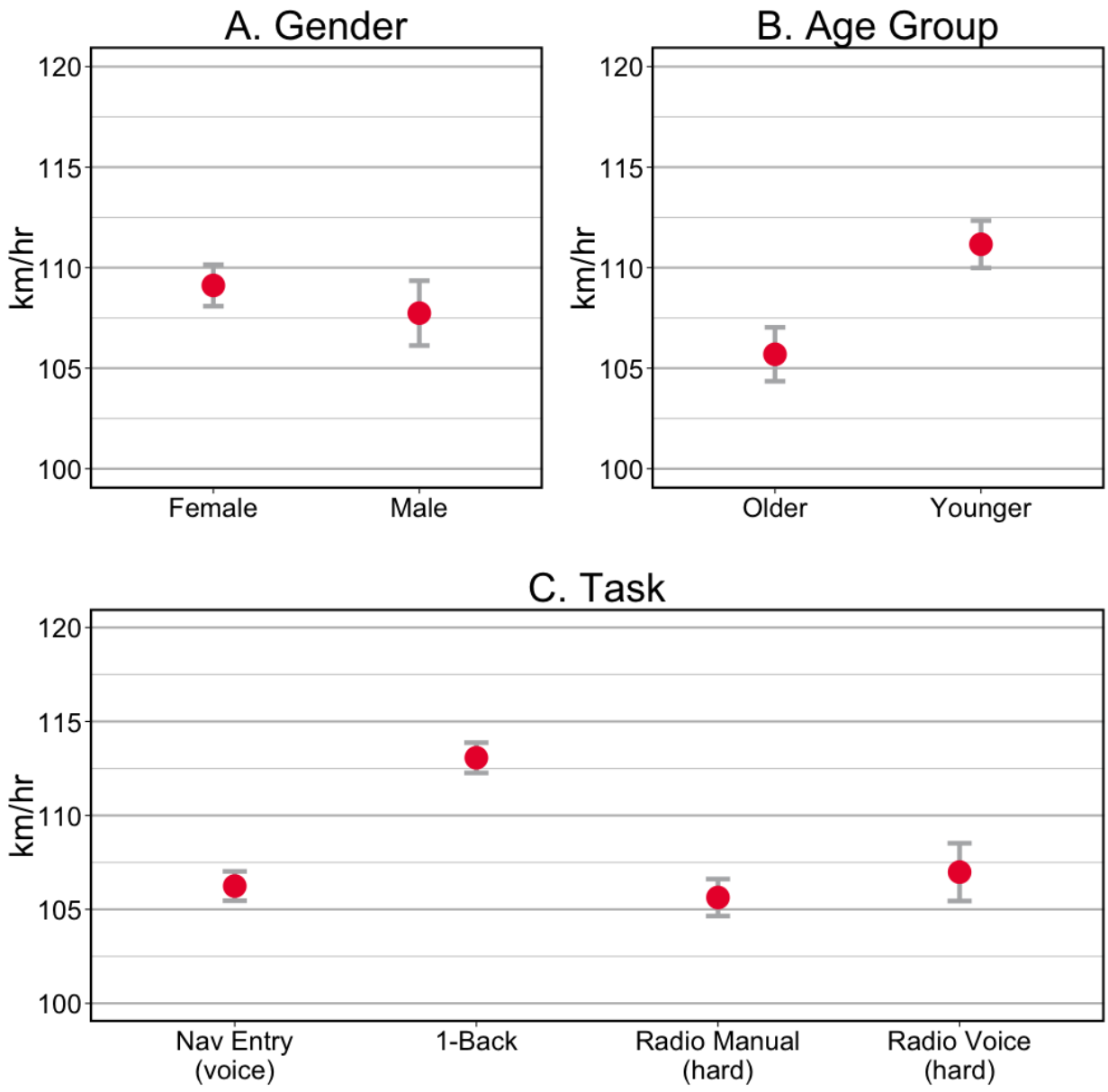


Figure B-10: Statistical summary plots of mean vehicle speed during error-free cases.

Mean speed was not affected by gender (p = .686), but was affected by age group (p = .003). Mean speed did not differ between the radio tasks (p = .209) or between the navigation entry and radio manual tasks (p = .640).

Variability of Velocity

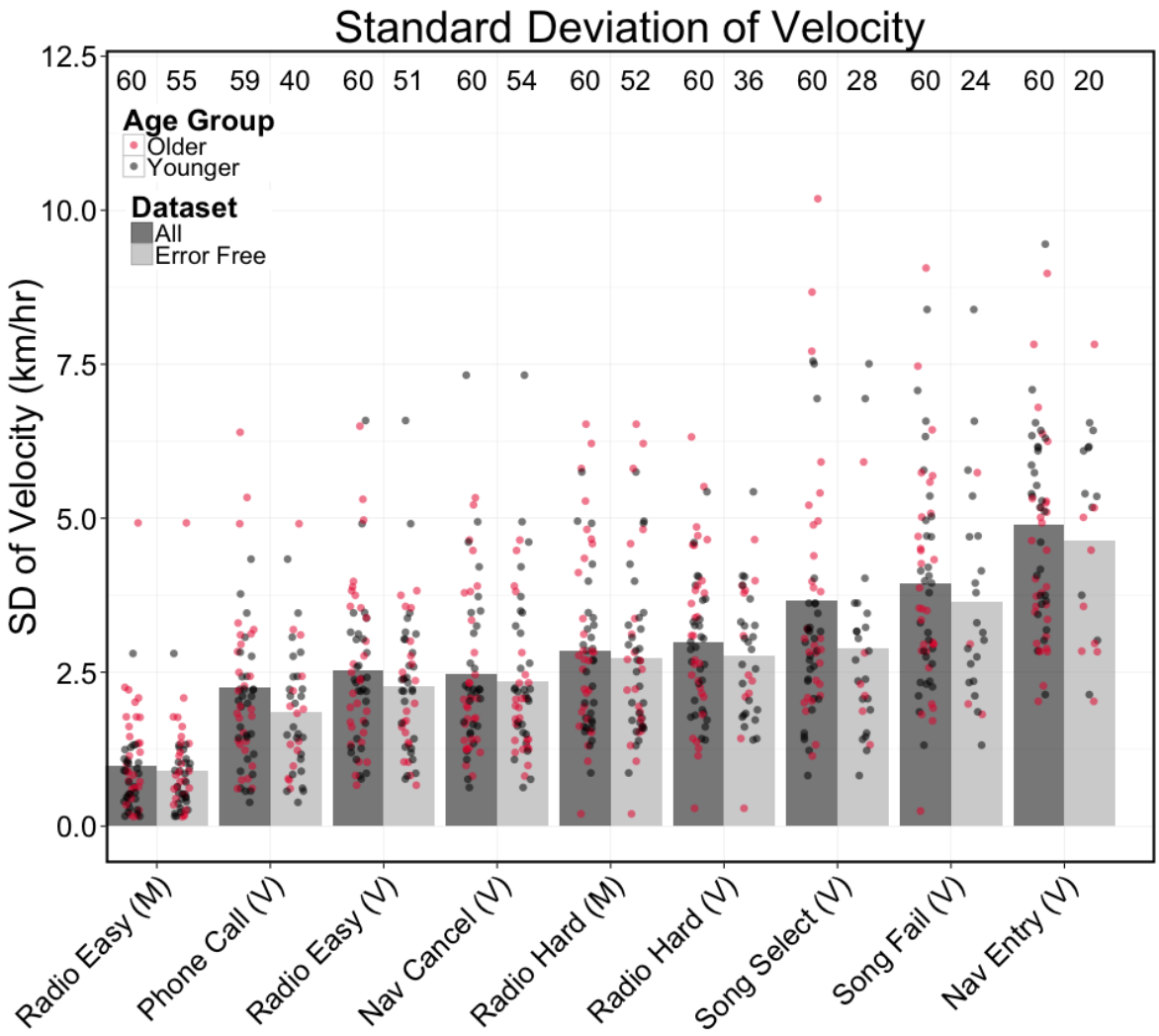


Figure B-11: Variability (standard deviation) of velocity during error-free cases (light gray).

There are few differences between the error-free and the overall samples.

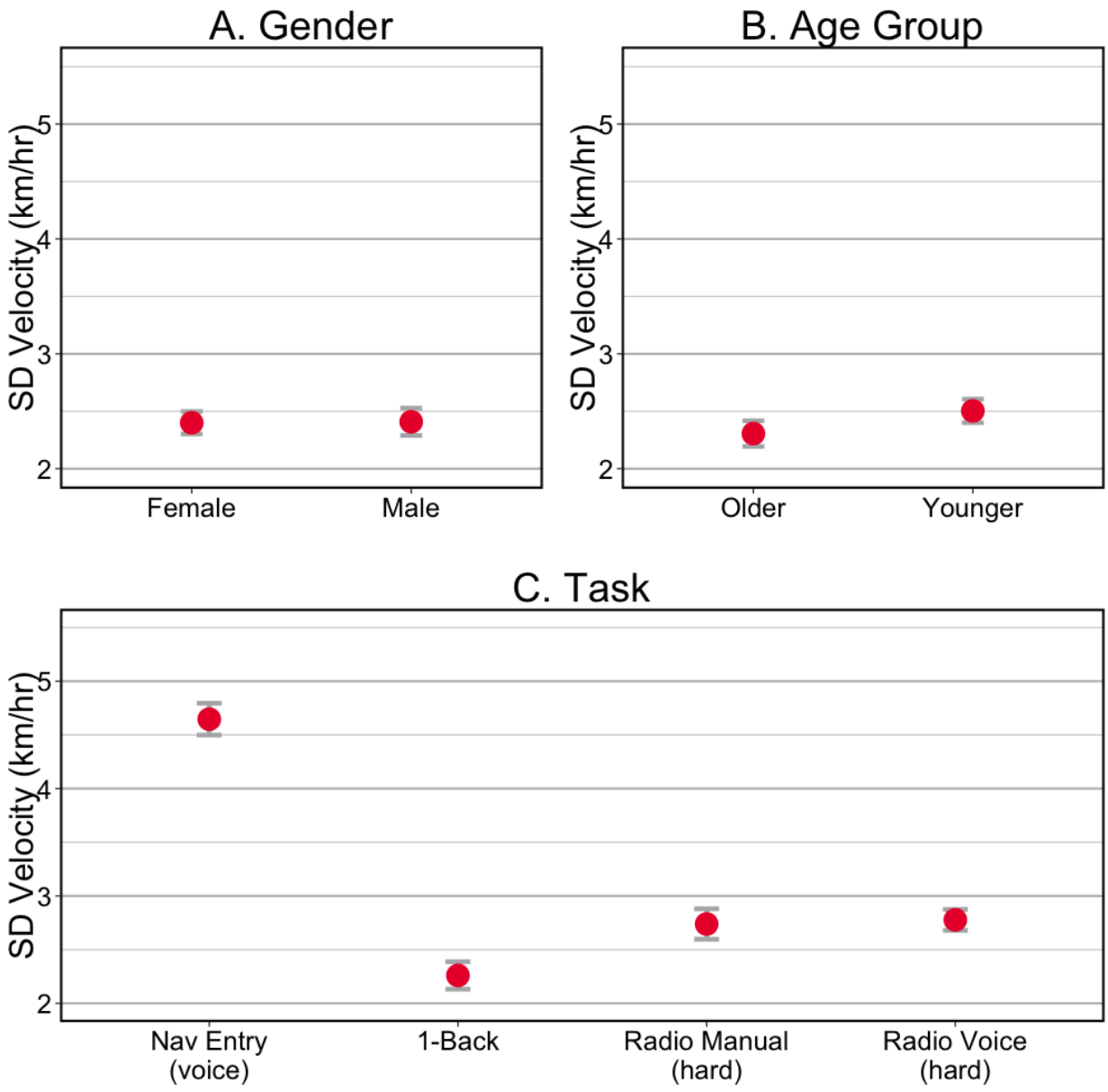


Figure B-12: Statistical summary plots for variability of velocity for error-free cases.

Variability was not affected by gender or age group ($p = .982$ and $p = .279$, respectively). Variability differed significantly between the radio manual and navigation entry tasks ($p < .001$), but did not differ between the two radio tasks ($p = .138$).

Acceleration Events

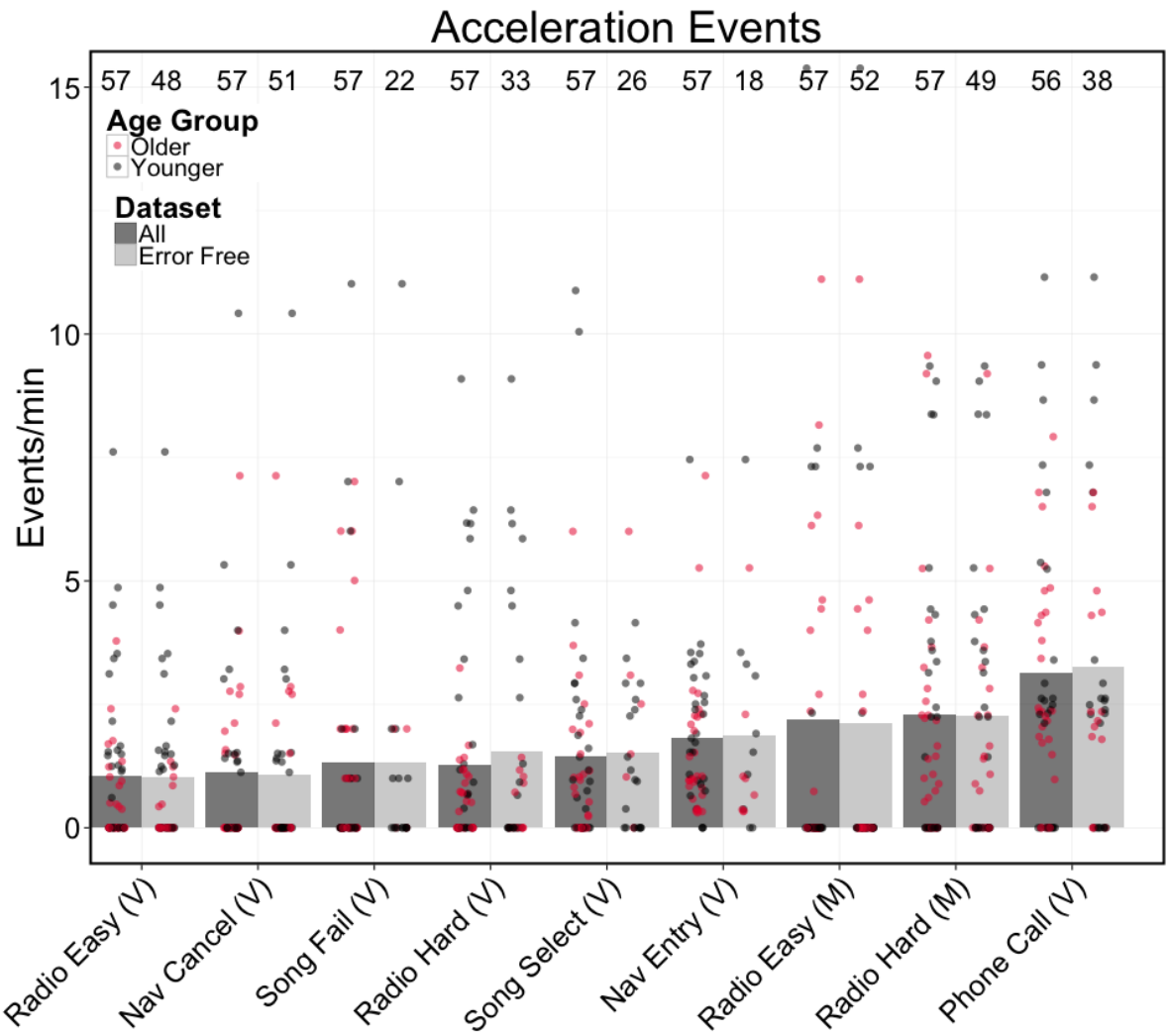


Figure B-13: Minor acceleration events (MinAE, defined as all accelerations greater than 0.1g) for error-free cases (light gray).

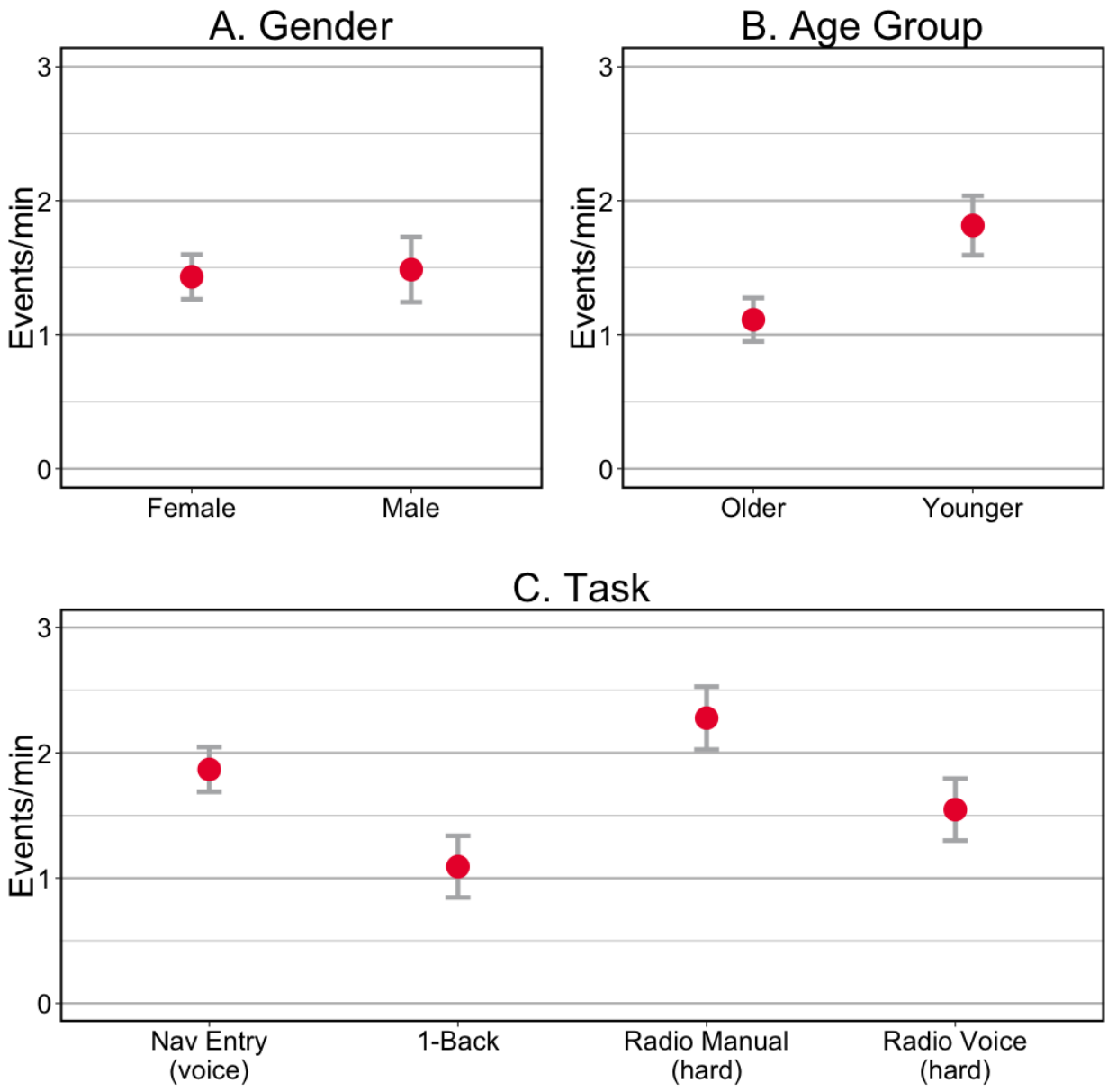


Figure B-14: Statistical summary plots for acceleration events for error-free cases.

Event frequency was not affected by gender (p = .441) or task type (p = .198 between radio tasks, p = .932 between the radio manual and navigation entry tasks), but accelerations differed significantly between age groups (p = .004), with younger participants showing more acceleration events than older ones.

Steering Wheel Angle

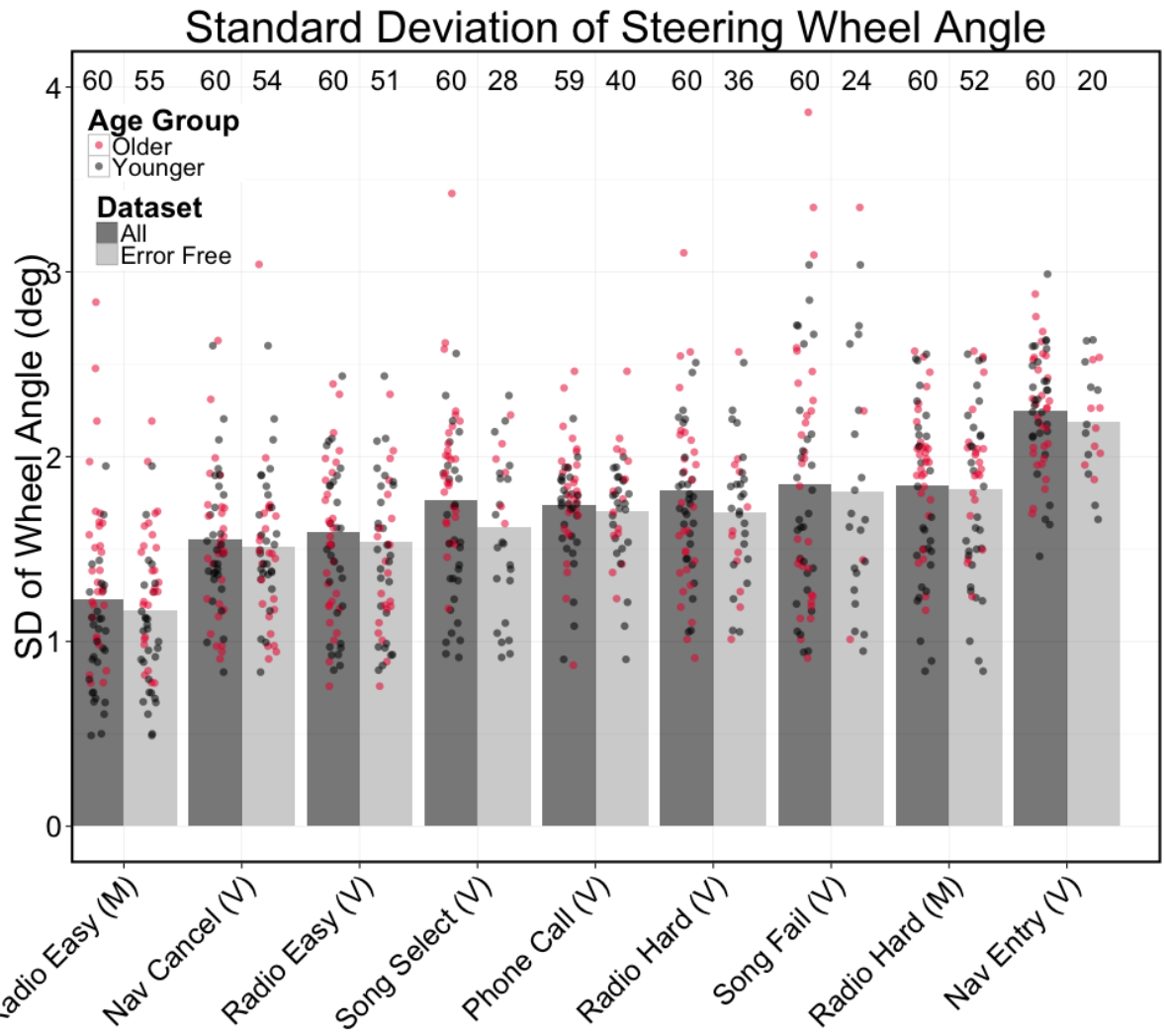


Figure B-15: Variability (standard deviation) of steering wheel angle for error-free cases (light gray).

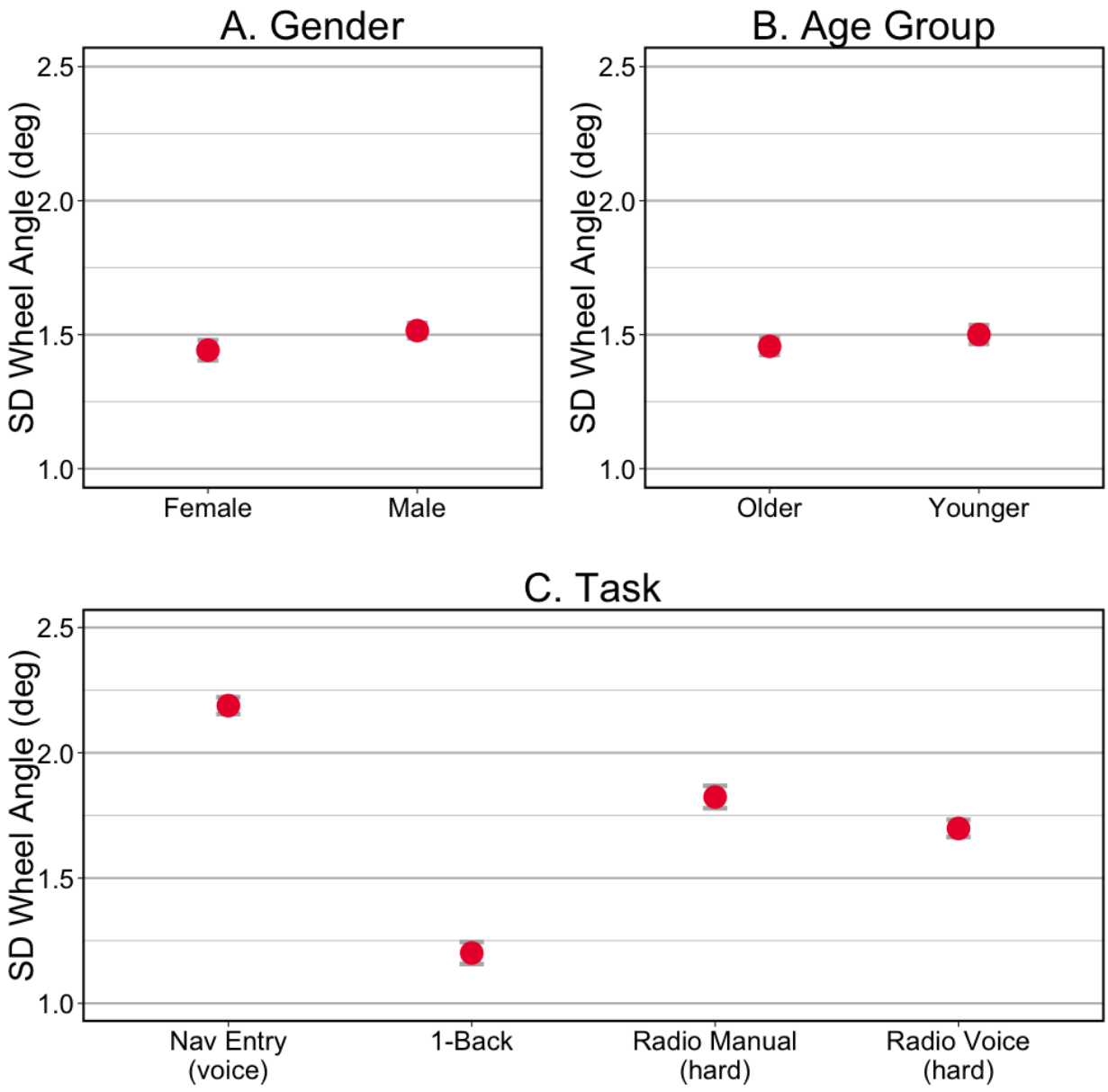


Figure B-16: Statistical summary plots for variability of wheel angle for error-free cases.

Wheel angle was not affected by gender (p = .096) or age group (p = .532). Steering wheel angle variability differed significantly between the radio manual and navigation entry tasks (p = .016), but not between the radio tasks (p = .249).

Minor Wheel Reversals

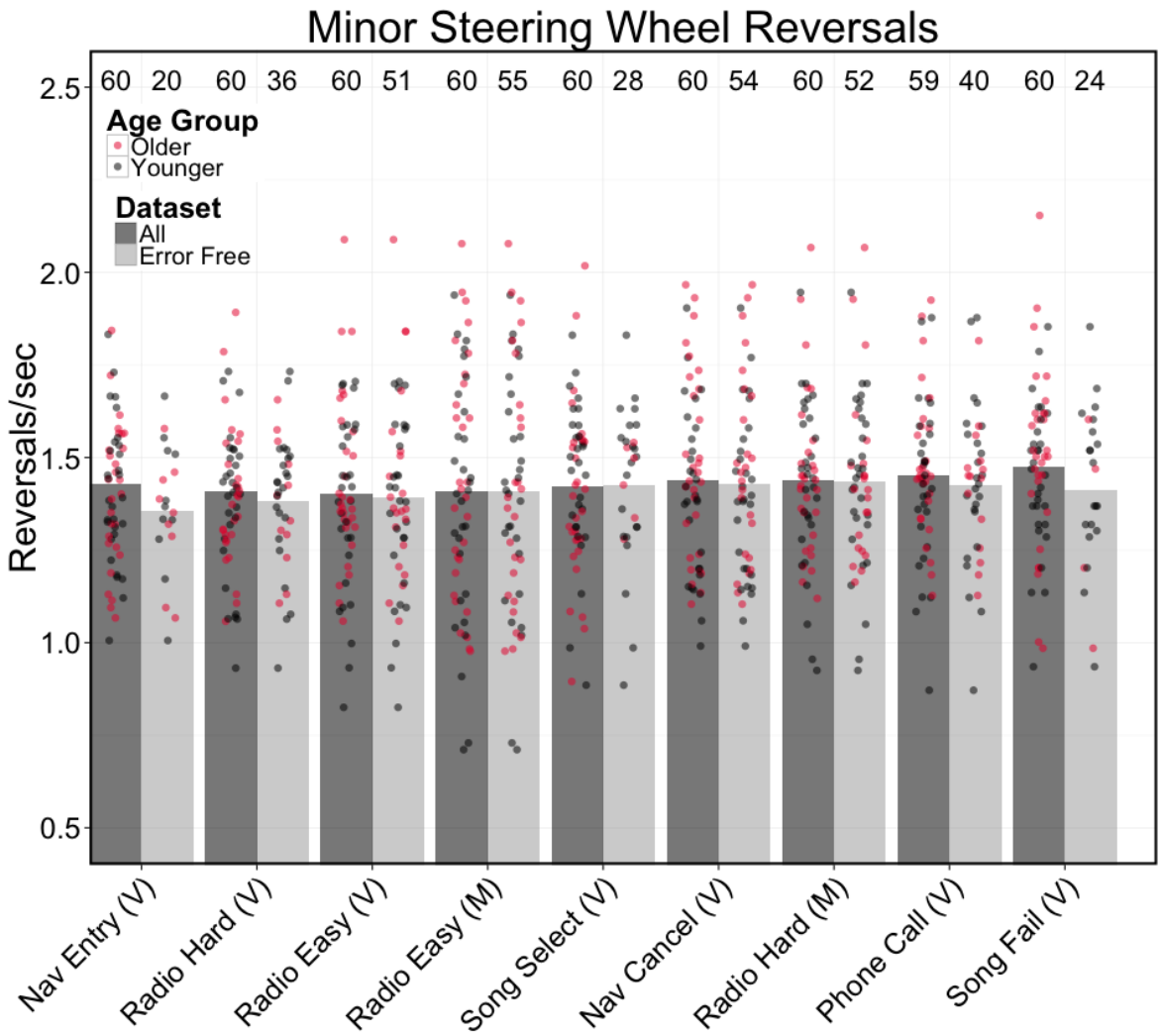


Figure B-17: Minor steering wheel reversals (see Methods) for error-free cases (light gray).

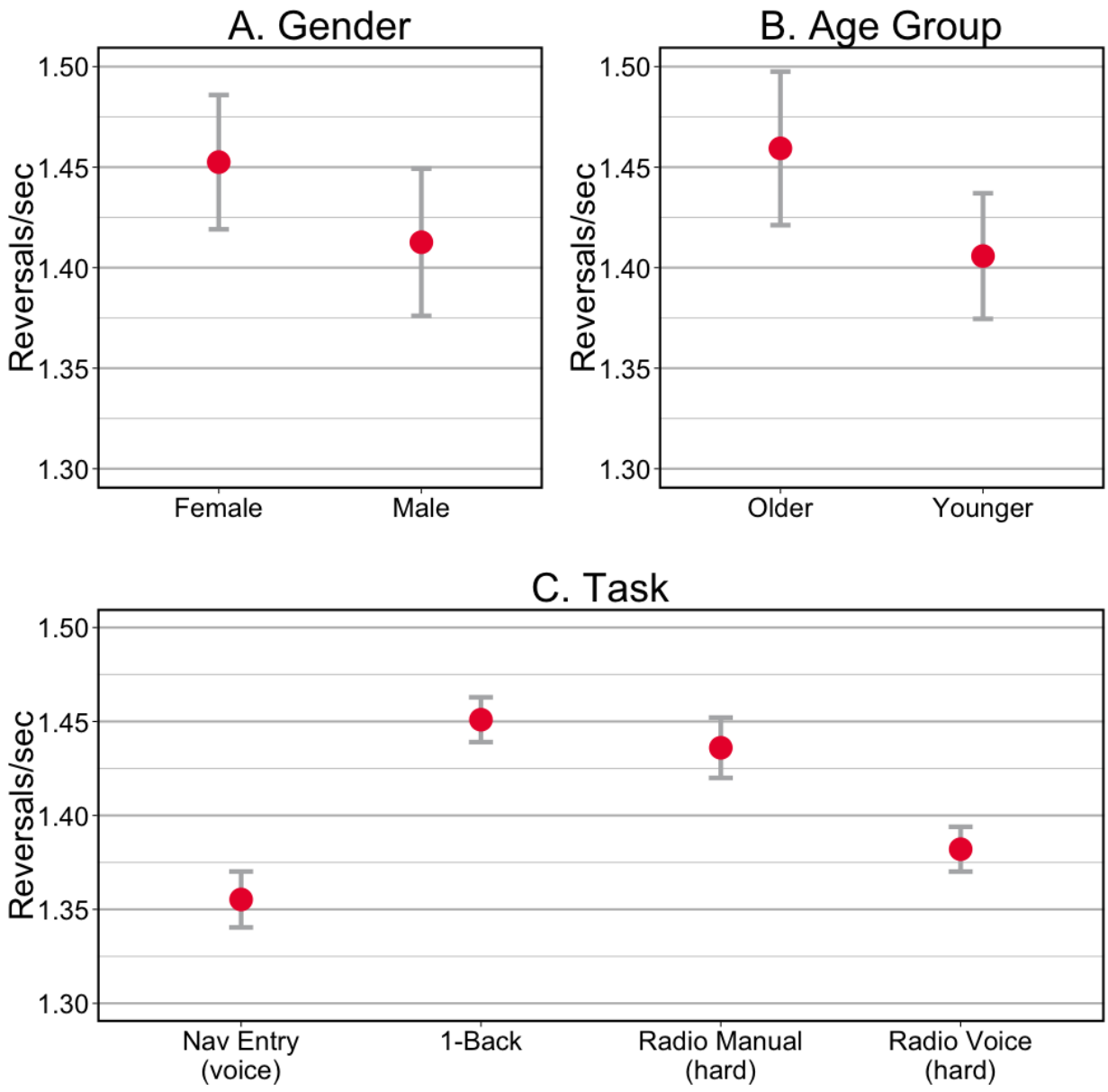


Figure B-18: Statistical summary plots for minor steering wheel reversals for error-free cases.

Wheel reversal rate was significantly affected by gender or age group ($p = .432$ and $p = .523$). Wheel reversal rate did not differ between the radio tasks ($p = .748$) or between the radio manual and navigation entry tasks ($p = .392$).

Major Wheel Reversals

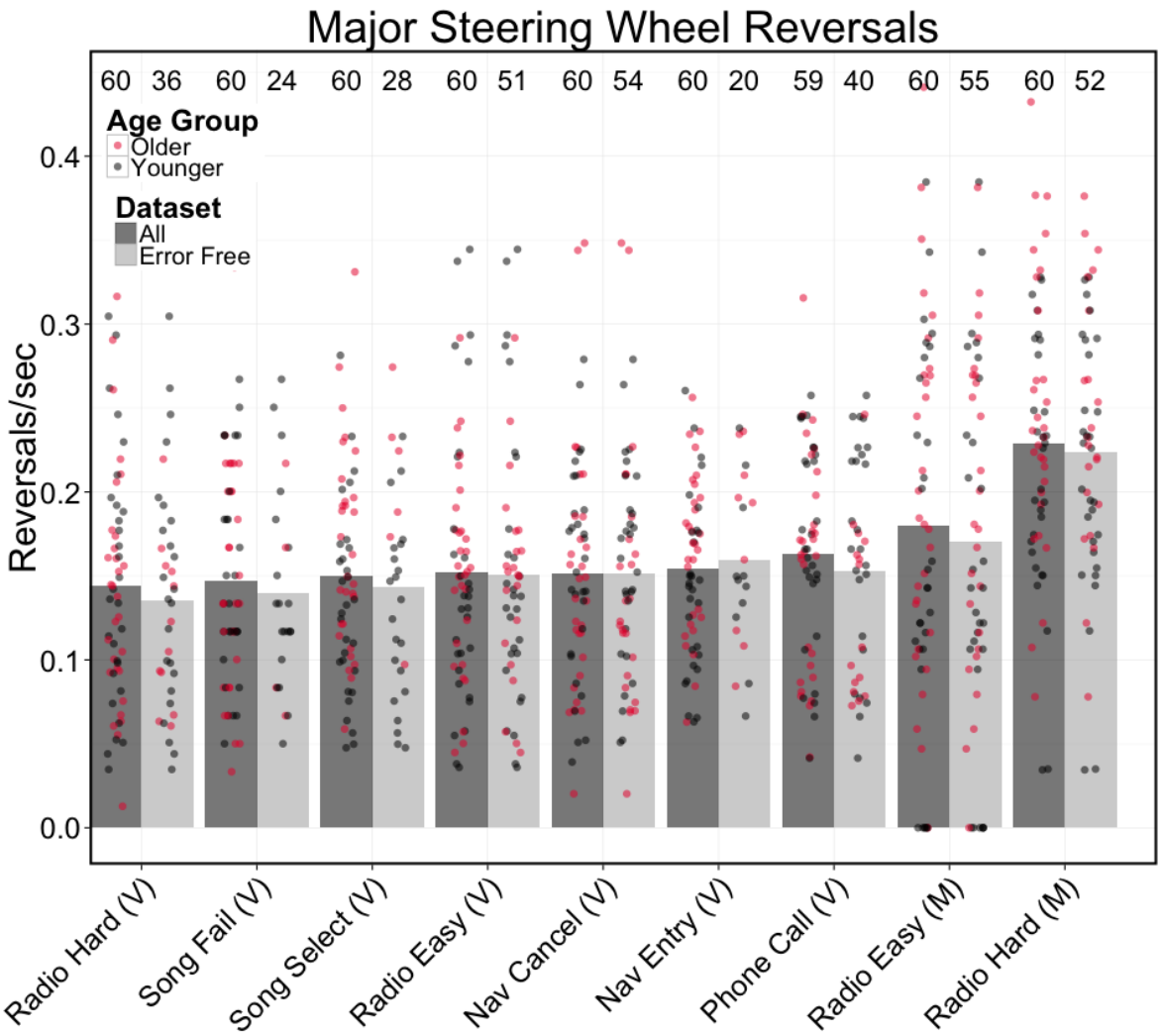


Figure B-19: Major wheel reversals for error-free cases (light gray).

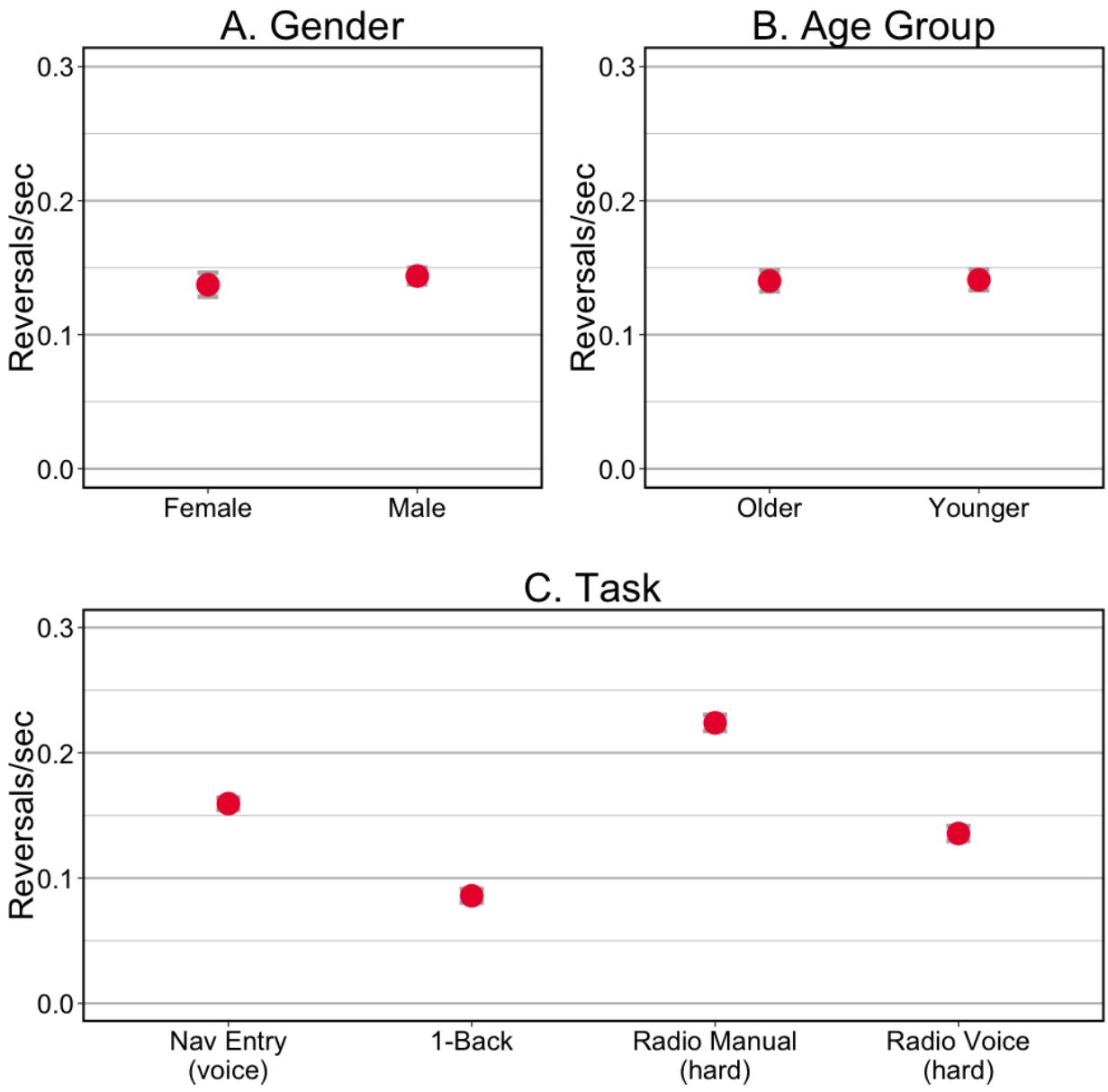


Figure B-20: Statistical summary plots for major wheel reversal rate for error-free cases.

Wheel reversals were not significantly affected by gender or age group ($p = .415$ and $p = .809$, respectively). Wheel reversals differed significantly between the radio tasks ($p < .001$) and between the radio manual and navigation entry tasks ($p = .001$).

Selected Glace Metrics Summary Table (Error Free Cases)

If one were to apply the NHTSA distraction cutpoints to the younger, older, and overall cohort, the table below (**Table B-1)** shows the percentage who would meet each of the criteria when only error-free cases are considered. Two entries are shown in italic and underlined where use of error-free cases changes a value from the entire analysis sample from below to above an 85% threshold (i.e. Song Select).

Task	Age Group	Long Duration Glances	Mean Glance Duration	Total Off-road Glance Time
Nav Cancel	Younger	96.60%	96.60%	100.00%
	Older	100.00%	100.00%	100.00%
	(all)	98.00%	98.00%	100.00%
Nav Entry	Younger	100.00%	100.00%	**18.20%**
	Older	100.00%	100.00%	**0.00%**
	(all)	100.00%	100.00%	**11.80%**
Radio Manual Easy	Younger	93.10%	100.00%	100.00%
	Older	**80.00%**	100.00%	95.00%
	(all)	87.80%	100.00%	98.00%
Radio Manual Hard	Younger	96.70%	100.00%	**73.30%**
	Older	88.20%	100.00%	**11.80%**
	(all)	93.60%	100.00%	**51.10%**
Radio Voice Easy	Younger	100.00%	100.00%	100.00%
	Older	100.00%	100.00%	93.80%
	(all)	100.00%	100.00%	97.80%
Radio Voice Hard	Younger	100.00%	100.00%	87.50%
	Older	100.00%	100.00%	***88.90%***
	(all)	100.00%	100.00%	87.90%
Song Select	Younger	95.50%	100.00%	90.90%
	Older	100.00%	100.00%	**75.00%**
	(all)	96.20%	100.00%	***88.50%***
Song Fail	Younger	100.00%	100.00%	**20.00%**
	Older	100.00%	100.00%	**50.00%**
	(all)	100.00%	100.00%	**25.00%**
Phone	Younger	100.00%	100.00%	93.30%
	Older	100.00%	100.00%	**68.20%**
	(all)	100.00%	100.00%	82.70%

Mean Off-Road Glance Duration

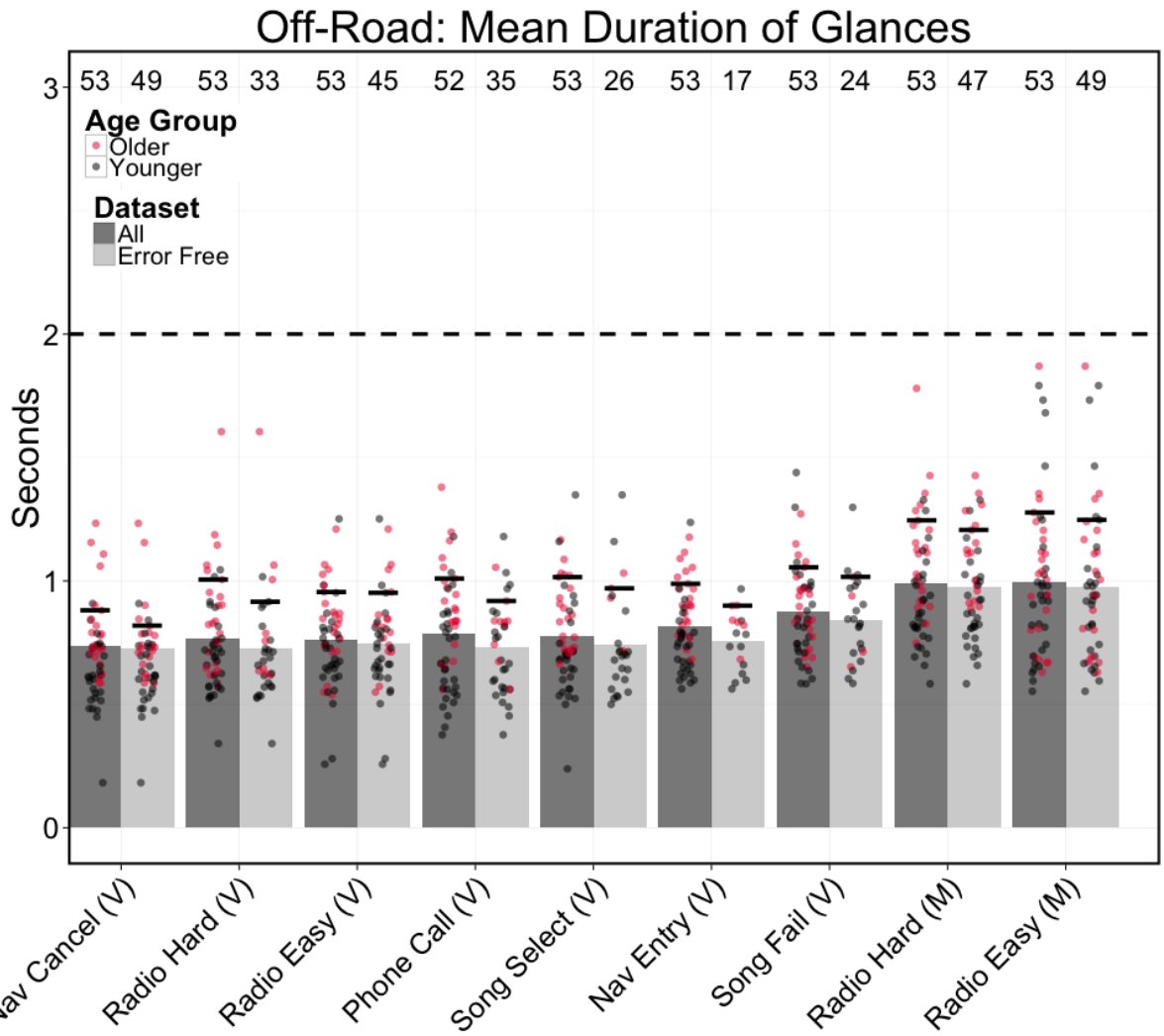


Figure B-21: Mean duration of glances during error-free cases (gray).

Mean glance duration is largely unchanged compared to the primary sample, despite a large reduction in sample size for some tasks, such as Navigation Entry.

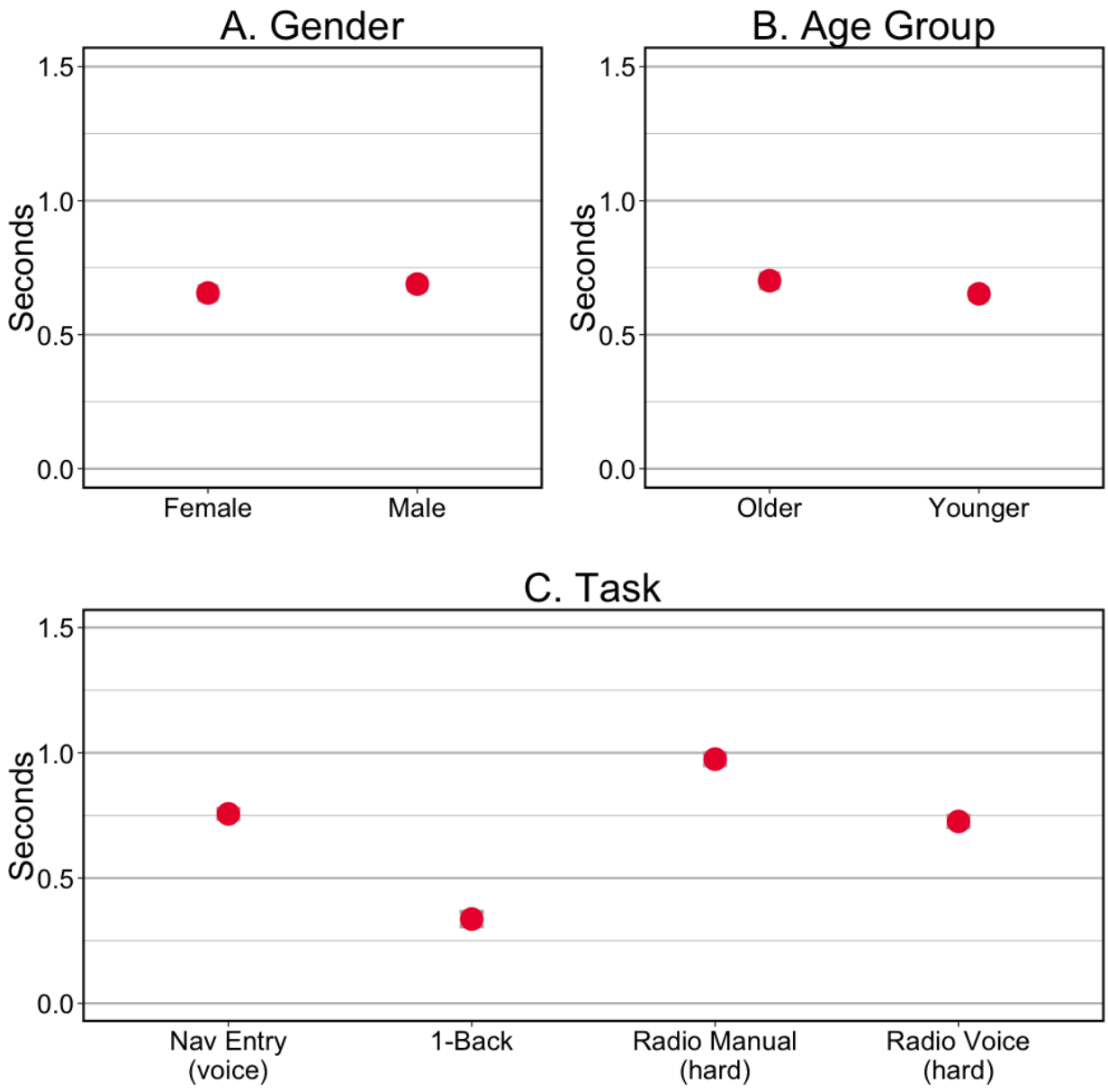


Figure B-22: Statistical summary plots for mean glance duration for error-free cases.

Mean glance duration was not affected by gender ($p = .306$) or age group ($p = .135$). Mean glance rate differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$).

Percentage of Long Duration (> 2s) Glances

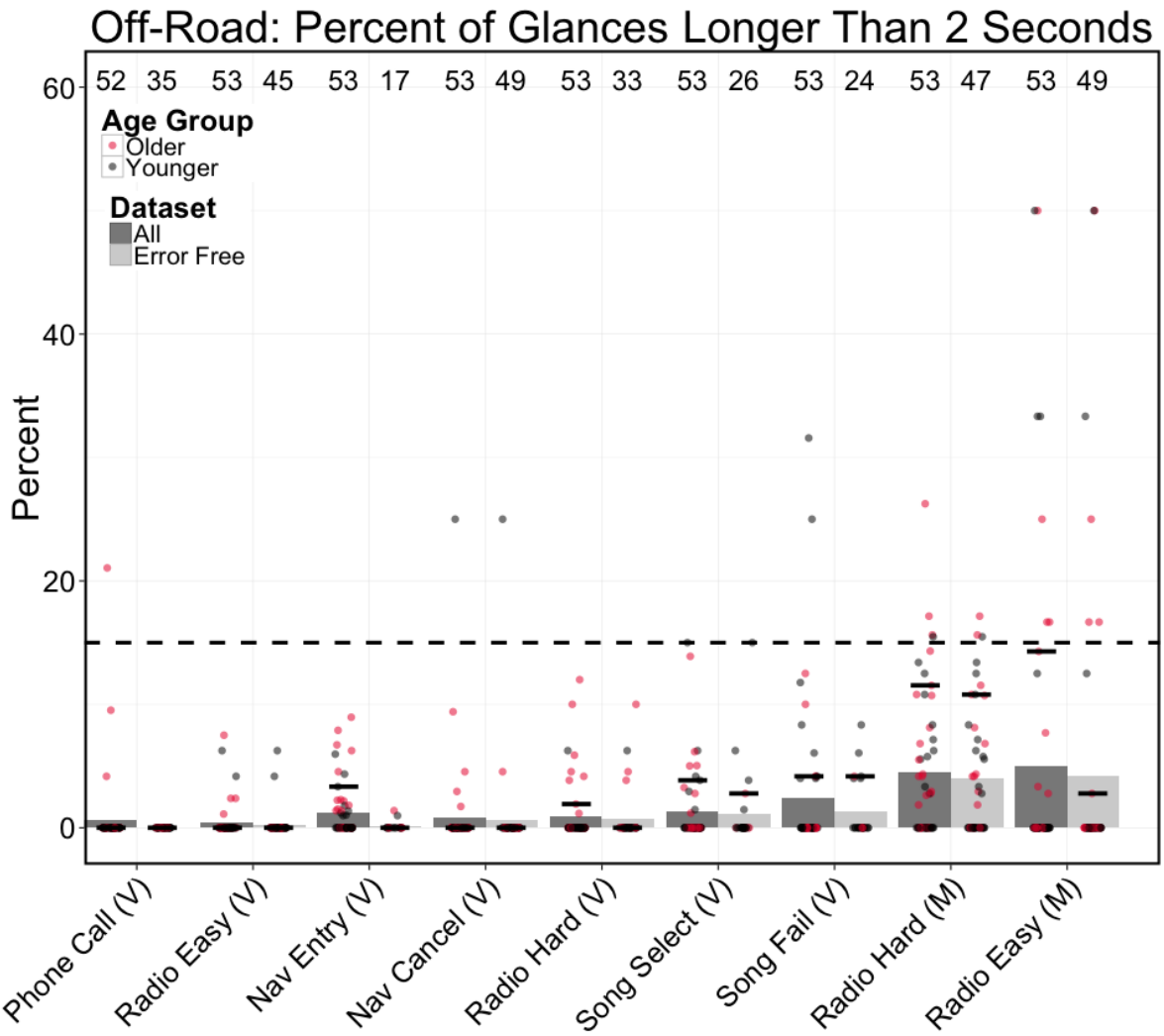


Figure B-23: Long glance rate for error-free cases (light gray).

The manual Radio Easy task represents one of the few cases where restricting the analysis to error-free cases appears to have an appreciable impact on the Long Glance Rate metric. In this instance, the 85% point for the sample moves from being just under the criterion to being markedly below.

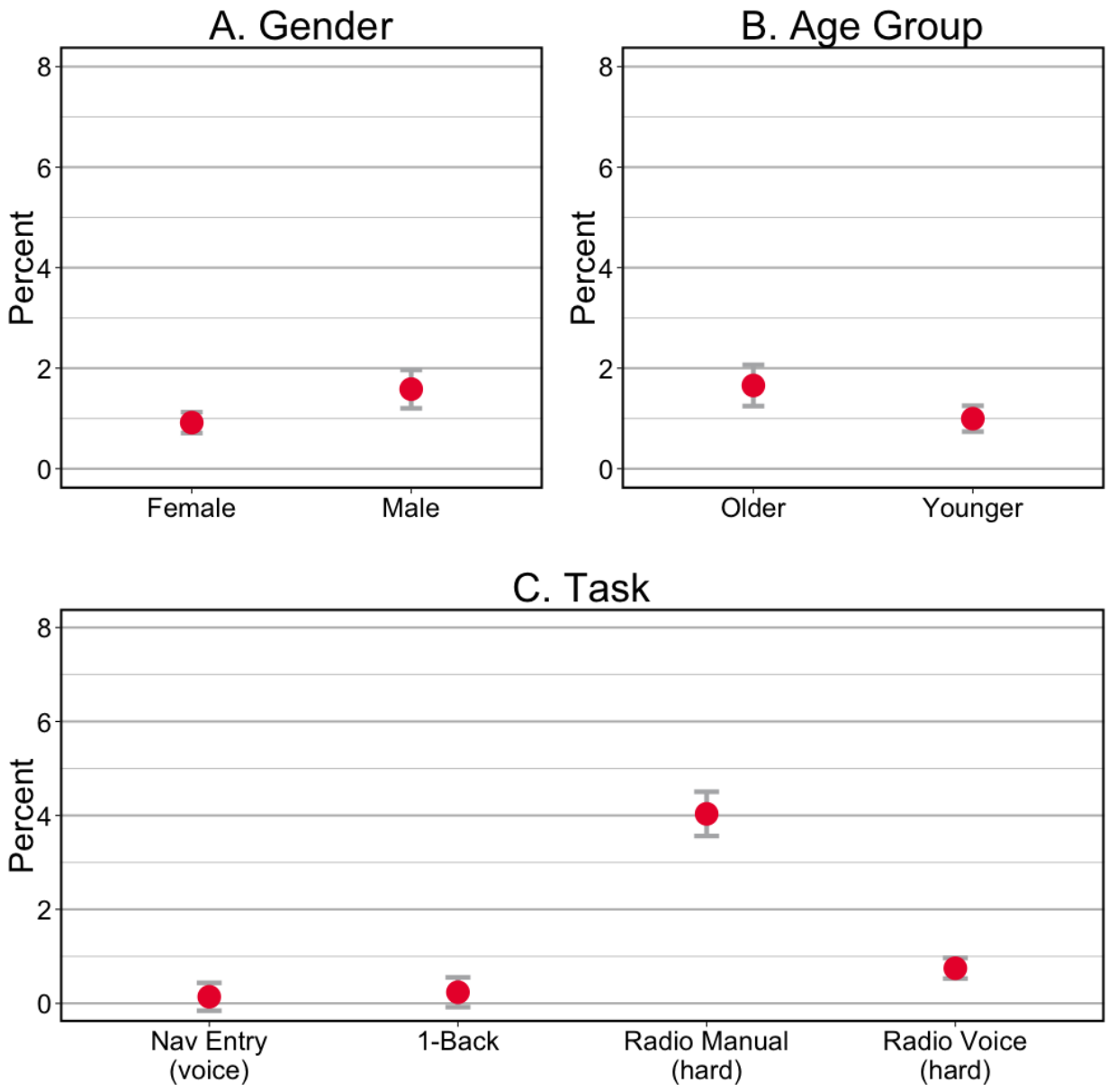


Figure B-24: Statistical summary plots for long glance rate for error-free cases.

Long glance rate was not affected by gender (p = .381), or age group (p = .143). Long glance rate differed significantly between the radio tasks (p = .001) and between the radio manual and navigation entry tasks (p = .022).

Total Off-Road Glance Time

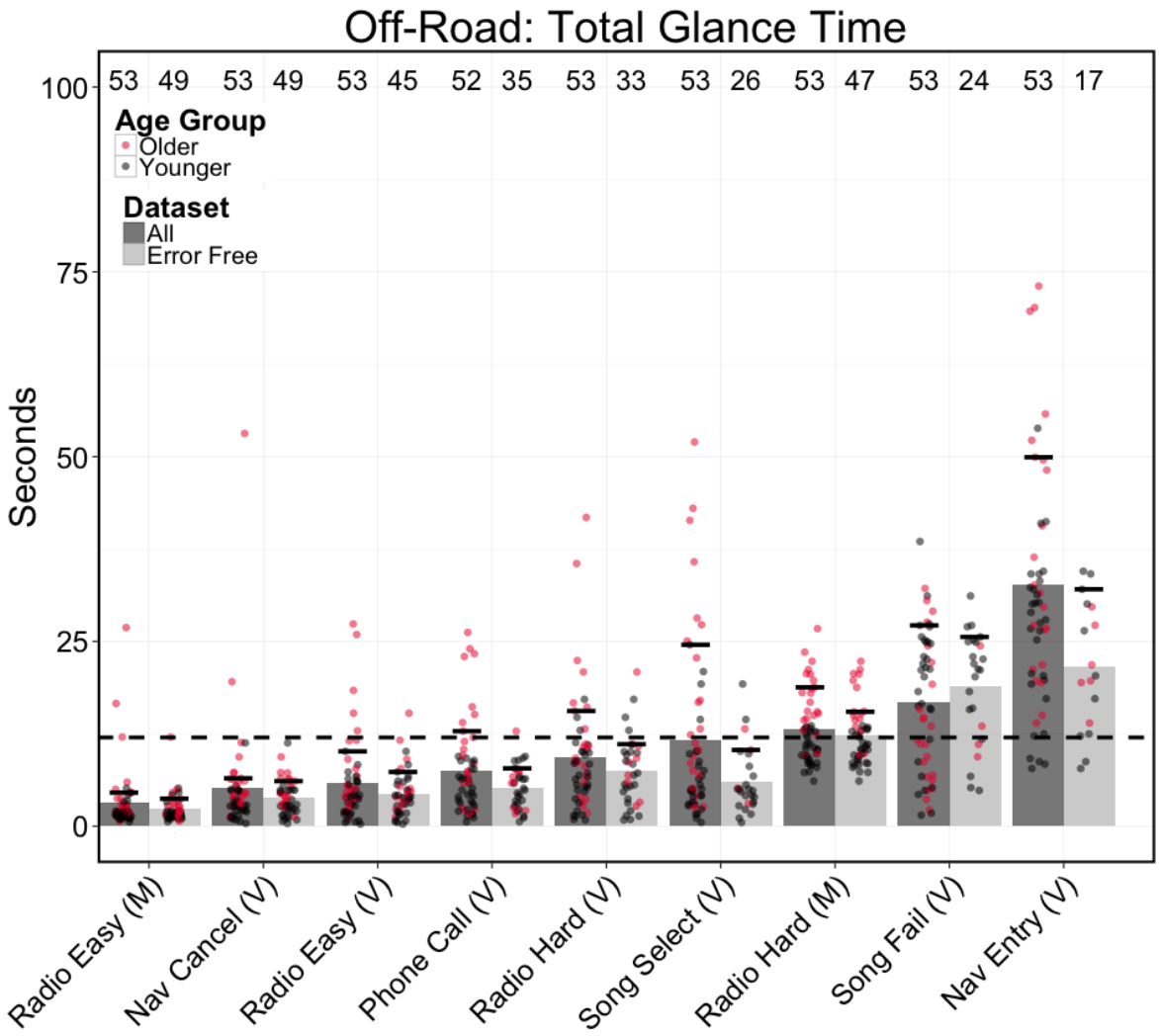


Figure B-25: Total off-road glance time during error-free cases (light gray).

Note the significant reduction in glance time for the error-free cases for the Navigation Entry task compared to the overall sample. Nonetheless, total glance time for these cases was still markedly above the 85% criteria for both The Alliance 20 second threshold (criterion 2.1 A), and the NHTSA 12 second threshold for this task. The Phone Dialing, manual Radio Hard tuning task, and the Song Fail task also produced the same result where or not the error-free restriction on case inclusion was applied. Only in the cases of the voice command version of the Radio Hard task and the Song Selection task, does use of the use of the error-free restriction make a difference in whether the 85% criteria is met.

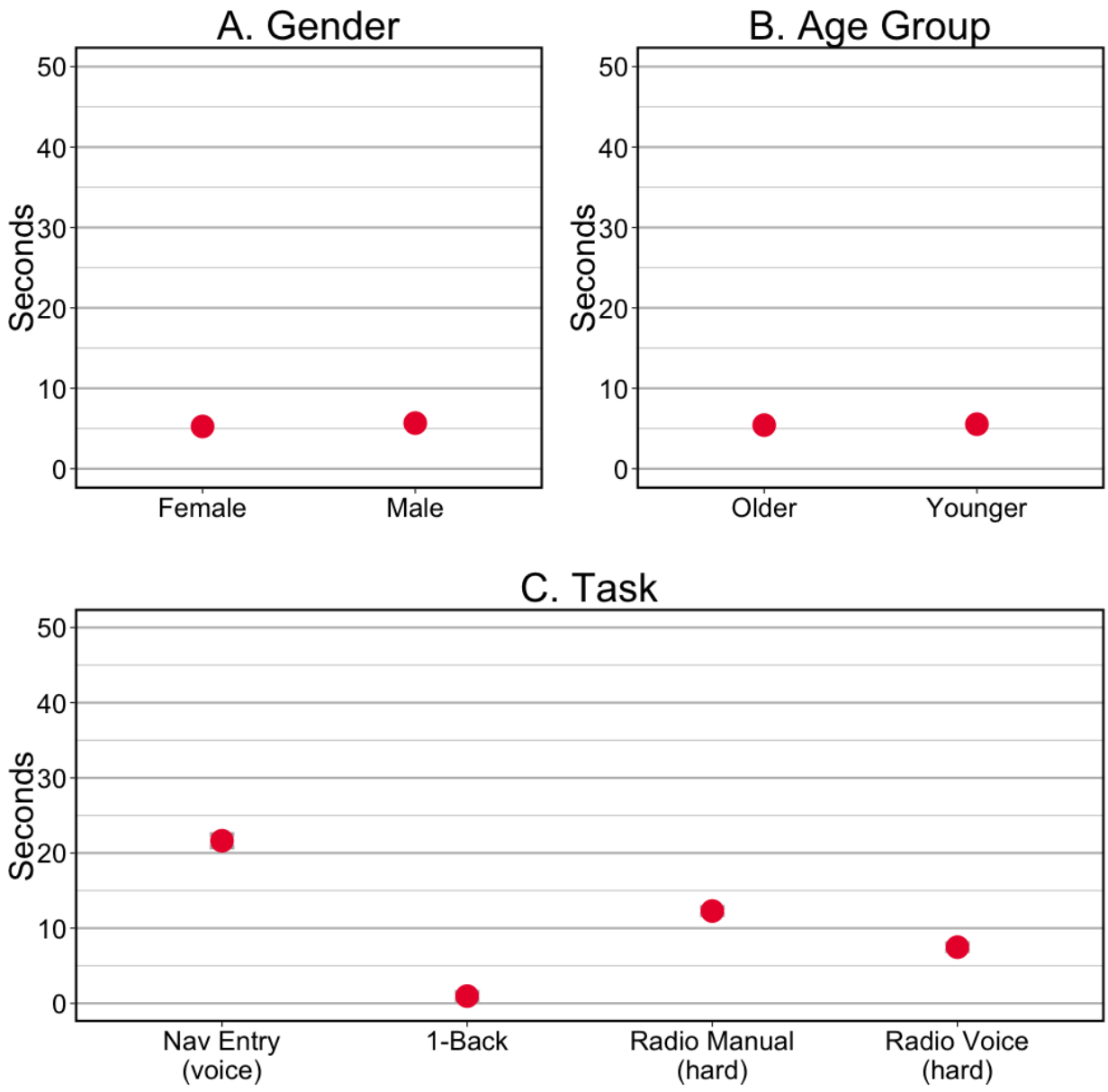


Figure B-26: Statistical summary plots for total glance time during error-free cases.

Glance time was not affected by gender ($p = .756$), or age group ($p = .624$). Glance time also differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

Number of Glances

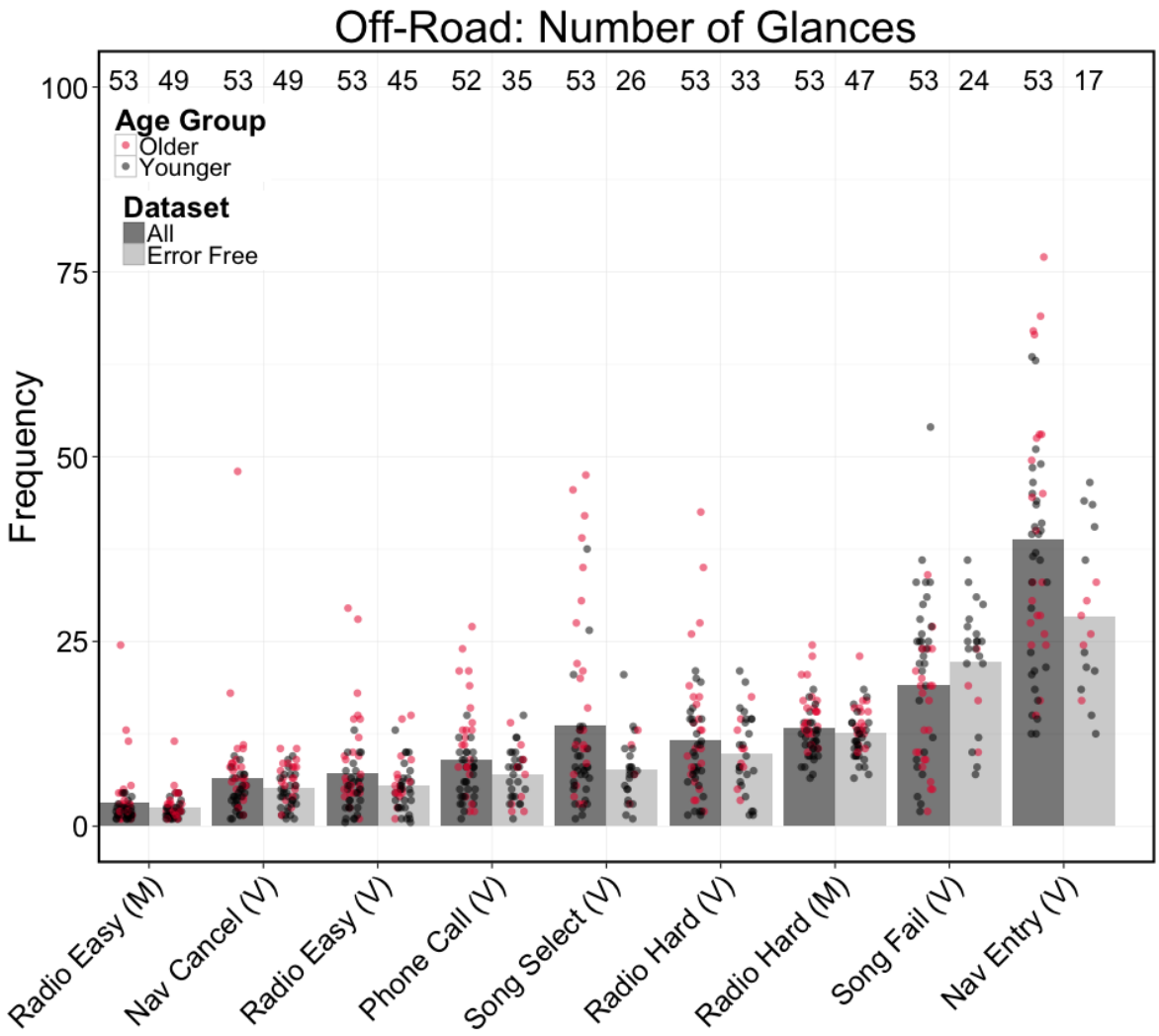


Figure B-27: Total number of off-road glances during error-free cases (light gray).

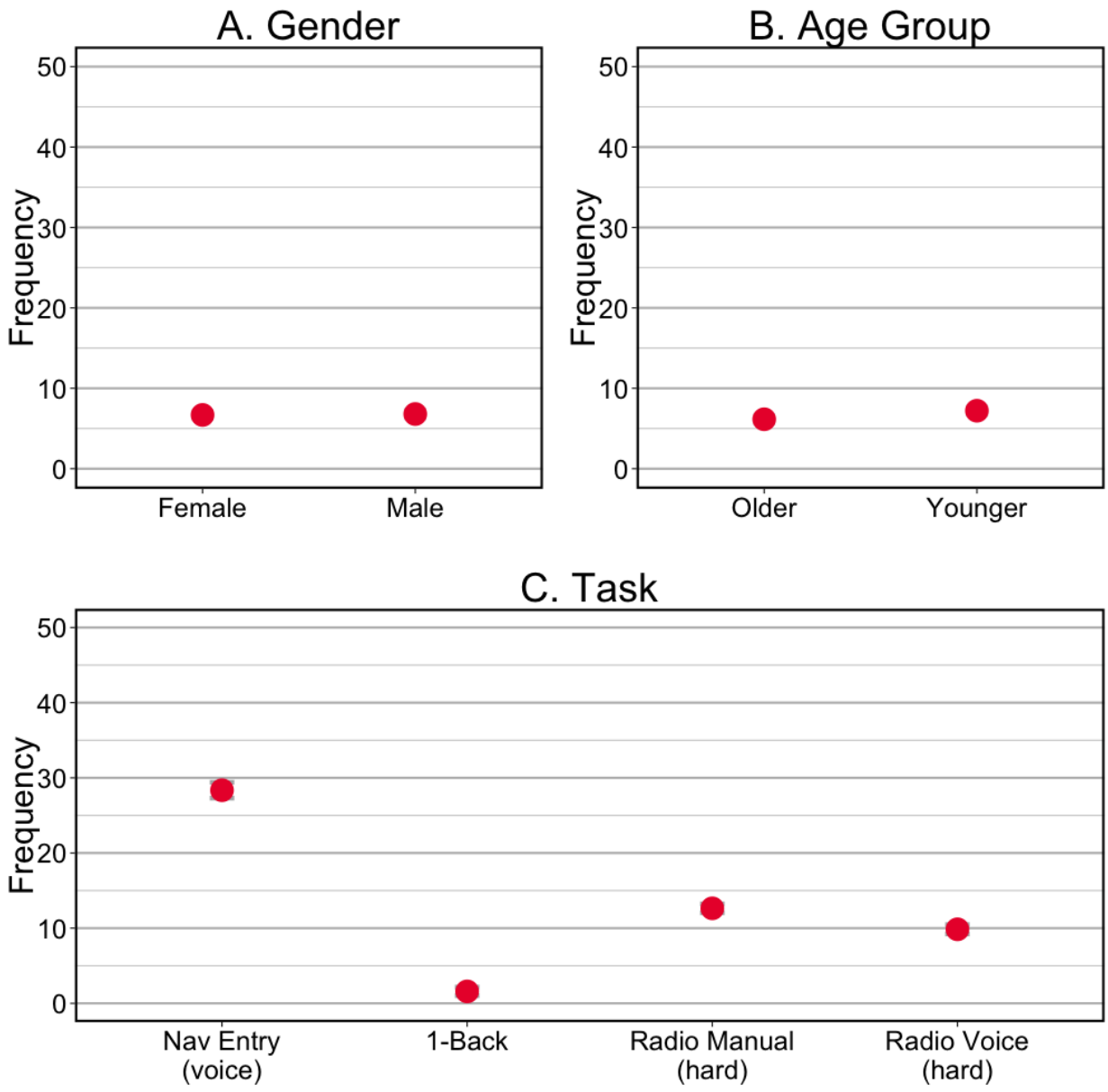


Figure B-28: Statistical summary plots for total number of off-road glances during error-free cases.

Number of glances was not affected by gender or age group ($p = .907$ and $p = .112$, respectively). Number of glances did not differ significantly between the radio tasks ($p = .079$), but did differ between the radio manual and navigation entry tasks ($p < .001$).

Orienting Response

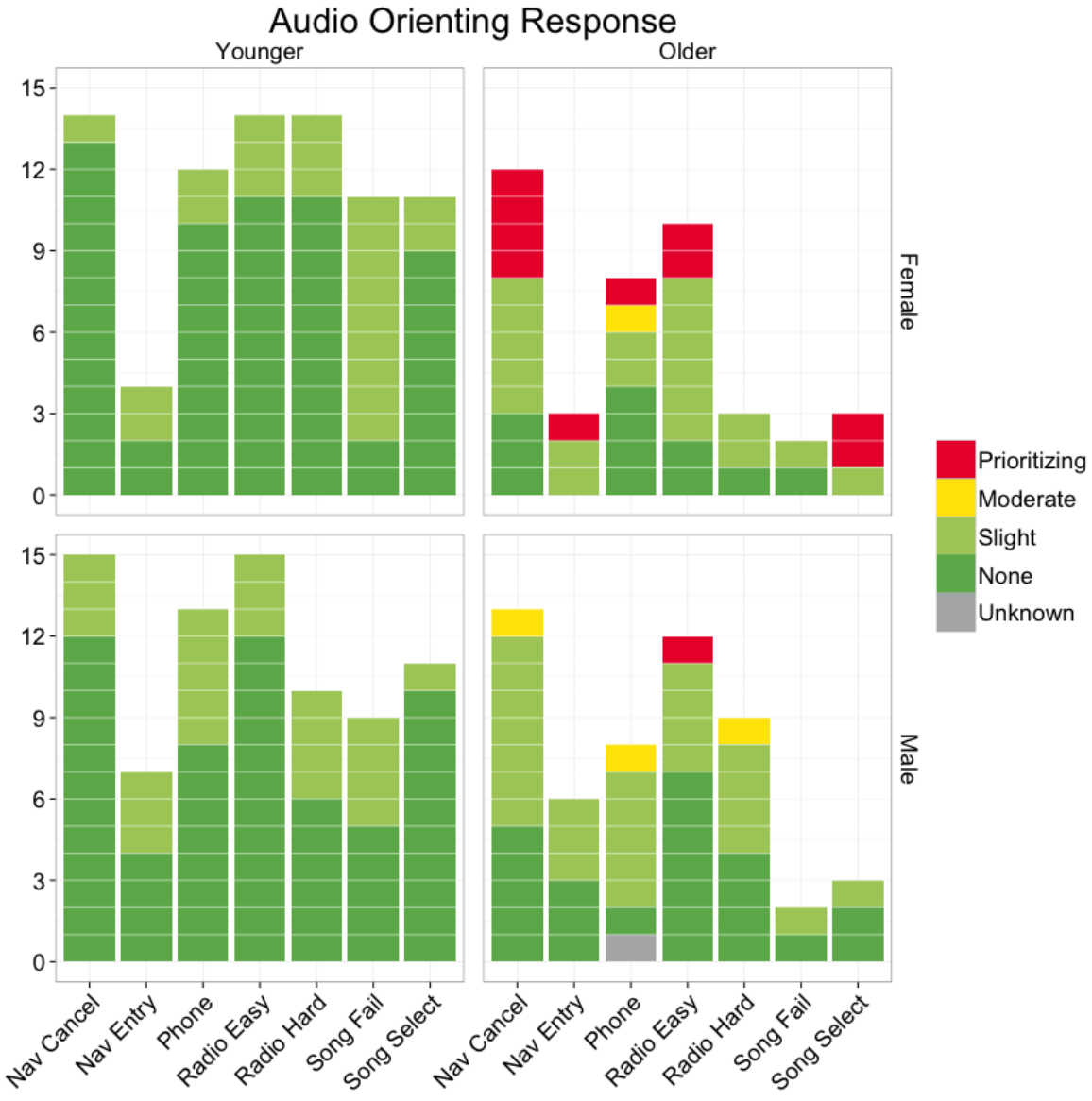


Figure B-29: An illustration of the Orienting Response for error-free cases.

Due to the varying number of participants in each subgroup, formal statistical analyses were not undertaken. However, it is apparent from the data that the OR effect is influenced most strongly by older women, even in error-free scenarios. As noted elsewhere, it should be noted that this analysis does not explicitly distinguish glances for visual confirmation from glances associated with OR behavior, and it is recognized that this is a partial confounding factor in evaluating this behavior pattern. (See Appendix D for definitions and coding details.)

APPENDIX C: TRIAL COMPARISON ANALYSIS

Introduction

The study design exposed drivers to each of the secondary tasks a number of times. First, each task was practiced while the vehicle remained parked. Tasks were practiced until participants felt comfortable performing them. During the on-road portions of the protocol, all tasks were performed twice (except the Song Fail task). In most instances, the two trials were sequential. For example, the two radio easy tasks (selecting a preset station) were presented one after another. In the case of the Navigation tasks, participants were presented with the first Navigation Entry task, followed by the first Navigation Cancel task, and then the second Navigation Entry task.

The Primary Analysis represents an aggregation of the two trial replications for each task, i.e. metrics were averaged across the two trials. Sampling behavior across two trials helps reduce extraneous variability in the data that might have arisen from factors such as momentary changes in driving demands or fluctuating attention. However, this aggregation may mask informative differences between the First Trial and Second Trial replications. As participants become more comfortable balancing the demands of each task with the demands of driving, their behaviors and physiological responses may change in a meaningful way. In other words, there may be learning or other experiential effects. Therefore, it would be useful to examine each set of replications separately. As noted earlier, it is also the case that the new NHTSA visual-manual guidelines for measuring visual-manual distraction recommend a practice trial under (simulated) driving conditions followed by one or more evaluation trials. Under this model, trial one would be considered the driving practice trial and the second trial would be considered the evaluation trial.

Methods

The methodology is the same as described in the Primary Analysis. However, all data presentation and analyses now examine the First Trial and Second Trial replications of each task separately. Task plots present trial data side-by-side, with dark gray bars representing the First Trial, and light gray bars representing the Second Trial. Statistical summary plots are presented separately for each trial type.

Note that the Song Fail task is excluded from this analysis, as this task was performed only once.

Results

Task Completion Time

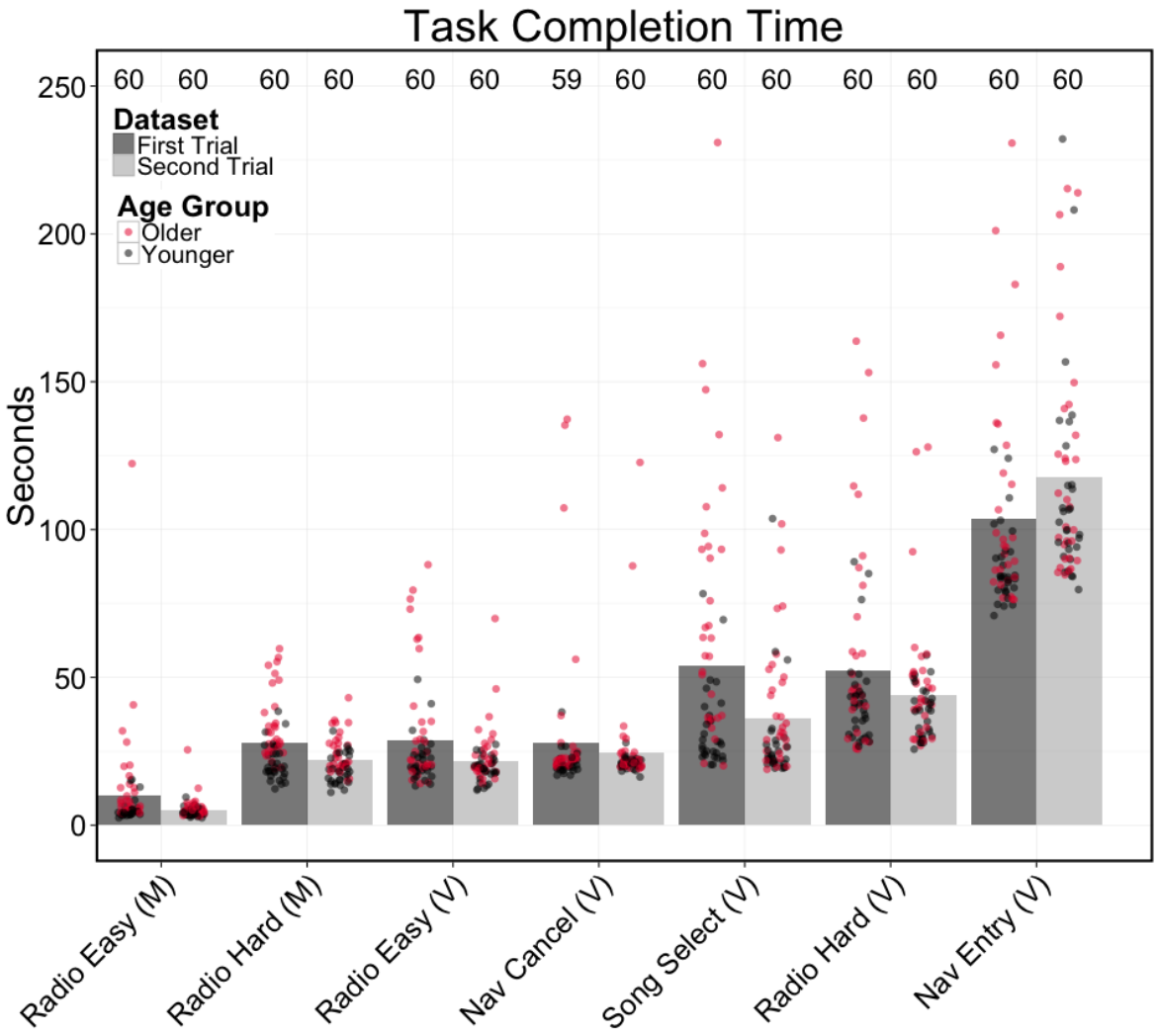


Figure C-1: Task completion for each task trial (dark gray for trial 1 and light gray for trial 2).

Completion time generally decreases during the second trial, except for the Navigation Entry and Phone tasks, which both increased (both statistically significantly, $p < .05$).

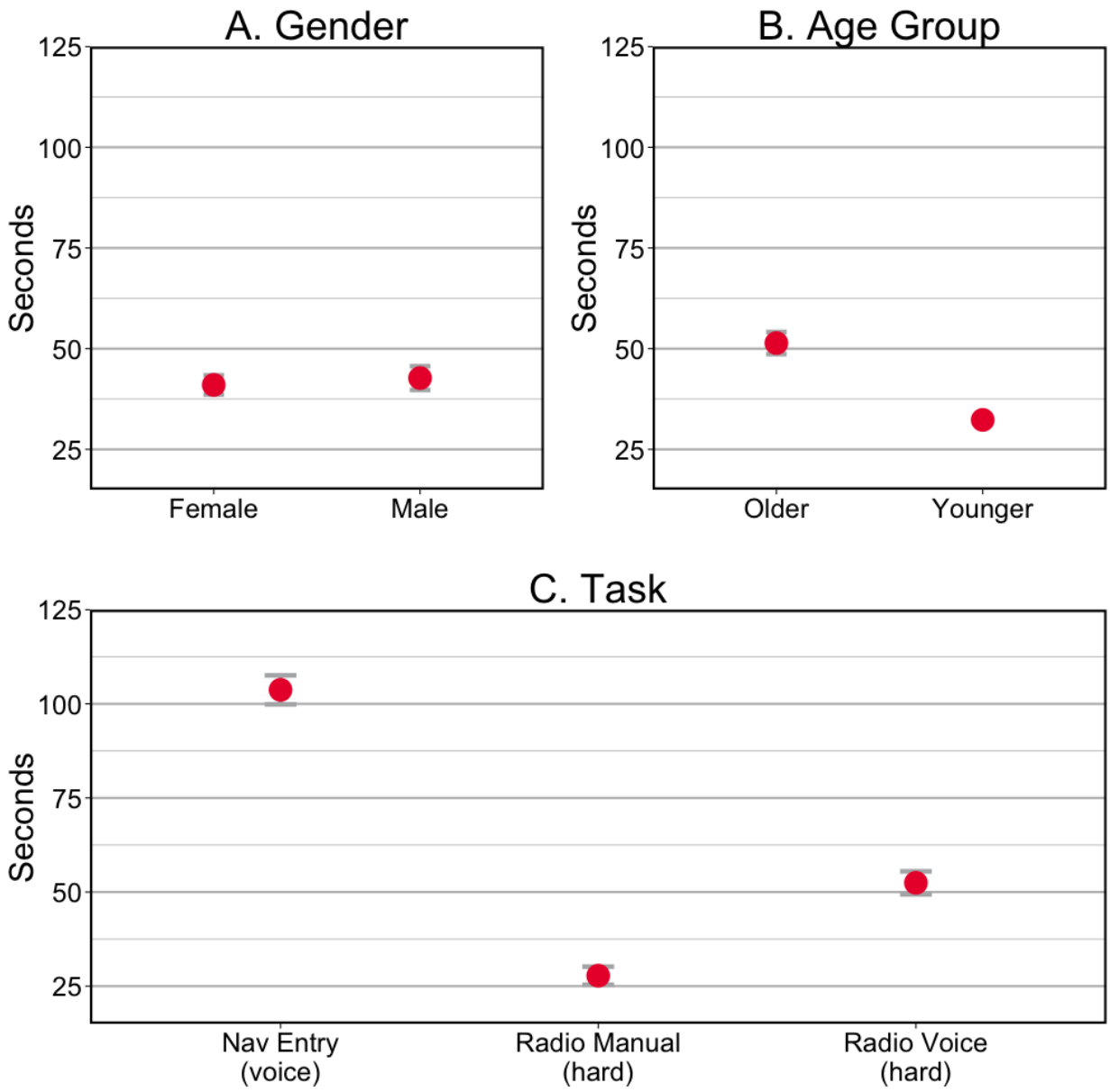


Figure C-2: Statistical summary plots for task completion time (**First Trial**).

The effect of gender was not significant ($p = .654$). Age group was significant ($p < .001$), with older participants taking longer to complete tasks than younger participants. Task completion time differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

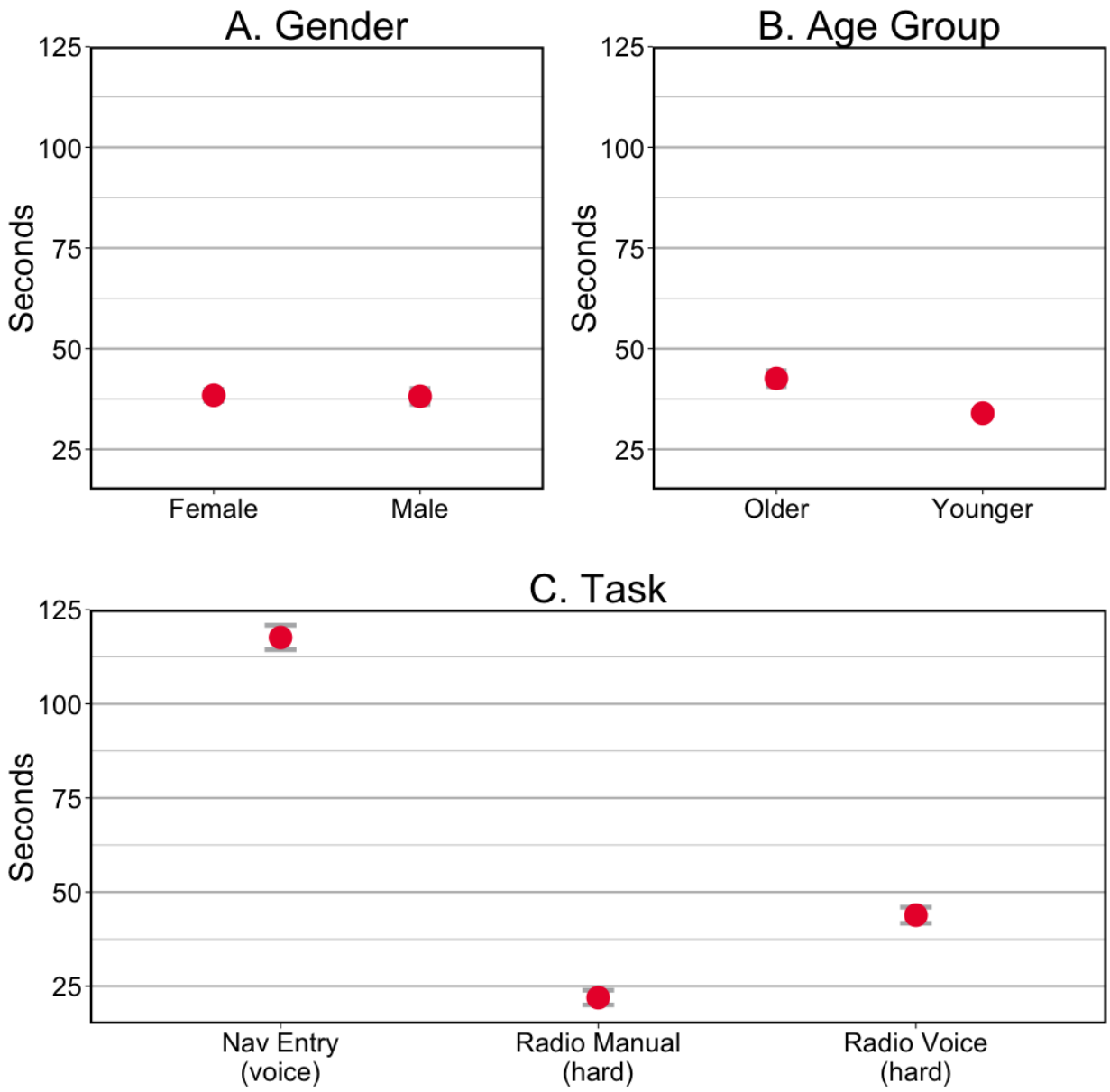


Figure C-3: Statistical summary plots for task completion time (**Second Trial**).

The pattern of findings for Trial 2 was consistent with the findings for Trial 1. The effect of gender was not significant ($p = .686$). Age group was significant ($p < .001$), with older participants taking longer to complete tasks than younger participants. Task completion time was significantly different between the radio tasks and between the radio manual and navigation entry task ($p < .001$ for both).

Heart Rate

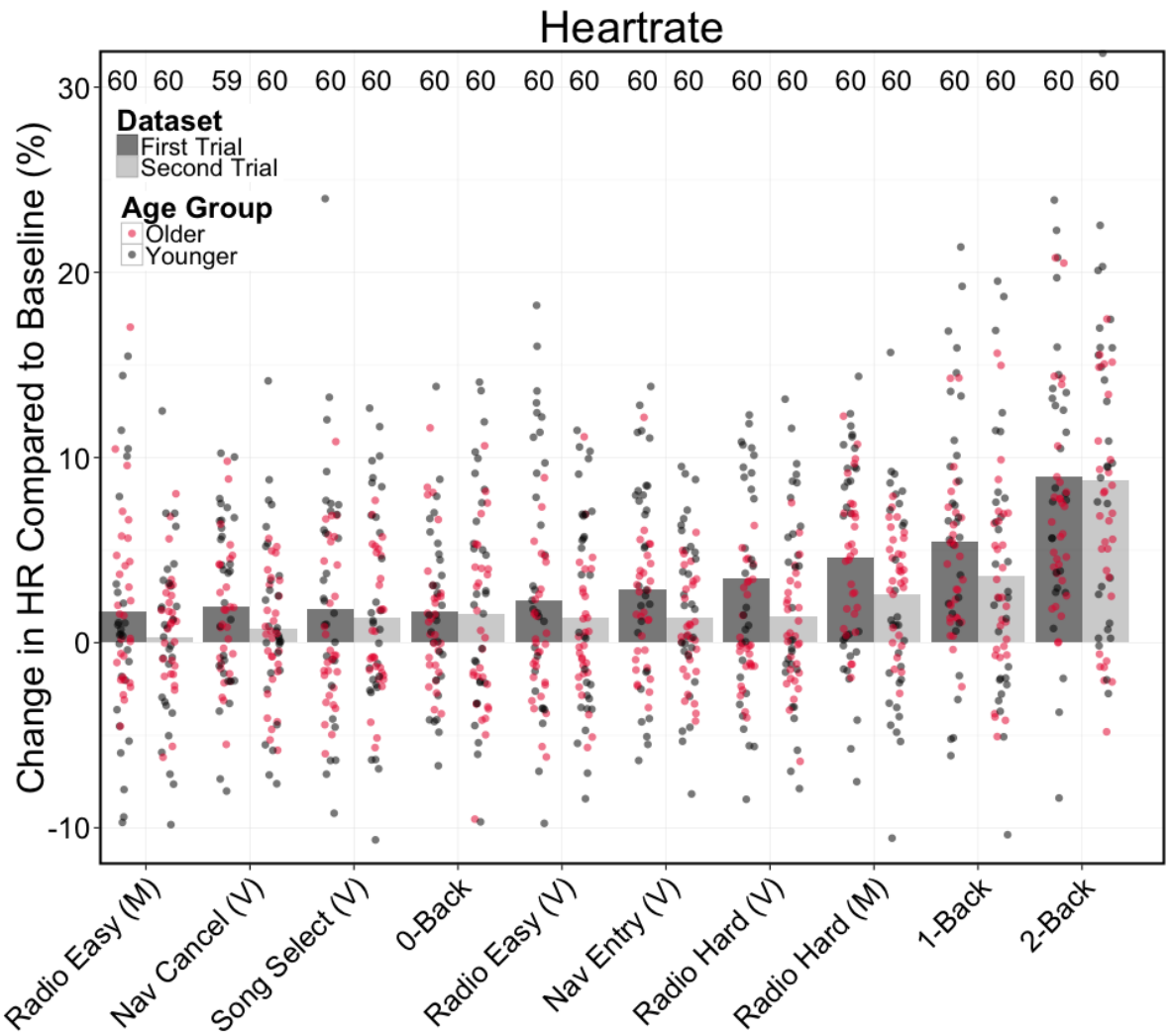


Figure C-4: Percent change in heart rate relative to an averaged baseline period of single-task driving during each task trial.

Heart rate tended to show a somewhat smaller response on the second trial of each task. The sole overt exception was the second phone dialing task, which also had a somewhat longer task completion time and higher mean SCL value for the second task.

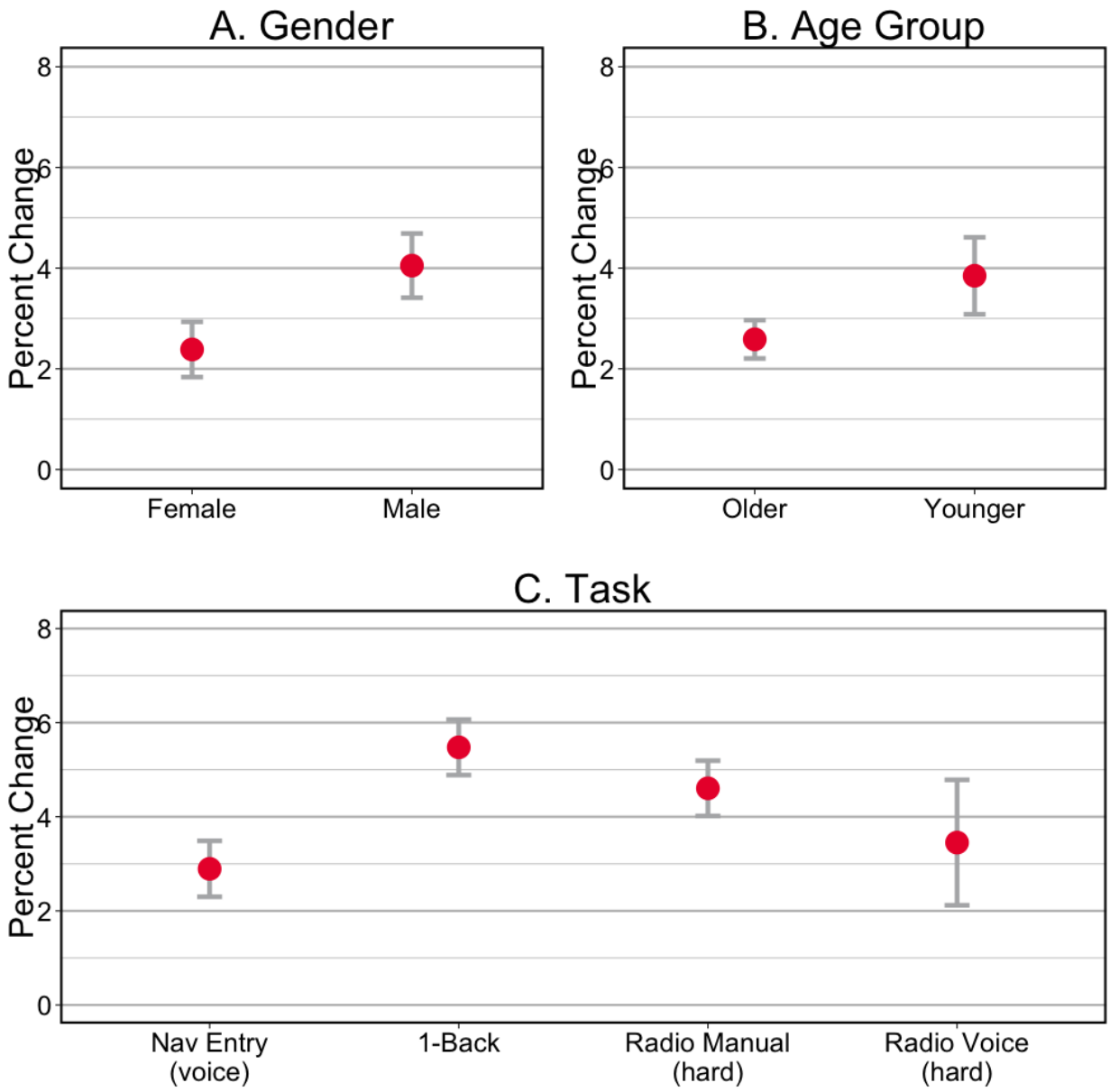


Figure C-5: Statistical summary plots for heart rate relative to an averaged baseline period of single-task driving (**First Trial**).

Heart rate differed significantly between genders (p = .016), with men showing greater heart rate changes than women. Change in heart rate was not affected by age group (p = .260). Heart rate differed significantly between the radio tasks (p = .01) and between the navigation entry and radio manual tasks (p = .015).

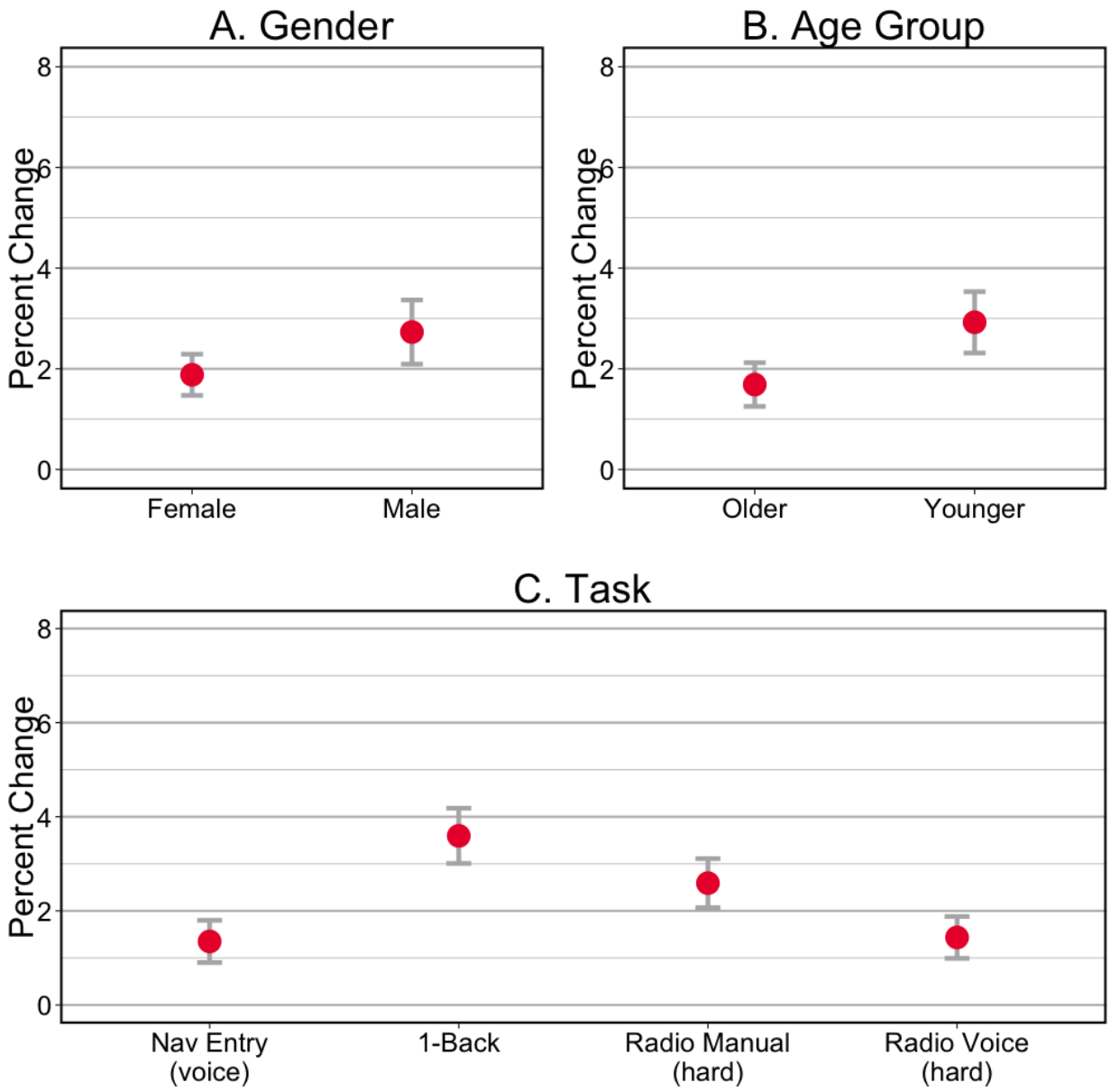


Figure C-6: Statistical summary plots for heart rate relative to an averaged baseline period of single-task driving (**Second Trial**).

The pattern of findings for Trial 2 was again consistent with the findings for Trial 1. Change in heart rate was not affected by gender (p = .260) or age group (p = .279). Heart rate did not change significantly between the radio tasks (p = .078), but did change significantly between the radio manual and navigation entry tasks (p .028).

Skin Conductance (SCL)

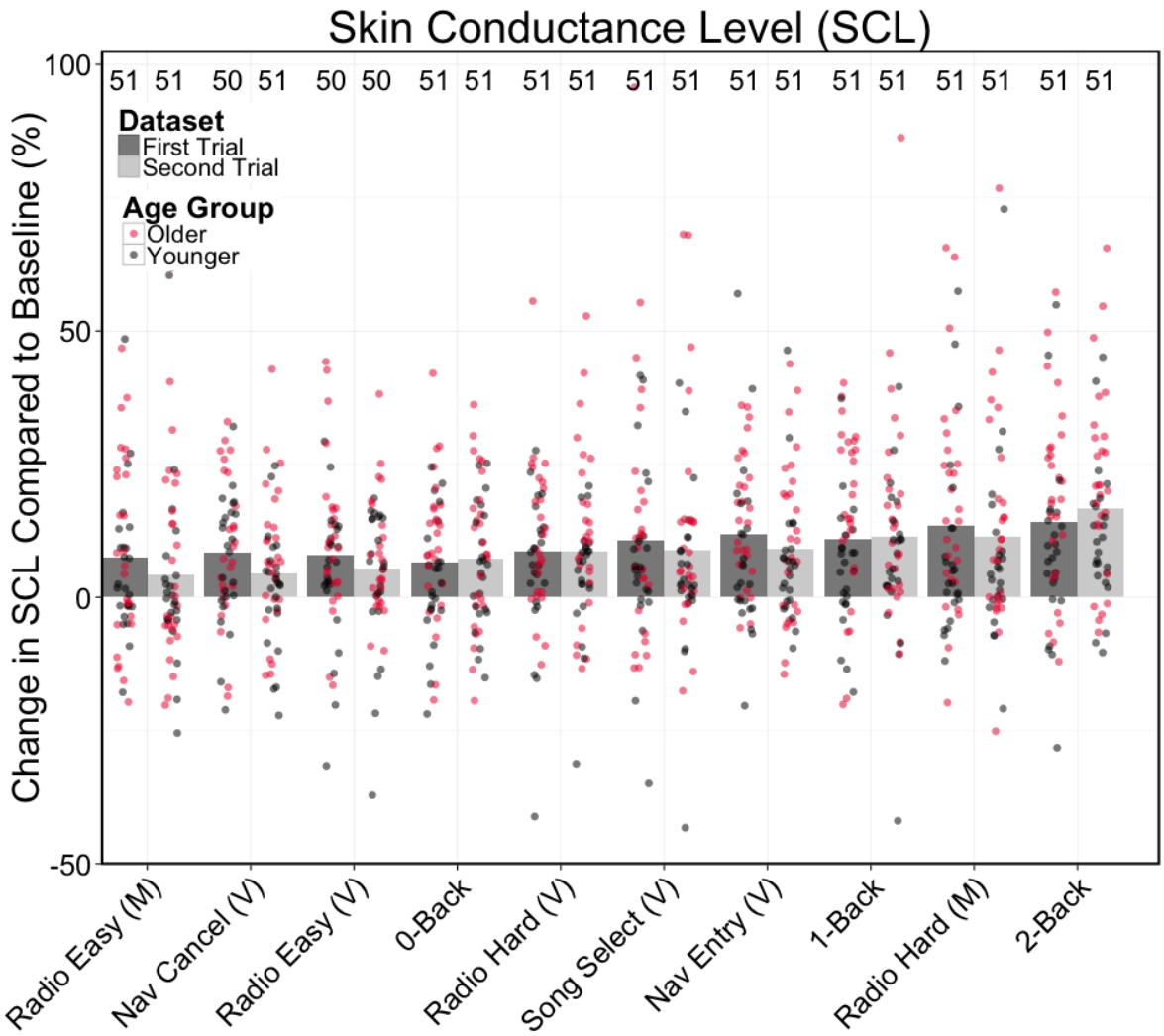


Figure C-7: Change in skin conductance level (SCL) relative to an averaged baseline period of single-task driving during each task trial.

Similar to what was seen in the heart rate data, there was a general trend for mean change in SCL values relative to baseline to be somewhat smaller during the second task trial. Exceptions appear in n-backs and the radio hard task where the mean arousal value is quite similar for both trials. The second phone task shows a nominally higher SCL value for the second trial as was the case for heart rate and task completion time.

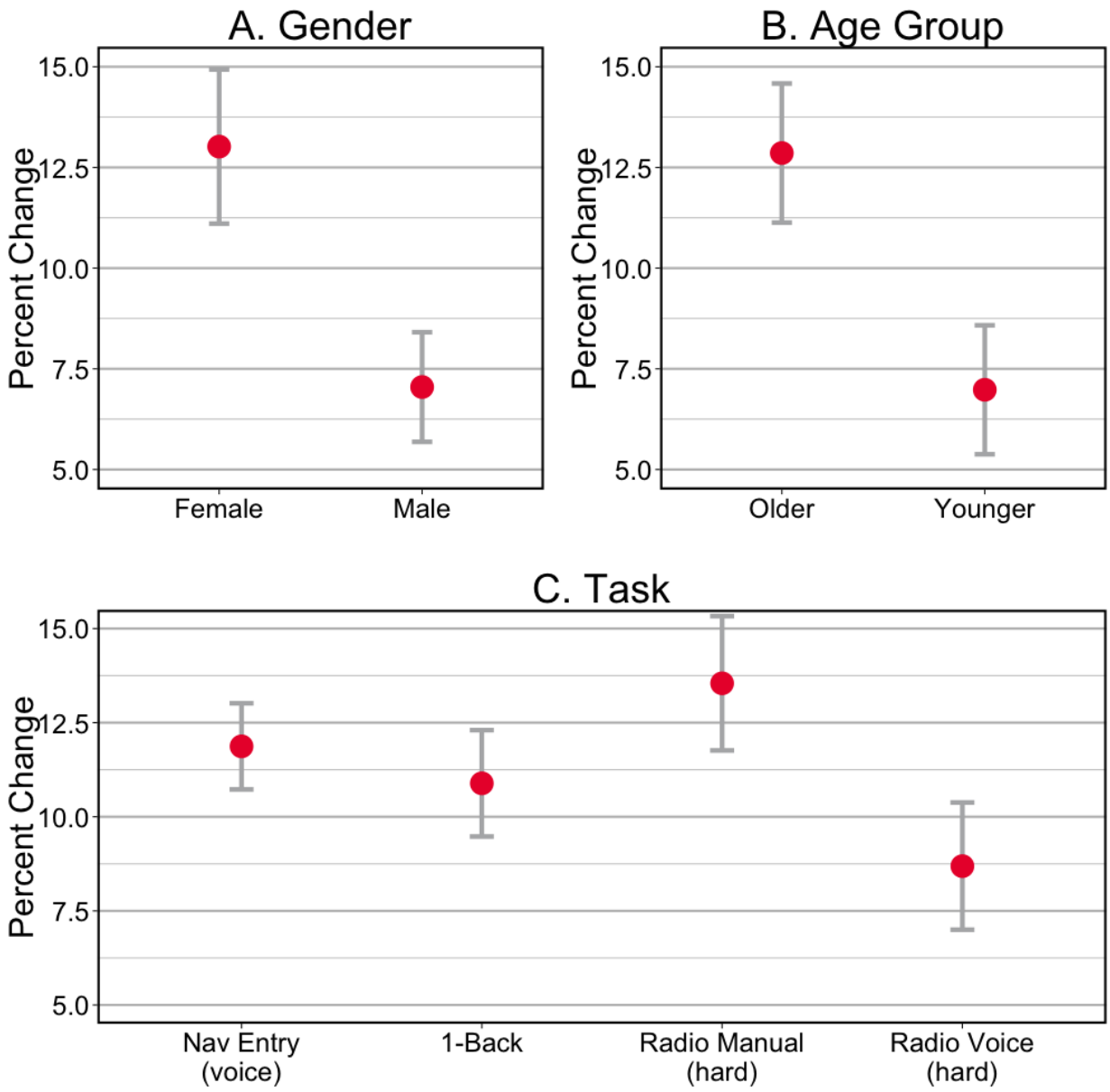


Figure C-8: Statistical summary plots for change in SCL relative to an averaged baseline period of single-task driving (**First Trial**).

SCL was significantly affected by gender (p = .035), with women showing elevated changes in SCL compared to men. Changes in SCL were also affected by age group (p = .009), with older participants showing greater percentage changes compared to younger. SCL did not differ between task comparisons (radio tasks p = .412, radio manual and navigation entry tasks p = .732).

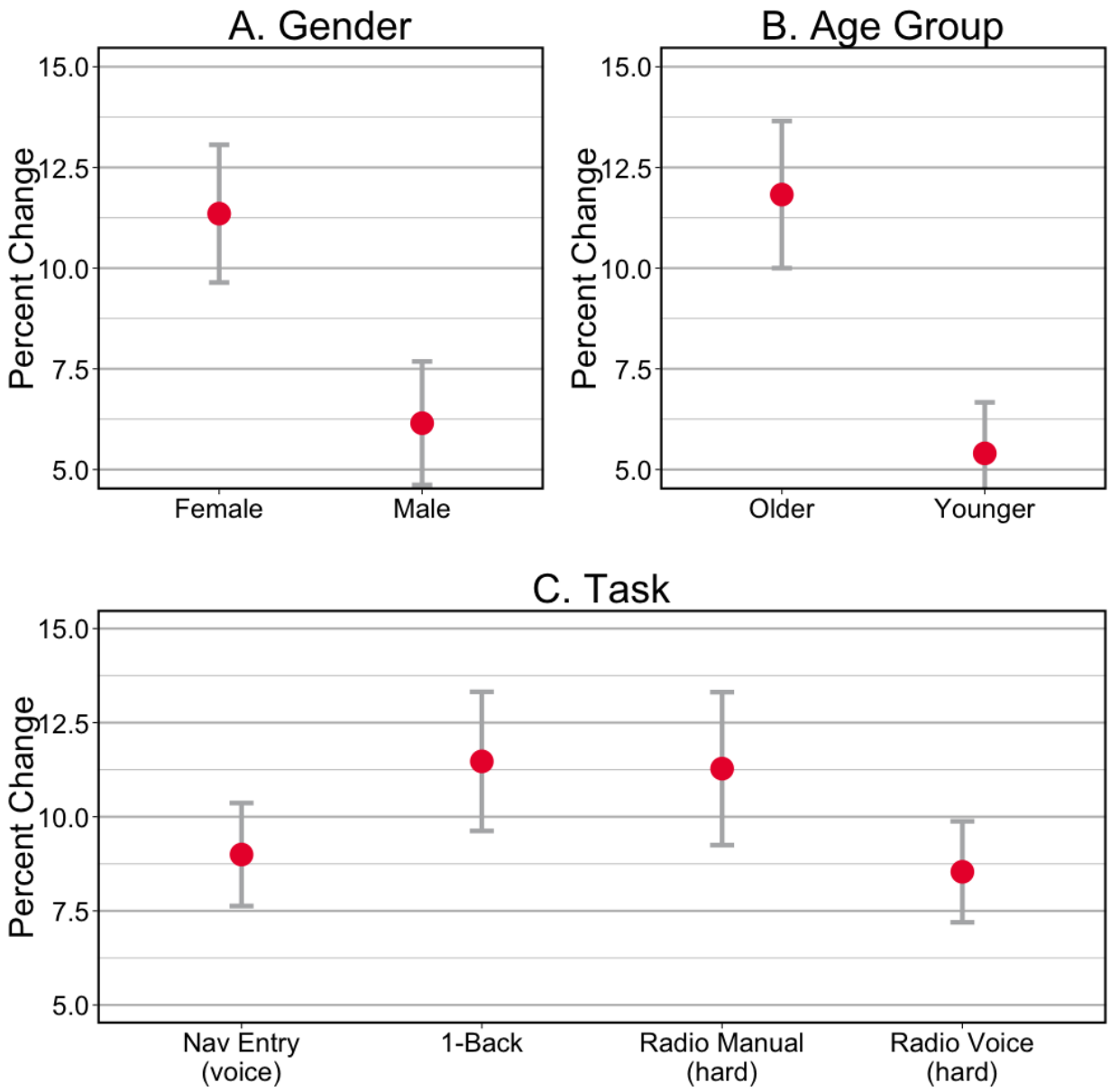


Figure C-9: Statistical summary plots for change in SCL relative to an averaged baseline period of single-task driving (**Second Trial**).

The age and gender findings were the same for the First and Second trials. SCL was significantly affected by gender ($p = .042$), with women having slightly greater changes in SCL than men. Age group also affected percentage based changes in SCL (.015), with older participants showing greater changes than younger ones. SCL did not differ between task comparisons (radio tasks $p = .697$, radio manual and navigation entry tasks $p = .978$).

Mean Velocity

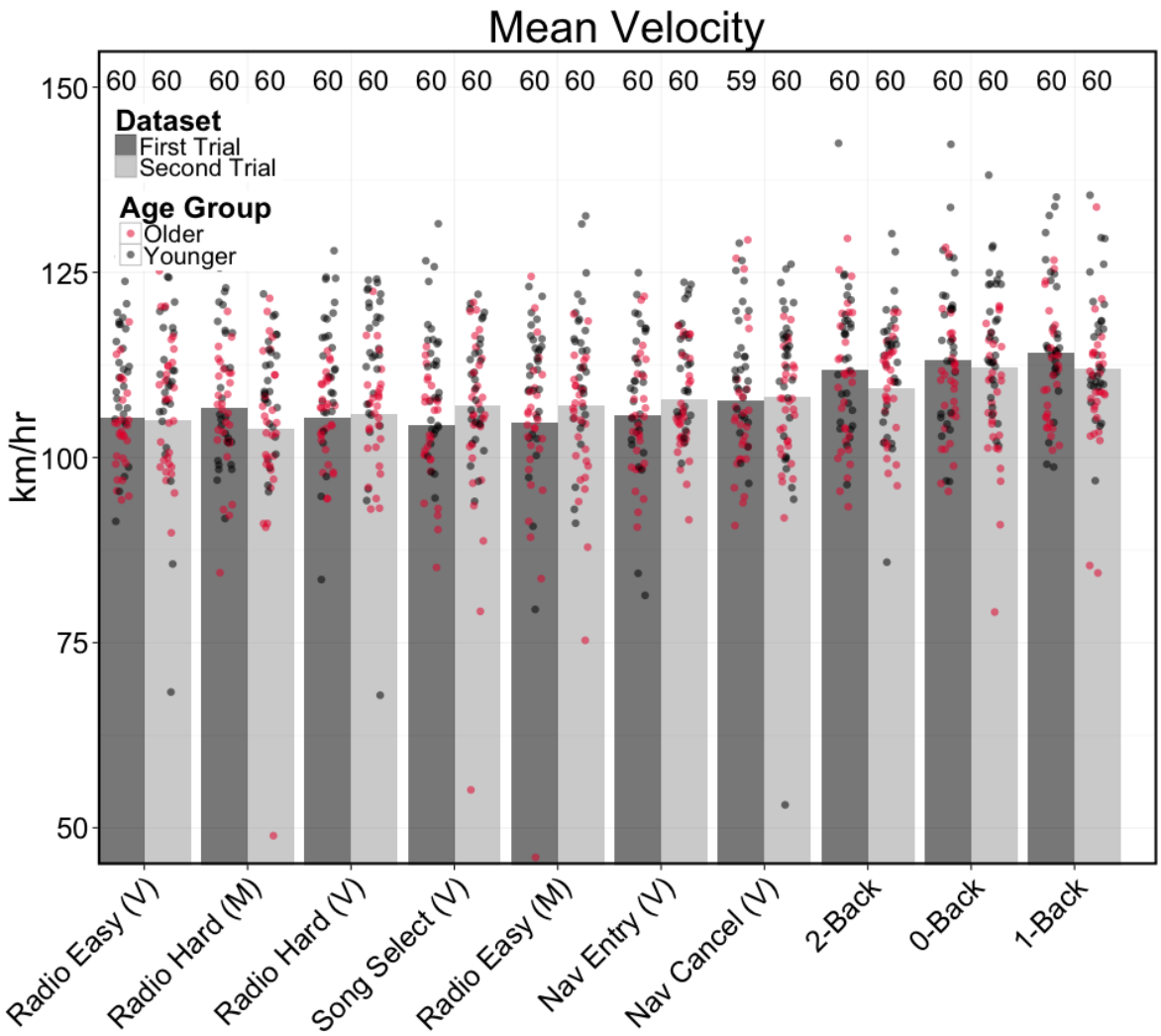


Figure C-10: Mean vehicle velocity during each task trial.

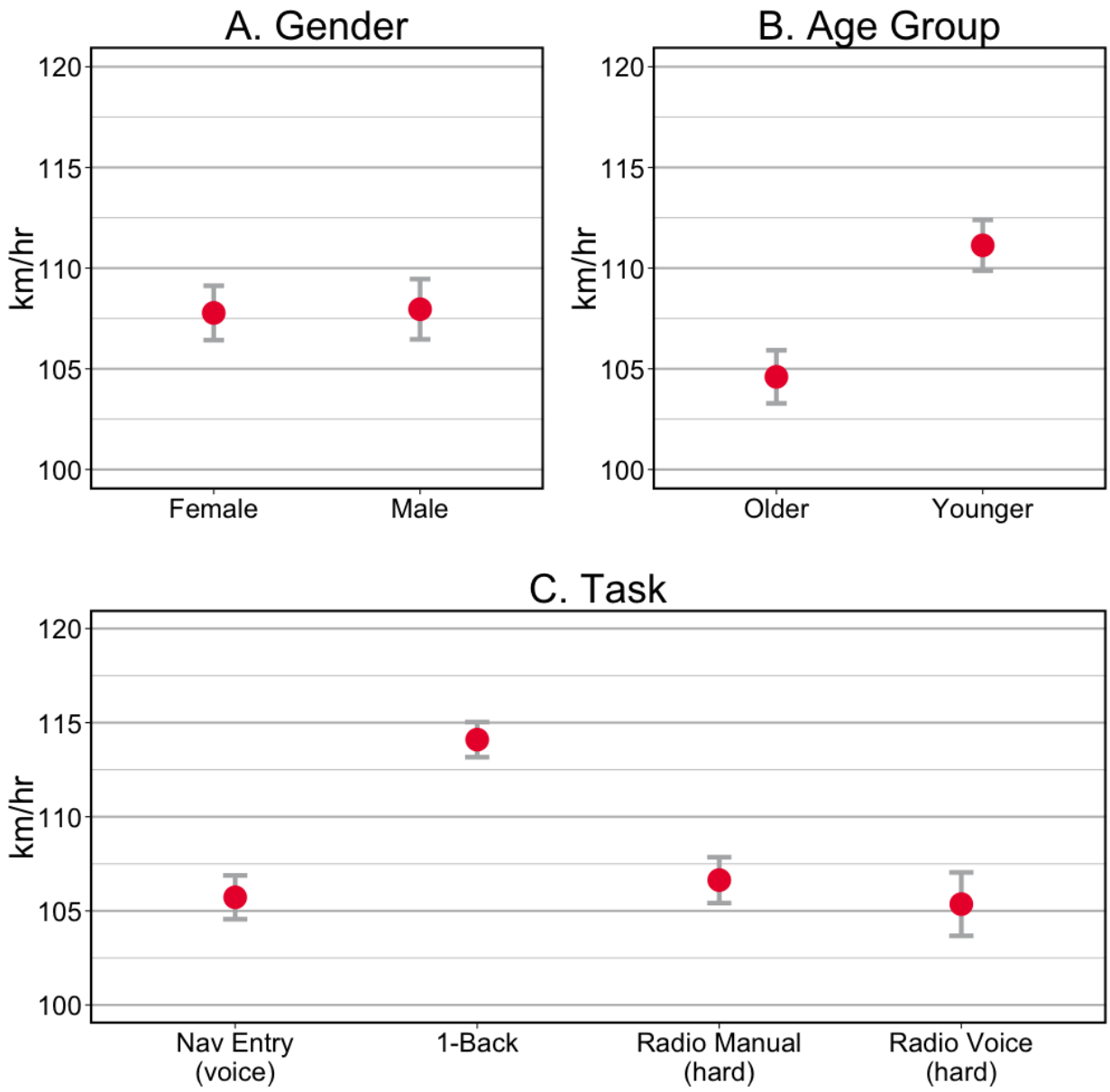


Figure C-11: Statistical summary plots for mean vehicle speed (**First Trial**).

The effect of gender was not significant (p = 0.959). Vehicle speed was significantly affected by age group (p = .001). Mean velocity did not differ between the radio tasks (p = .805) or between the radio manual and navigation entry tasks (p = .510).

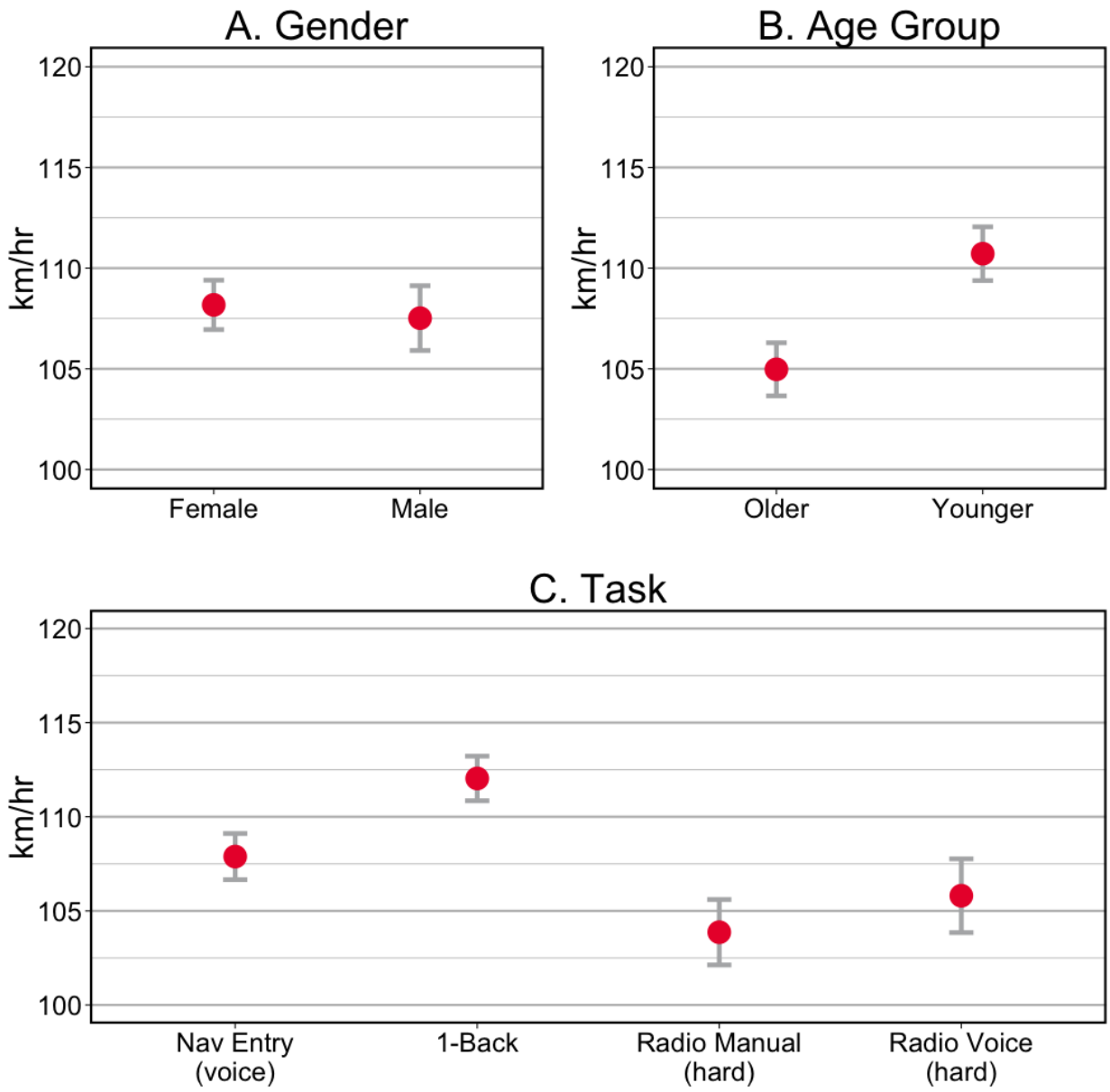


Figure C-12: Statistical summary plots for mean vehicle speed (**Second Trial**).

The age and gender findings were the same for the First and Second trials. The effect of gender was not significant (p = 0.854). Vehicle speed was significantly affected by age group (p = .003). Mean velocity did not differ between the radio tasks (p = .174) but did differ between the radio manual and navigation entry tasks (p = .038).

Variability of Velocity

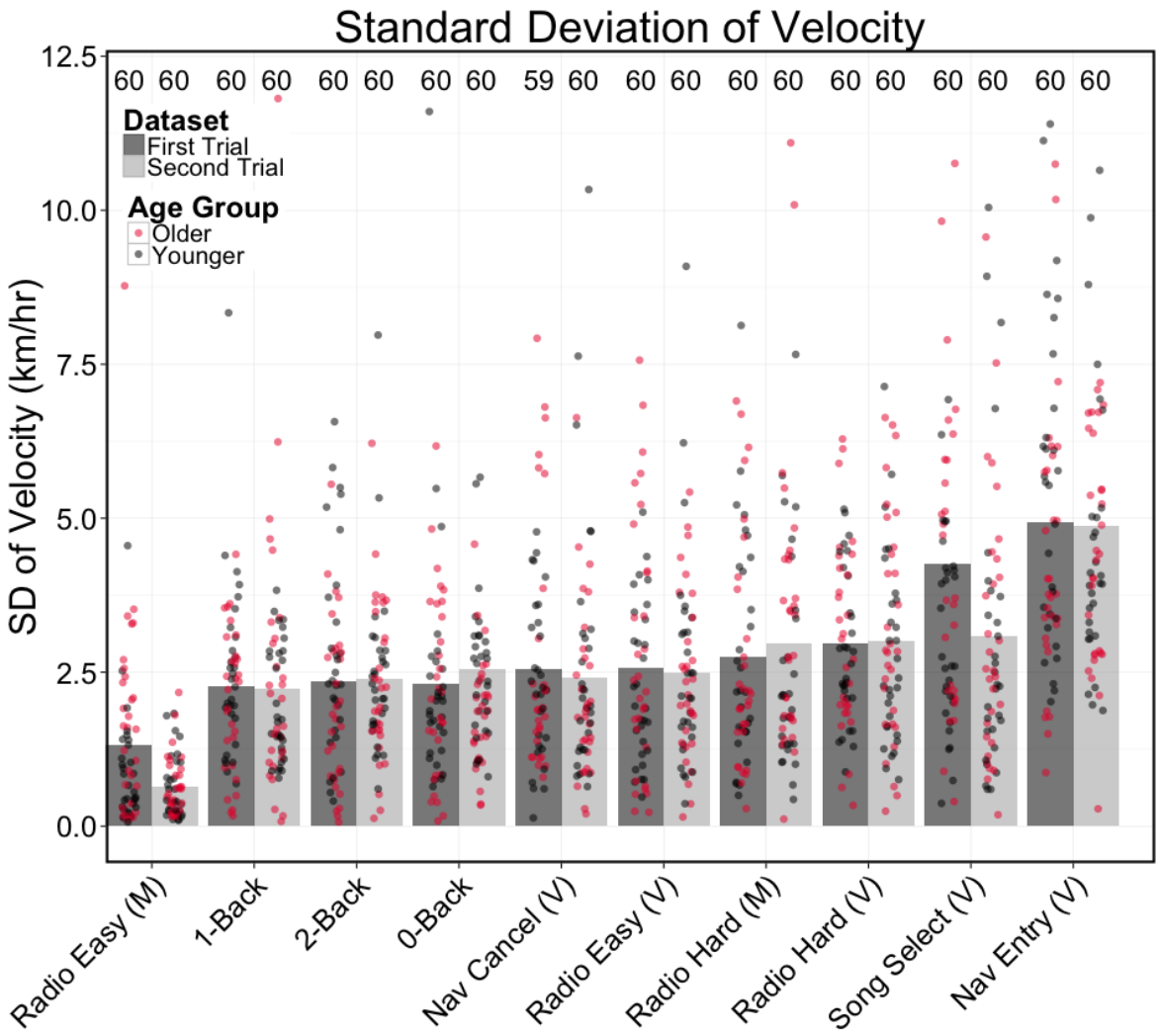


Figure C-13: Variability (standard deviation) of vehicle velocity for each task trial.

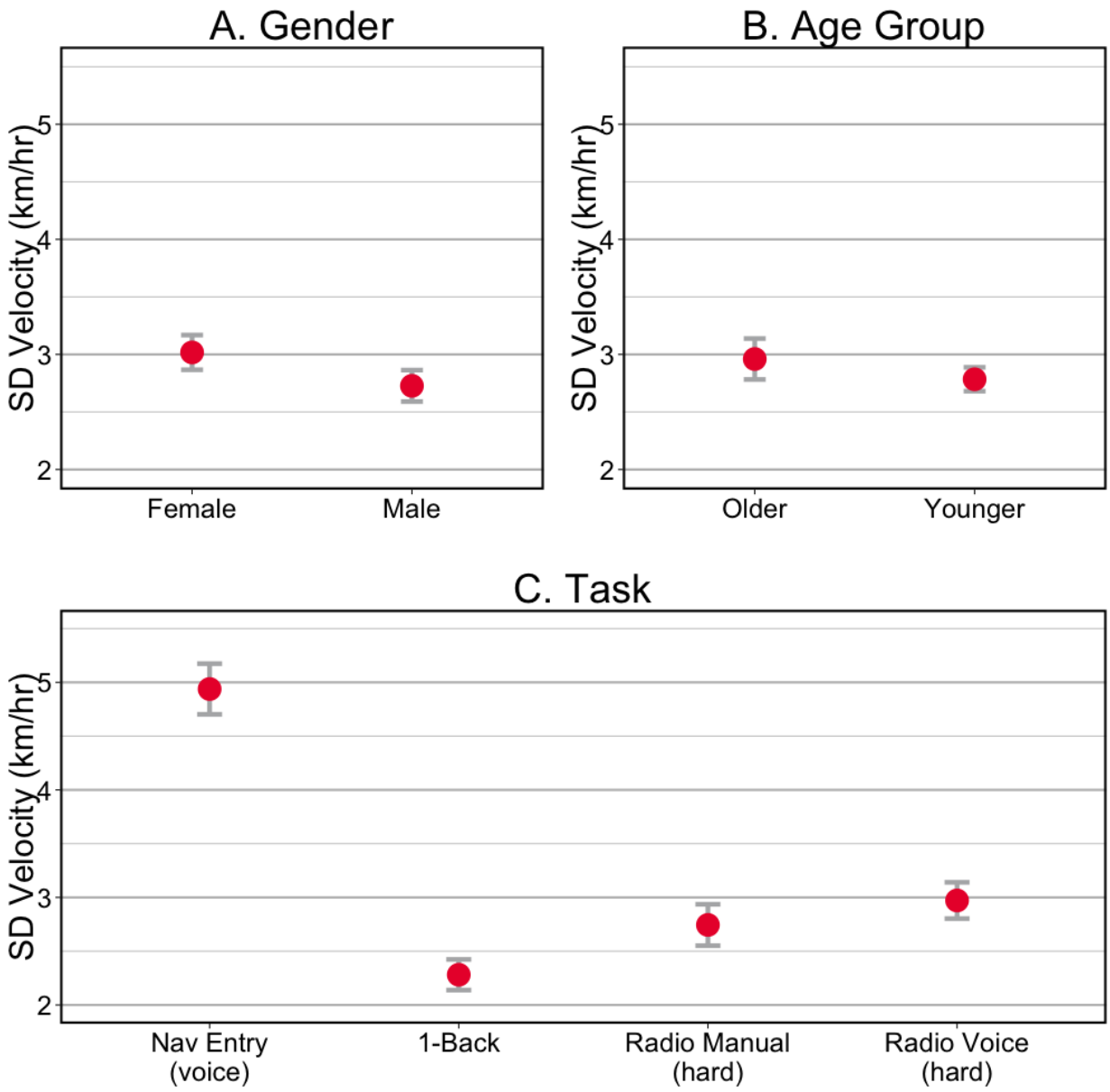


Figure C-14: Statistical summary plots for SD of vehicle speed (**First Trial**).

SD of vehicle speed was not affected by gender ($p = .358$) or age group ($p = .440$). SD of vehicle speed did not differ between the radio tasks ($p = .304$), but did differ between the radio manual and navigation entry tasks ($p < .001$).

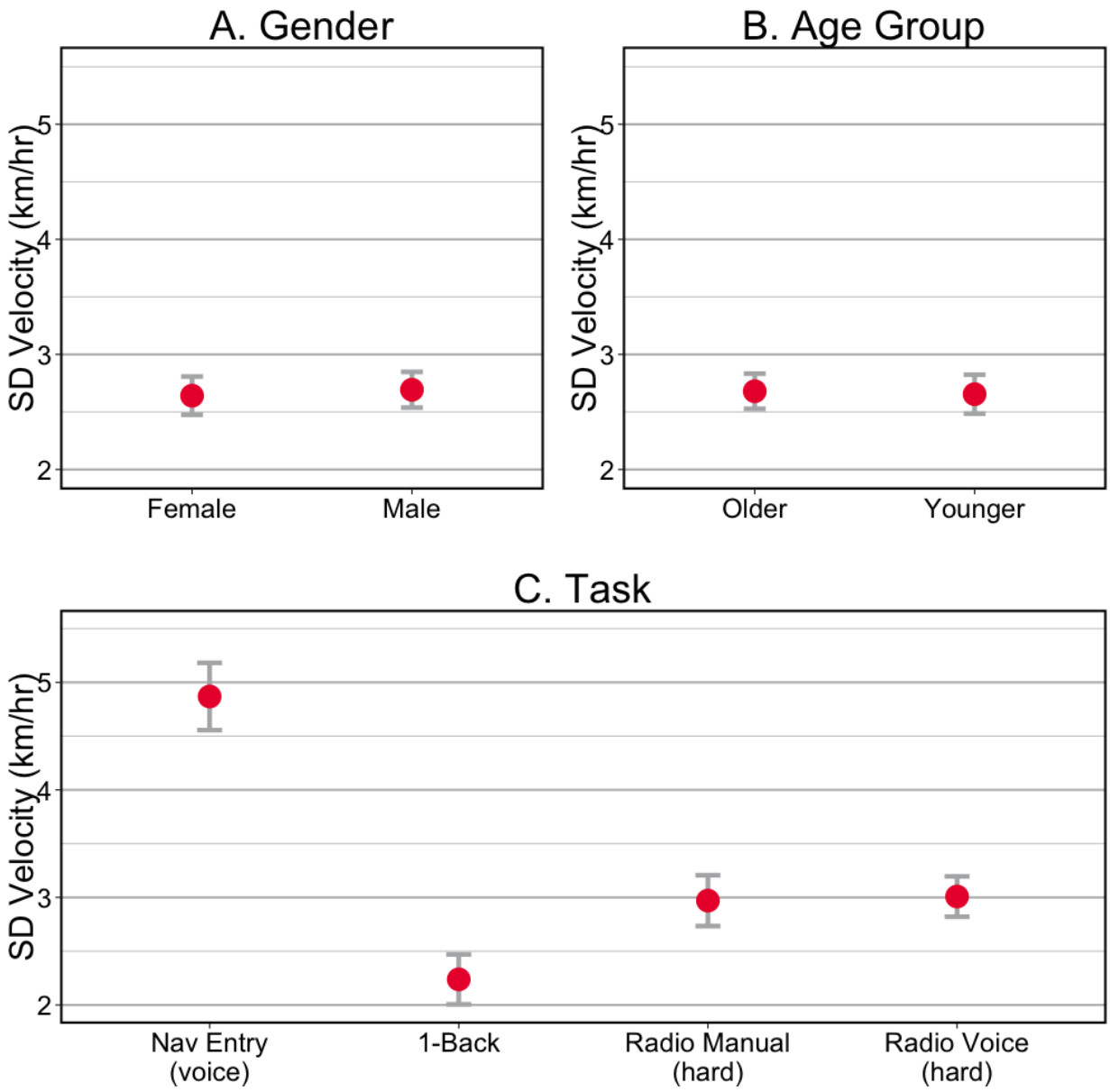


Figure C-15: Statistical summary plots for SD of vehicle speed (**Second Trial**).

As with the First trial, SD of vehicle speed was not affected in the Second by gender ($p = .458$) or age group ($p = .513$). SD of vehicle speed did not differ between the radio tasks ($p = .594$), but did differ between the radio manual and navigation entry tasks ($p < .001$).

Acceleration Events

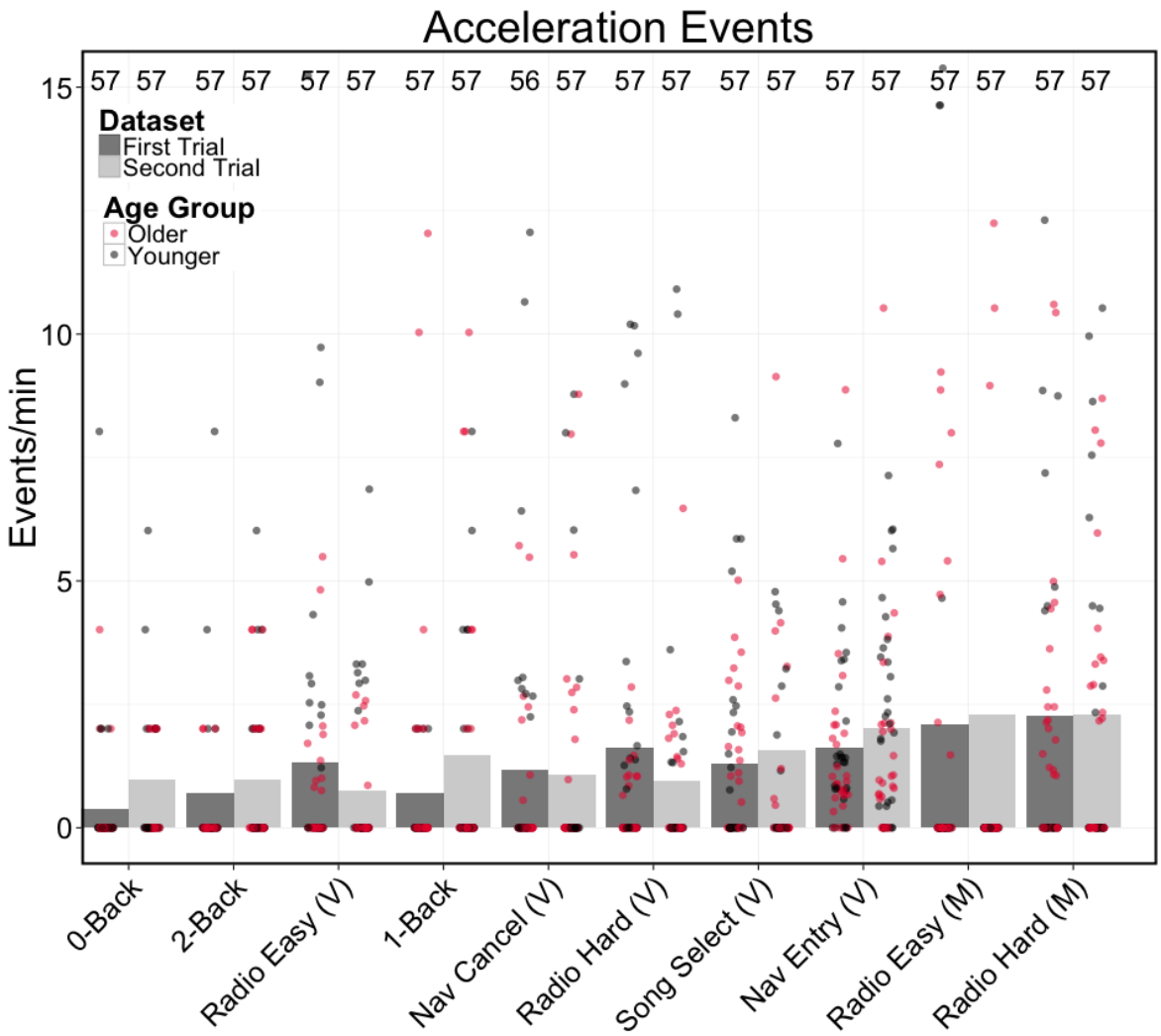


Figure C-16: Acceleration events during each task trial.

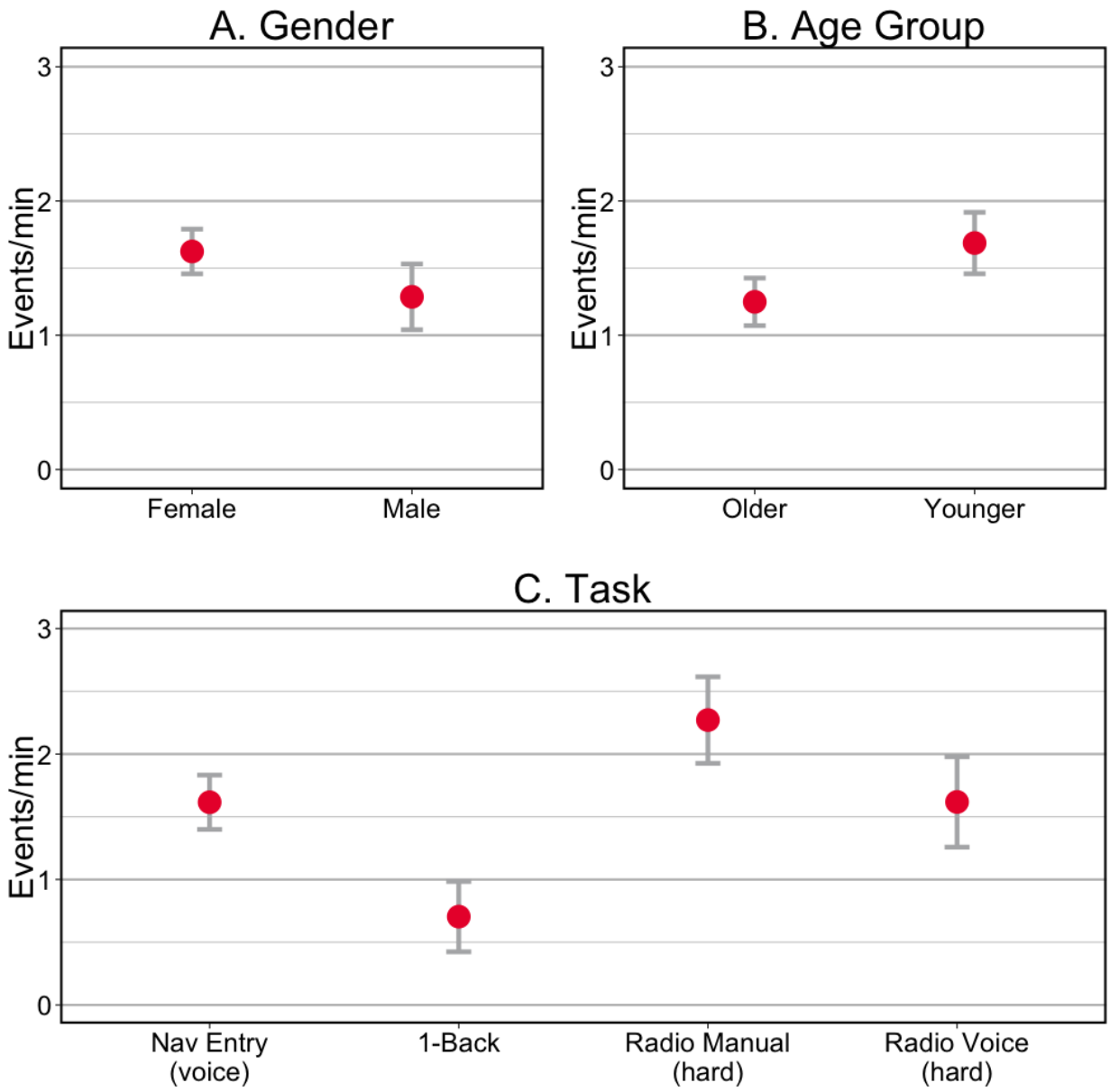


Figure C-17: Statistical summary plots for acceleration events (**First Trial**).

Accelerations were significantly affected by gender (p = .034), with women demonstrating slightly more minor acceleration events than men. Age did not affect acceleration events (p = .120). Acceleration events differed significantly between the radio tasks (p = .040), but not between the radio manual and navigation entry tasks (p = .616).

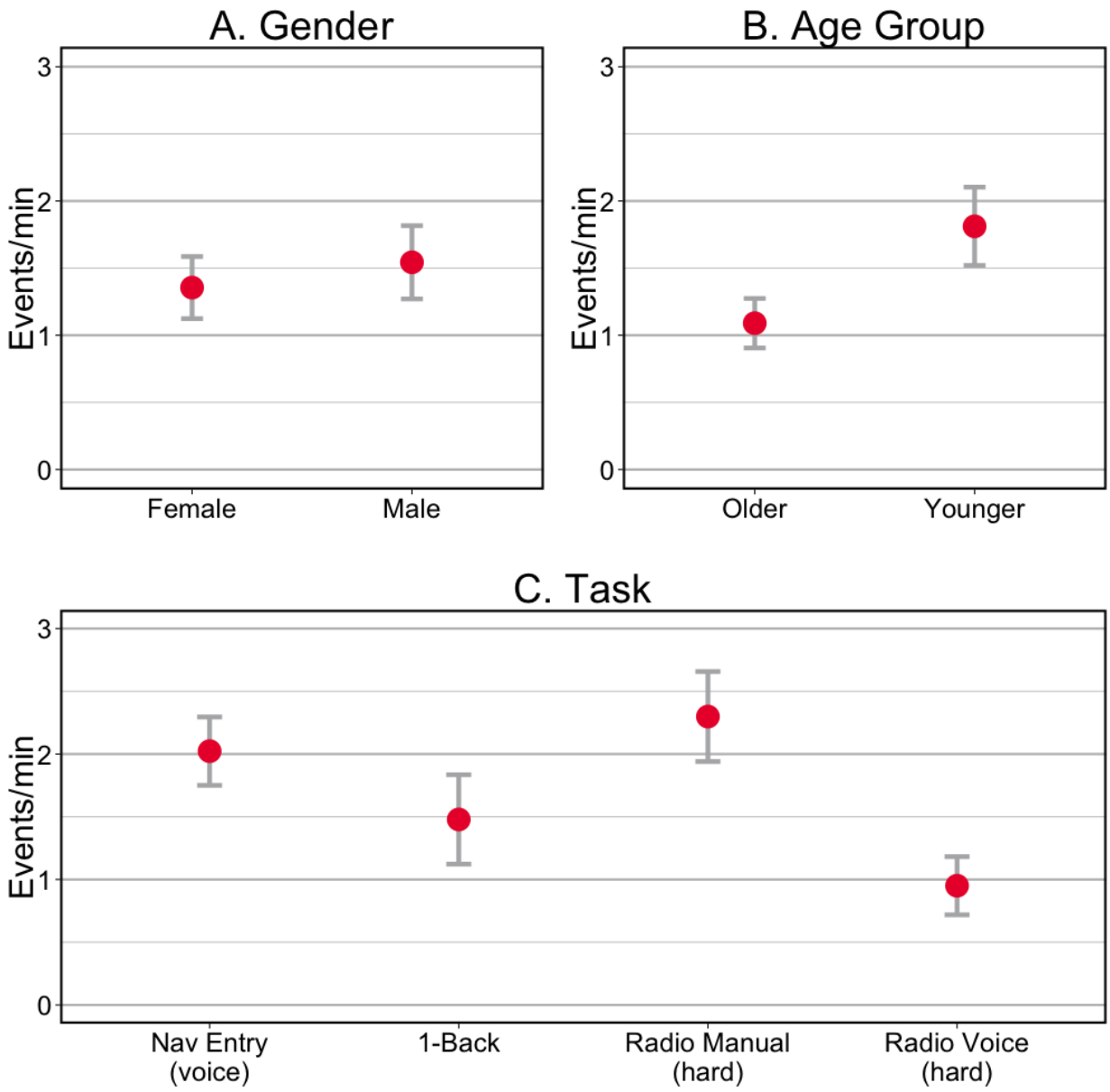


Figure C-18: Statistical summary plots for acceleration events (**Second Trial**).

In contrast with the high consistency seen for other variables across trials, the gender effect apparent in the First trial (women showing slightly more minor acceleration events than men), this gender difference did not appear in the Second trial ($p = .660$). Consistent with the First trial, age did not affect minor acceleration events in the Second ($p = .070$). Acceleration events differed significantly between the radio tasks ($p = .013$), but not between the radio manual and navigation entry tasks ($p = .947$).

Steering Wheel Angle

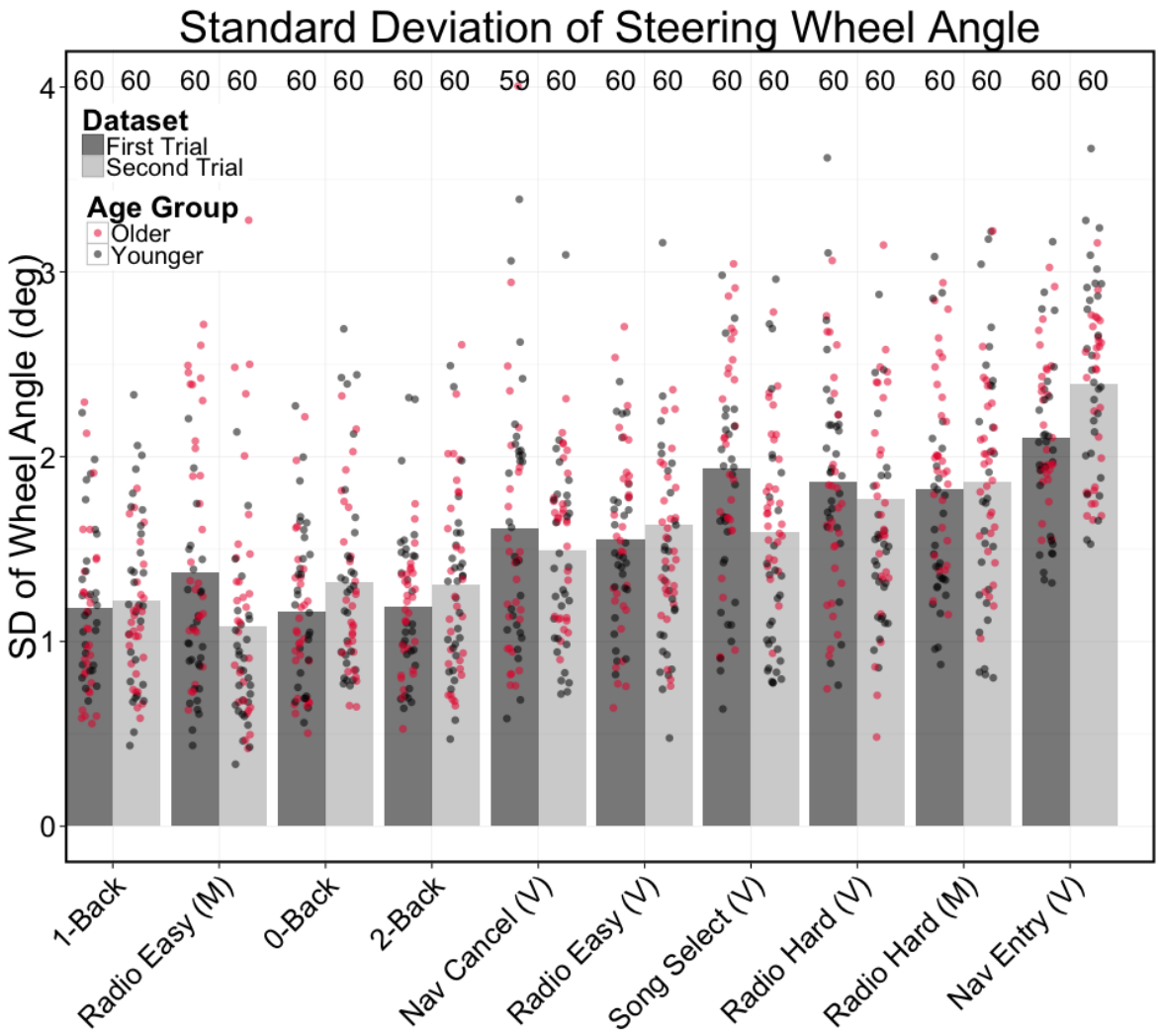


Figure C-19: Steering wheel angle variability (standard deviation) during each task trial.

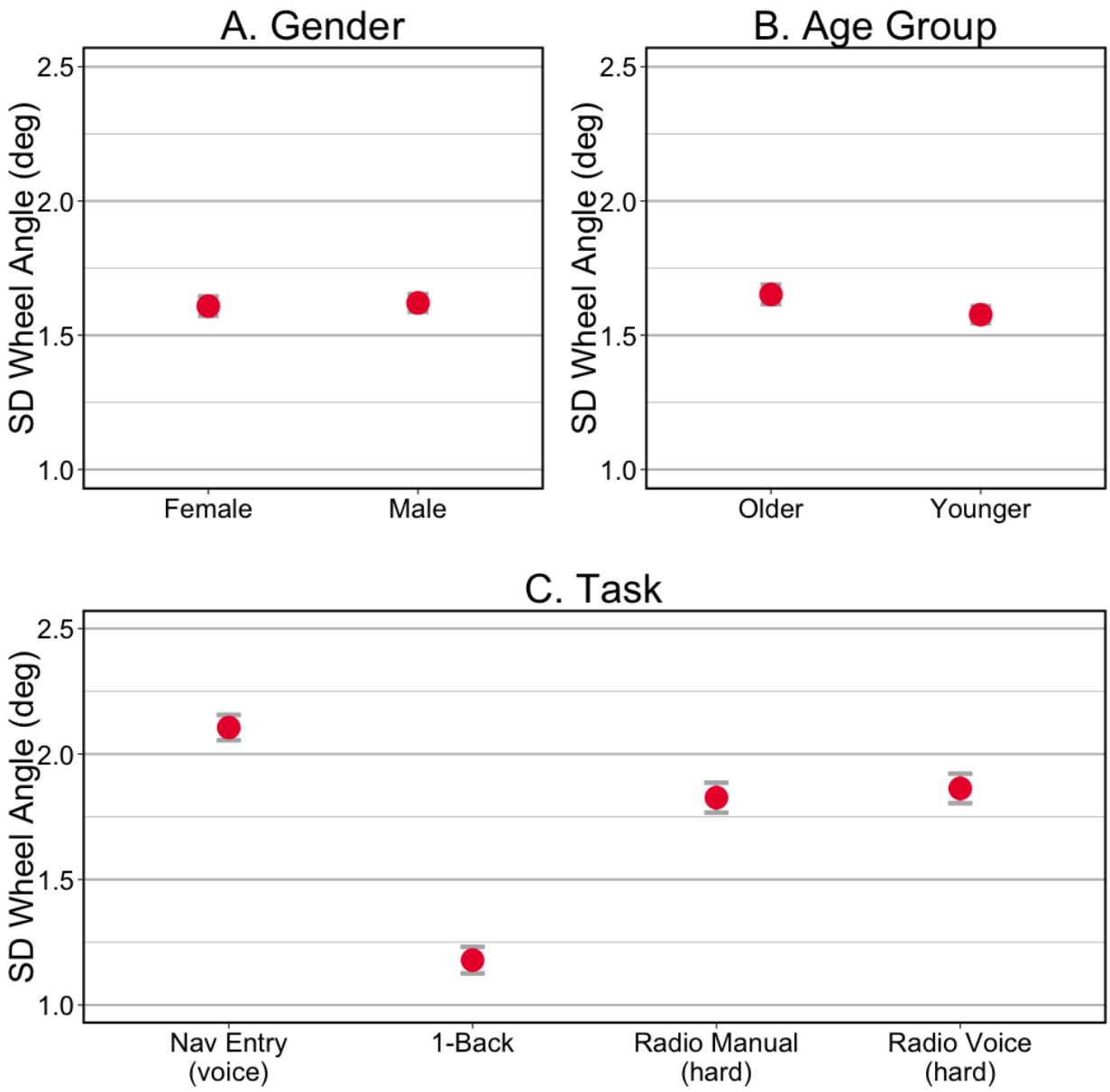


Figure C-20: Statistical summary plots for variability of steering wheel angle (**First Trial**).

Wheel angle was not affected by gender or age group ($p = .582$ and $p = .096$, respectively). Wheel angle differed significantly between the radio manual and navigation entry tasks ($p = .006$), but not between the two radio tasks ($p = .604$).

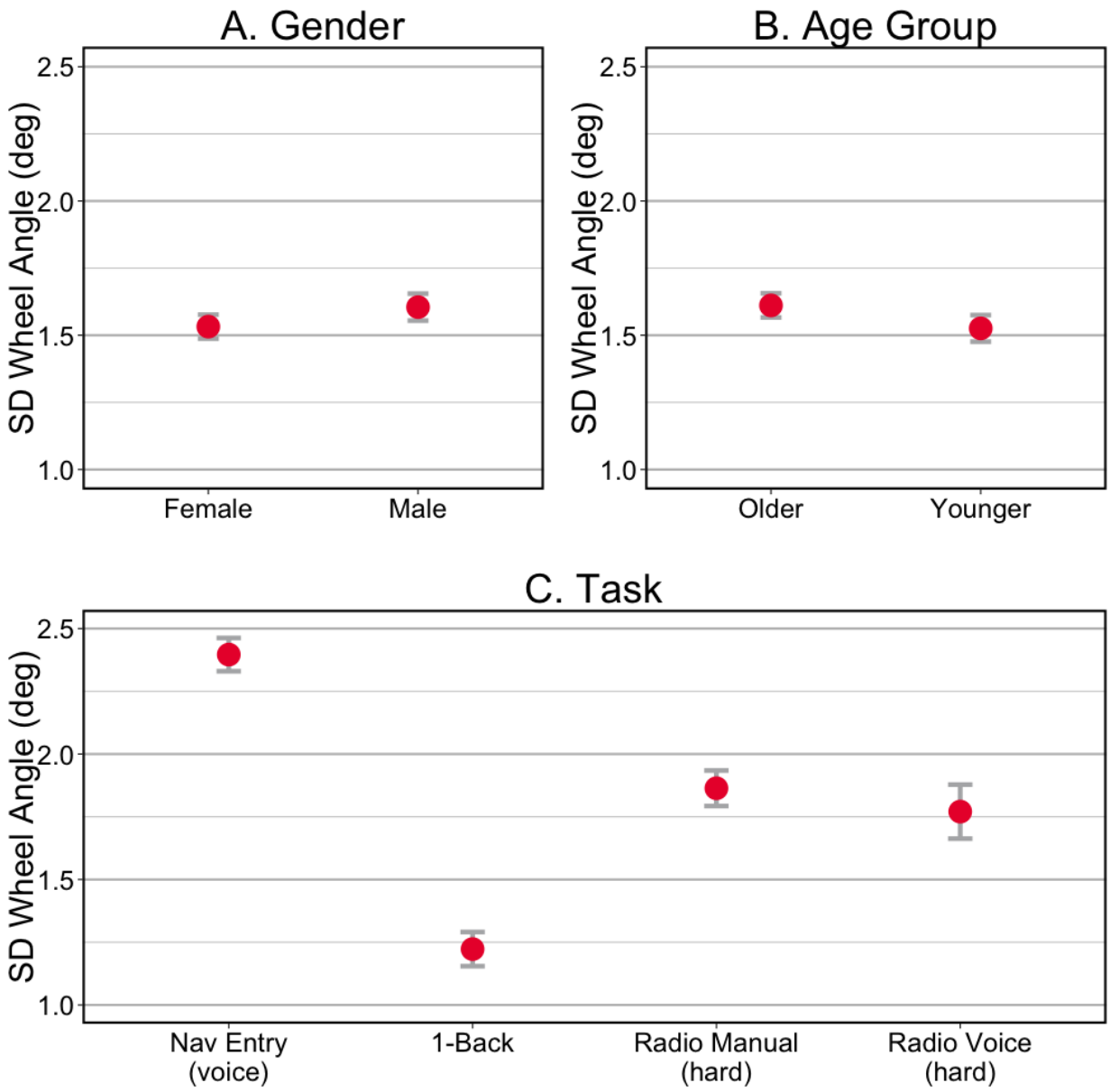


Figure C-21: Statistical summary plots for variability of steering wheel angle (**Second Trial**).

The overall findings for gender and age were consistent across the First and Second Trials. During the Second trial, steering wheel angle was again not affected by gender or age group ($p = .485$ and $p = .102$, respectively). Wheel angle differed significantly between the radio manual and navigation entry tasks ($p < .001$), and between the two radio tasks ($p = .049$).

Minor Wheel Reversals

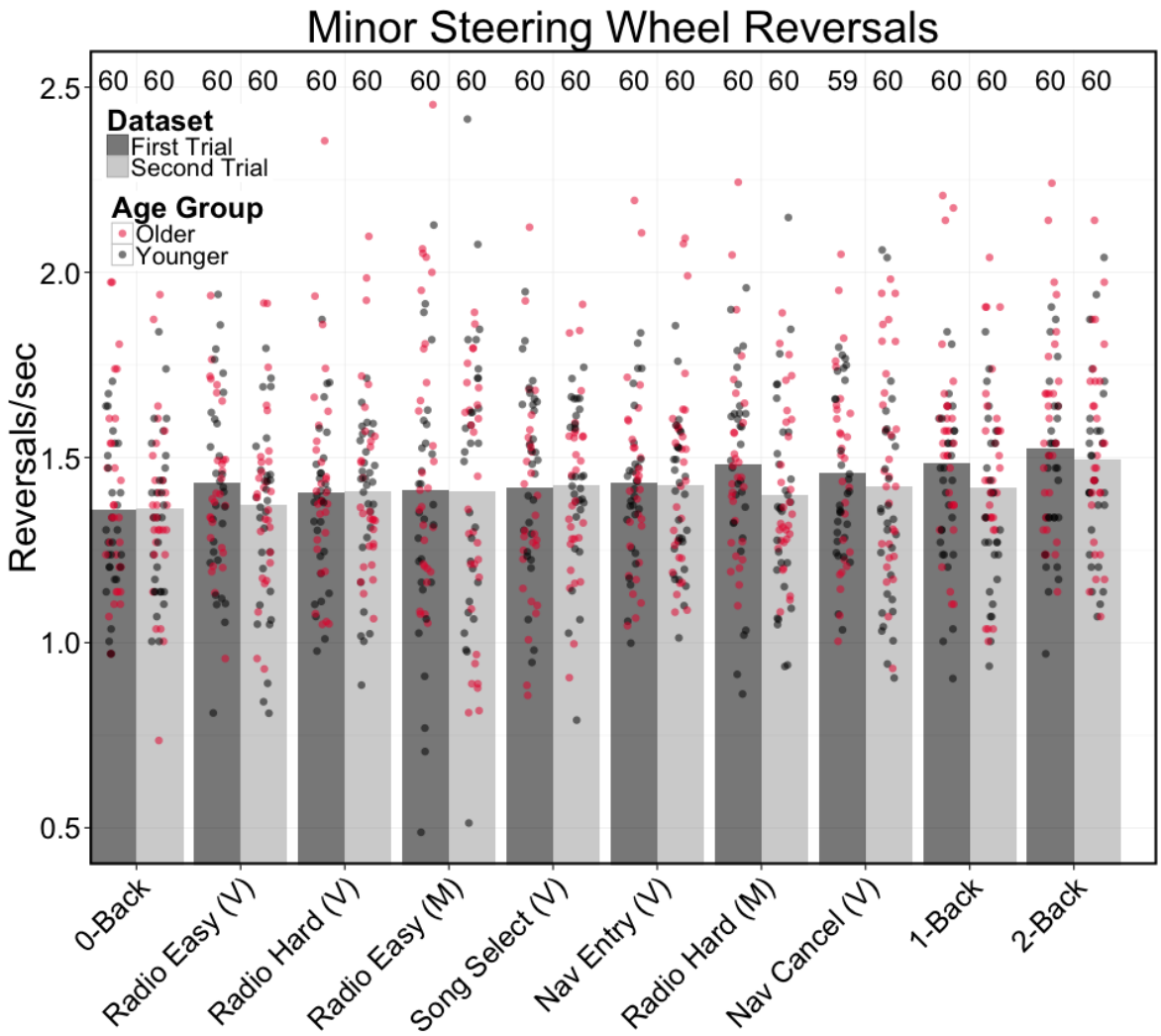


Figure C-22: Minor steering wheel reversal (SWR) rate for each task trial.

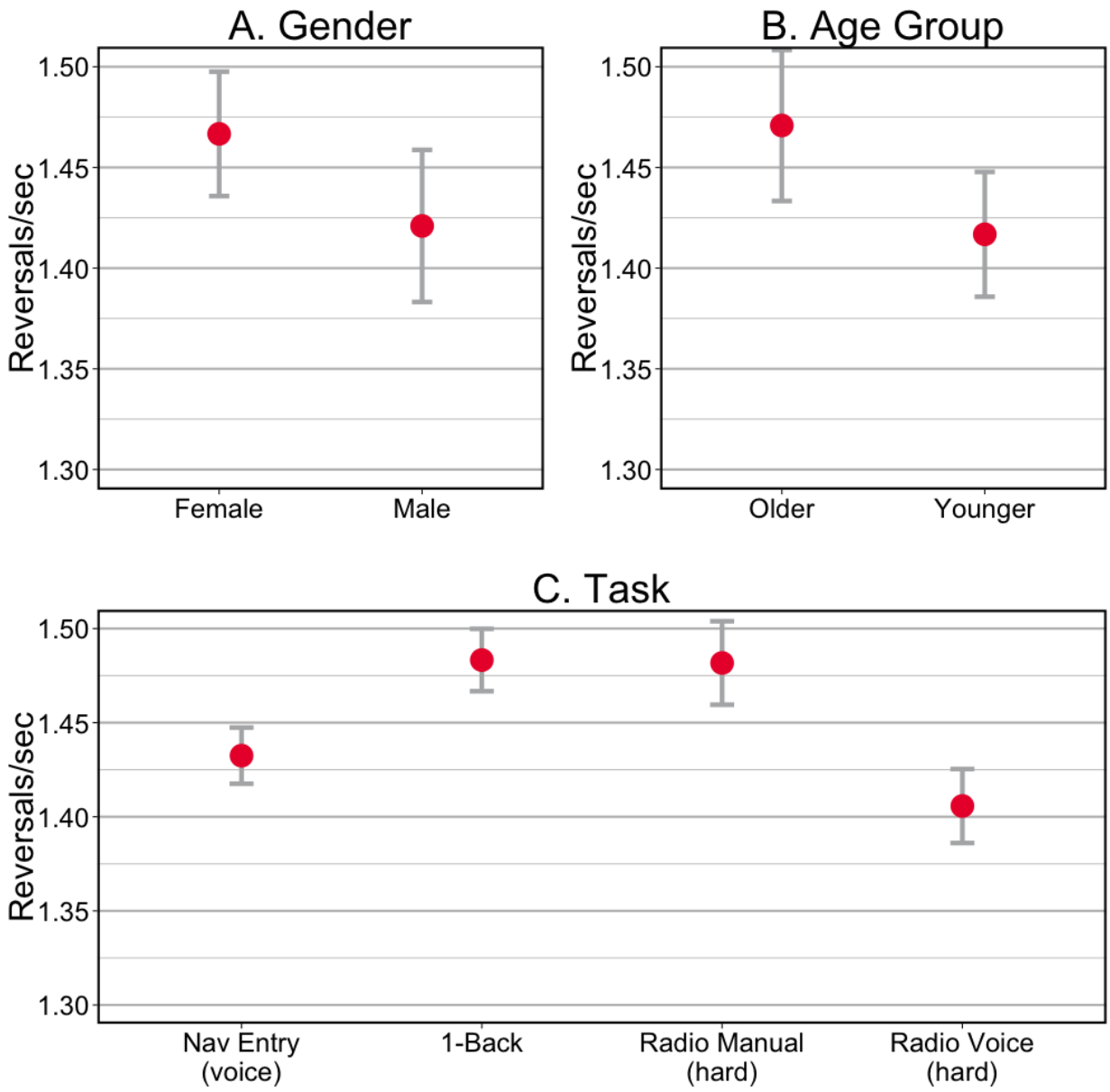


Figure C-23: Statistical summary plots for minor SWR (**First Trial**).

SWR was not affected by gender or age group (p = .335 and p = .467). Minor SWR differed significantly between the radio tasks (p = .019), but not between the radio manual and navigation entry tasks (p = .129).

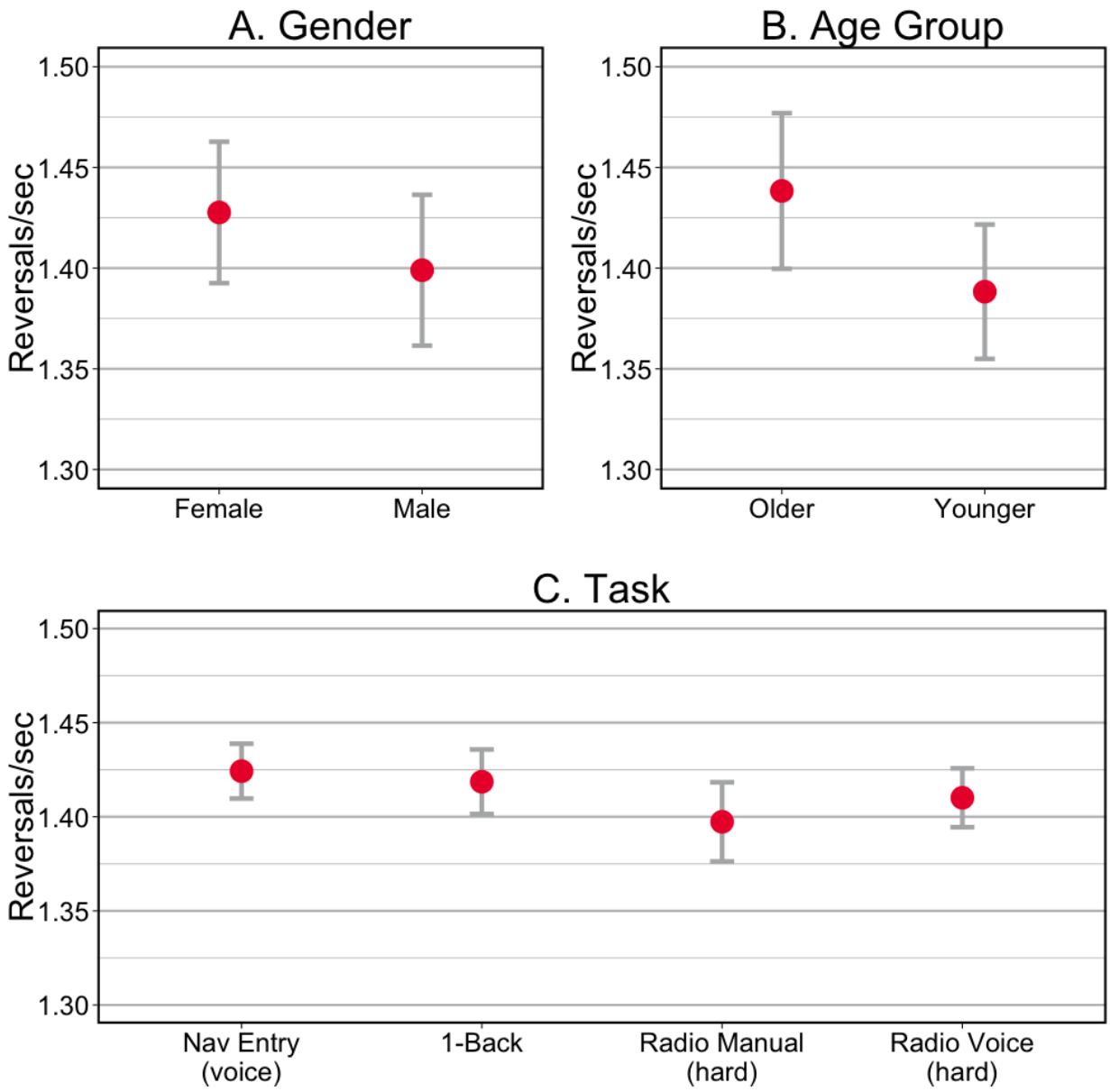


Figure C-24: Statistical summary plots for minor SWR (**Second Trial**).

The nominal pattern seen in the First trial with females and older participants showing a higher minor SWR again appeared for the Second trial. However, this patterning was again not statistically significant ($p = .643$, and $p = .485$, respectively). Minor SWR did not significantly between the radio tasks ($p = .473$), or between the radio manual and navigation entry tasks ($p = .255$).

Major Wheel Reversals

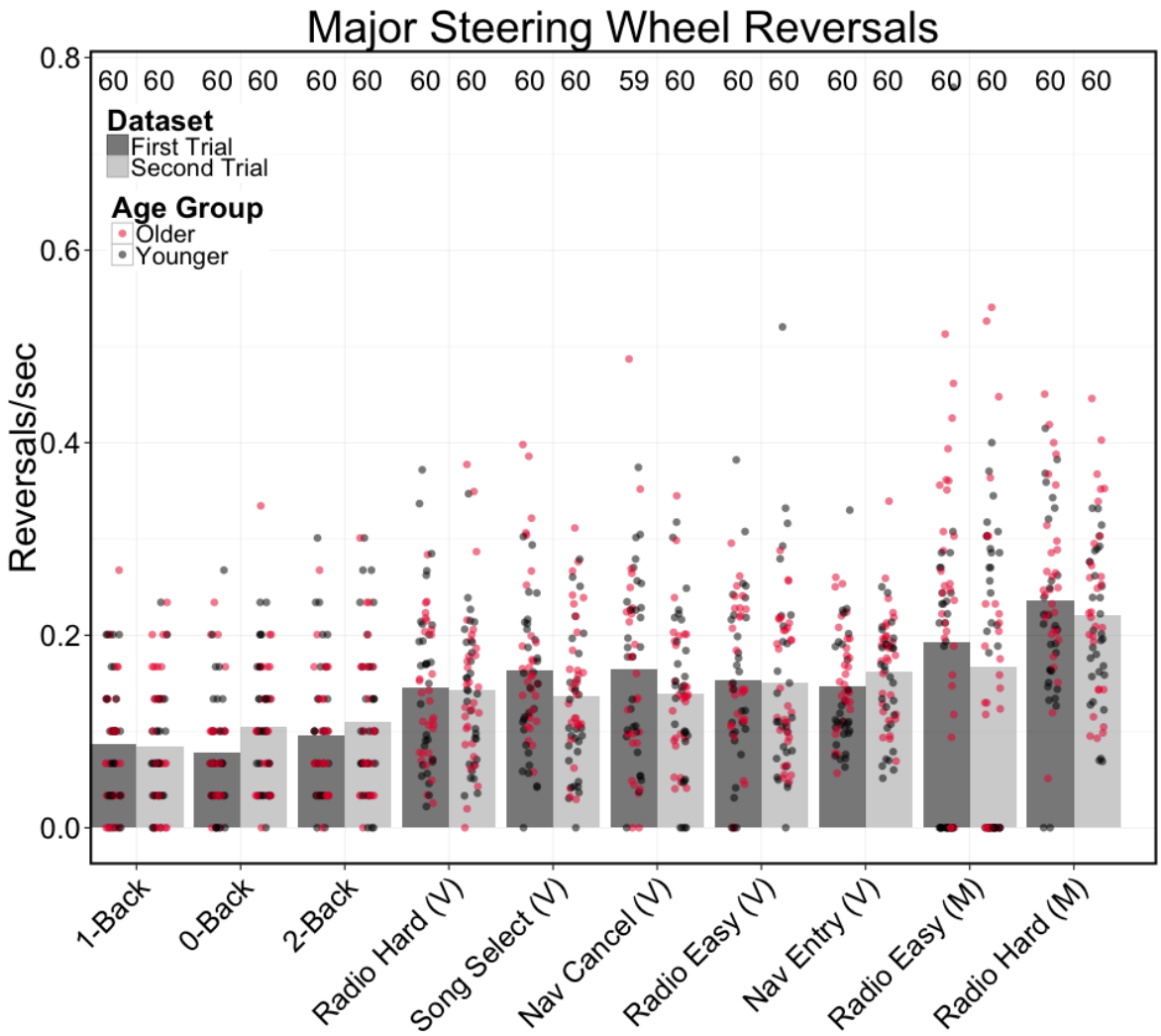


Figure C-25: Major SWR during each task trial.

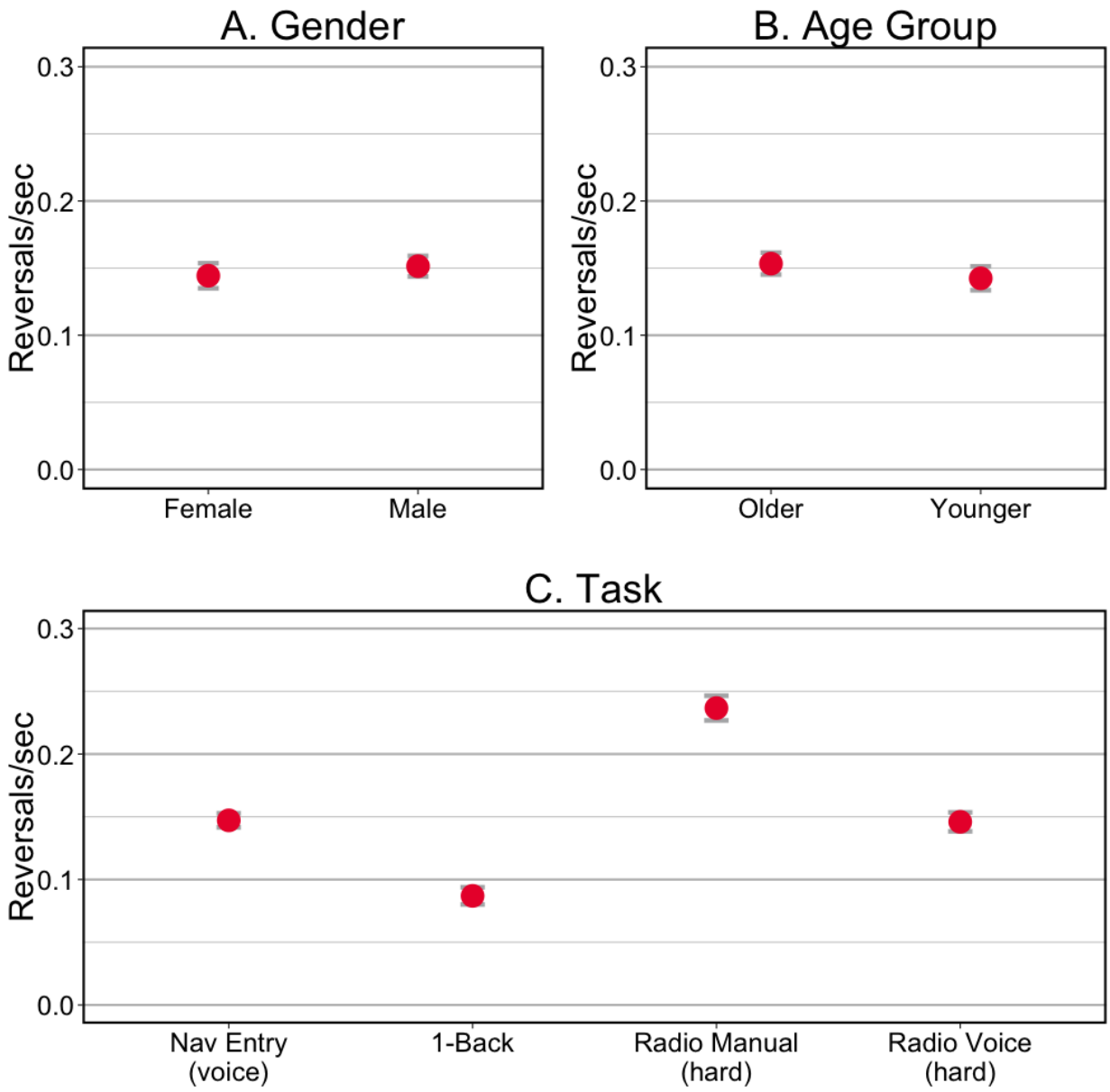


Figure C-26: Statistical summary plots for major SWR (**First Trial**).

Major SWR was not affected by gender or age group ($p = .552$ and $p = .390$, respectively). Major SWR differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

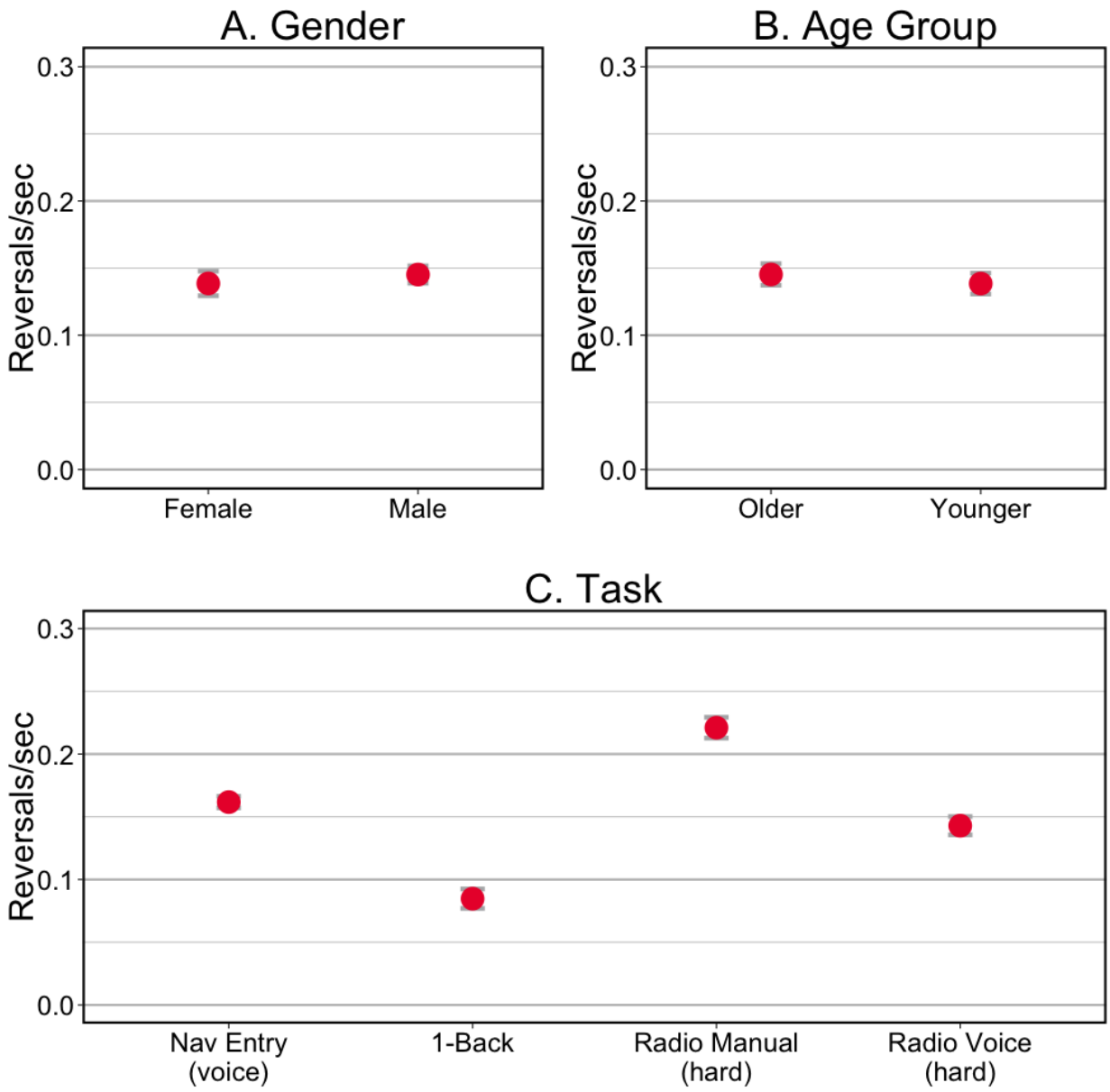


Figure C-27: Statistical summary plots for major SWR (**Second Trial**).

For the Second trials, major SWR was again not affected by gender or age group ($p = .440$ and $p = .741$, respectively). SWR differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

Selected Glance Metrics Summary Table (First & Second Trails)

If one were to apply the NHTSA distraction cutpoints to participants in the younger, older, and overall cohort, **Table C-1** below shows the percentage who would meet each of the criteria considering the First and Second trials independently. Entries for situations where less than 85% of a group meet a threshold are bolded and shown in red.

Task	Age Group	Long Duration Glances		Mean Glance Duration		Total Off-Road Glance Time	
		First Trial	Second Trial	First Trial	Second Trial	First Trial	Second Trial
Nav Cancel	Younger	96.70%	96.70%	96.70%	96.70%	100.00%	96.67%
	Older	100.00%	100.00%	100.00%	100.00%	**81.82%**	95.65%
	(all)	98.10%	98.10%	98.10%	98.10%	92.31%	96.23%
Nav Entry	Younger	100.00%	100.00%	100.00%	100.00%	**20.00%**	**10.00%**
	Older	95.70%	95.70%	100.00%	100.00%	**4.35%**	**0.00%**
	(all)	98.10%	98.10%	100.00%	100.00%	**13.21%**	**5.66%**
Radio M Easy	Younger	90.00%	96.70%	90.00%	100.00%	100.00%	100.00%
	Older	**82.60%**	91.30%	95.70%	100.00%	86.96%	95.65%
	(all)	86.80%	94.30%	92.50%	100.00%	94.34%	98.11%
Radio M Hard	Younger	93.30%	96.70%	100.00%	100.00%	**73.33%**	**90.00%**
	Older	**82.60%**	91.30%	95.70%	100.00%	**13.04%**	**34.78%**
	(all)	88.70%	94.30%	98.10%	100.00%	**47.17%**	**66.04%**
Radio V Easy	Younger	100.00%	100.00%	100.00%	100.00%	96.55%	100.00%
	Older	100.00%	100.00%	100.00%	100.00%	**69.57%**	**78.26%**
	(all)	100.00%	100.00%	100.00%	100.00%	**84.62%**	90.57%
Radio V Hard	Younger	100.00%	100.00%	100.00%	100.00%	**83.33%**	96.67%
	Older	95.70%	95.70%	95.70%	100.00%	**52.17%**	**73.91%**
	(all)	98.10%	98.10%	98.10%	100.00%	**69.81%**	**86.79%**
Song Select	Younger	96.70%	100.00%	96.70%	100.00%	**80.00%**	90.00%
	Older	95.70%	100.00%	100.00%	100.00%	**43.48%**	**60.87%**
	(all)	96.20%	100.00%	98.10%	100.00%	**64.15%**	**77.36%**
Song Fail	Younger	93.30%	N/A	100.00%	N/A	**26.67%**	N/A
	Older	100.00%	N/A	100.00%	N/A	**52.17%**	N/A
	(all)	96.20%	N/A	100.00%	N/A	**37.74%**	N/A
Phone	Younger	100.00%	100.00%	100.00%	100.00%	96.67%	90.00%
	Older	100.00%	100.00%	100.00%	100.00%	**63.64%**	**68.18%**
	(all)	100.00%	100.00%	100.00%	100.00%	**82.69%**	**80.77%**

Mean Glance Duration

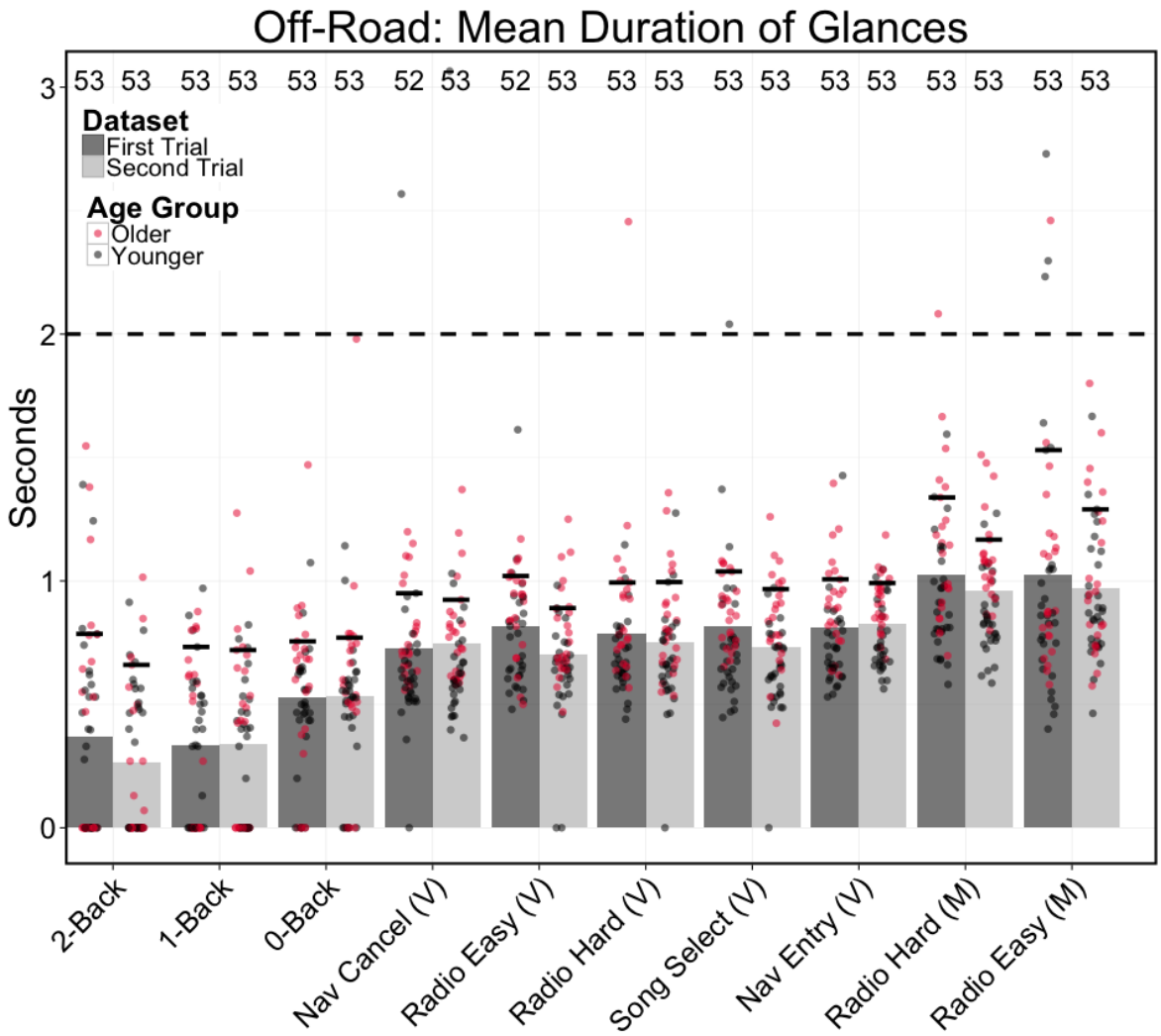


Figure C-28: Mean duration of off-road glances during each trial.

For the majority of participants, mean glance duration falls well below 2 seconds. The patterning of mean values and the 85% point for the sample either remains relatively consistent between the first and second trials, or shows a lower value for the second trial. An apparent improvement with the second trial on this metric is most evident in the two manual radio tasks.

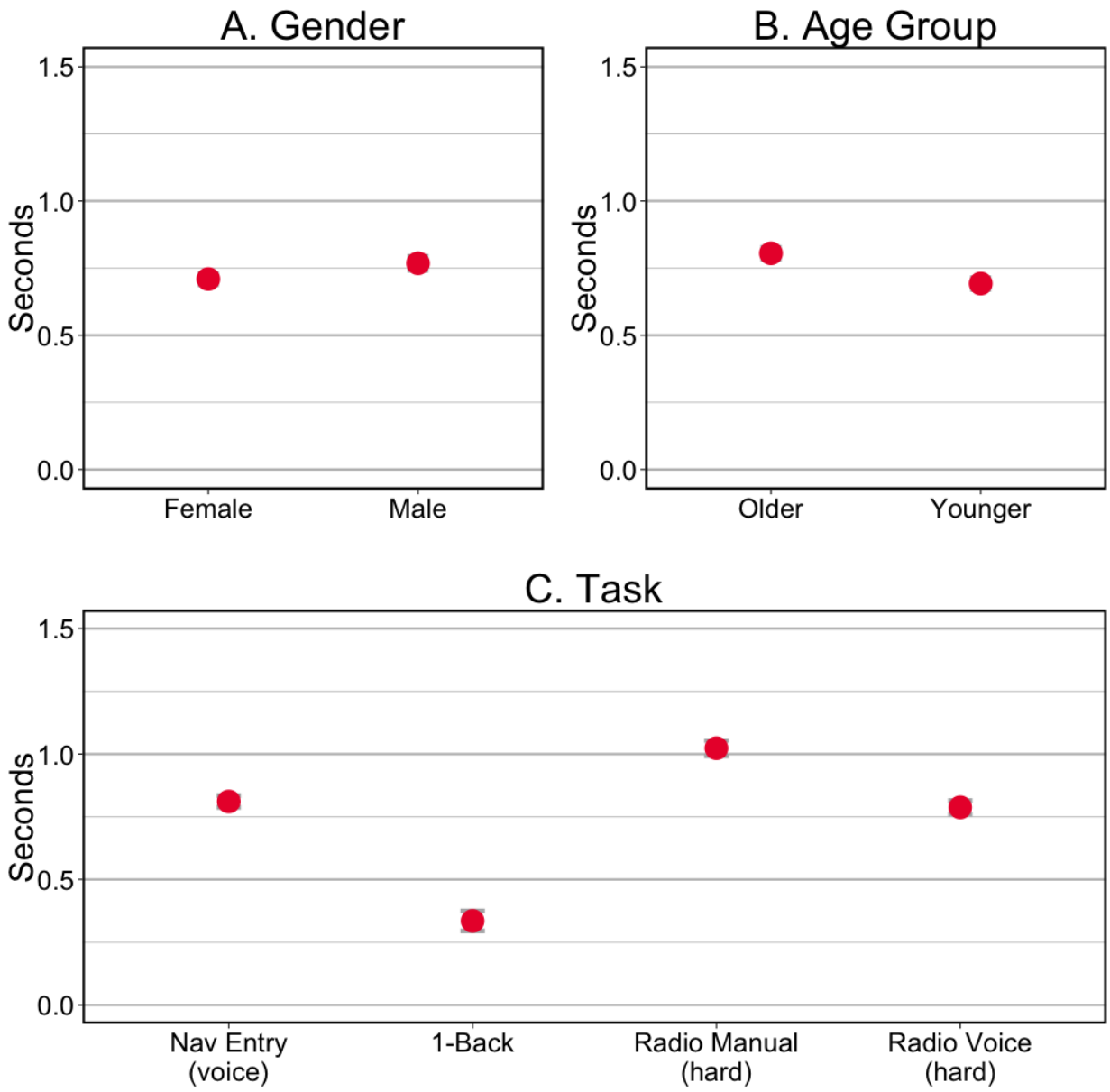


Figure C-29: Statistical summary plots for mean glance duration (**First Trial**).

There was a borderline difference in glance duration between genders ($p = .061$), with men having slightly longer mean glance durations than women. Glance duration also differed significantly by age group ($p = .001$). Mean glance duration differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$).

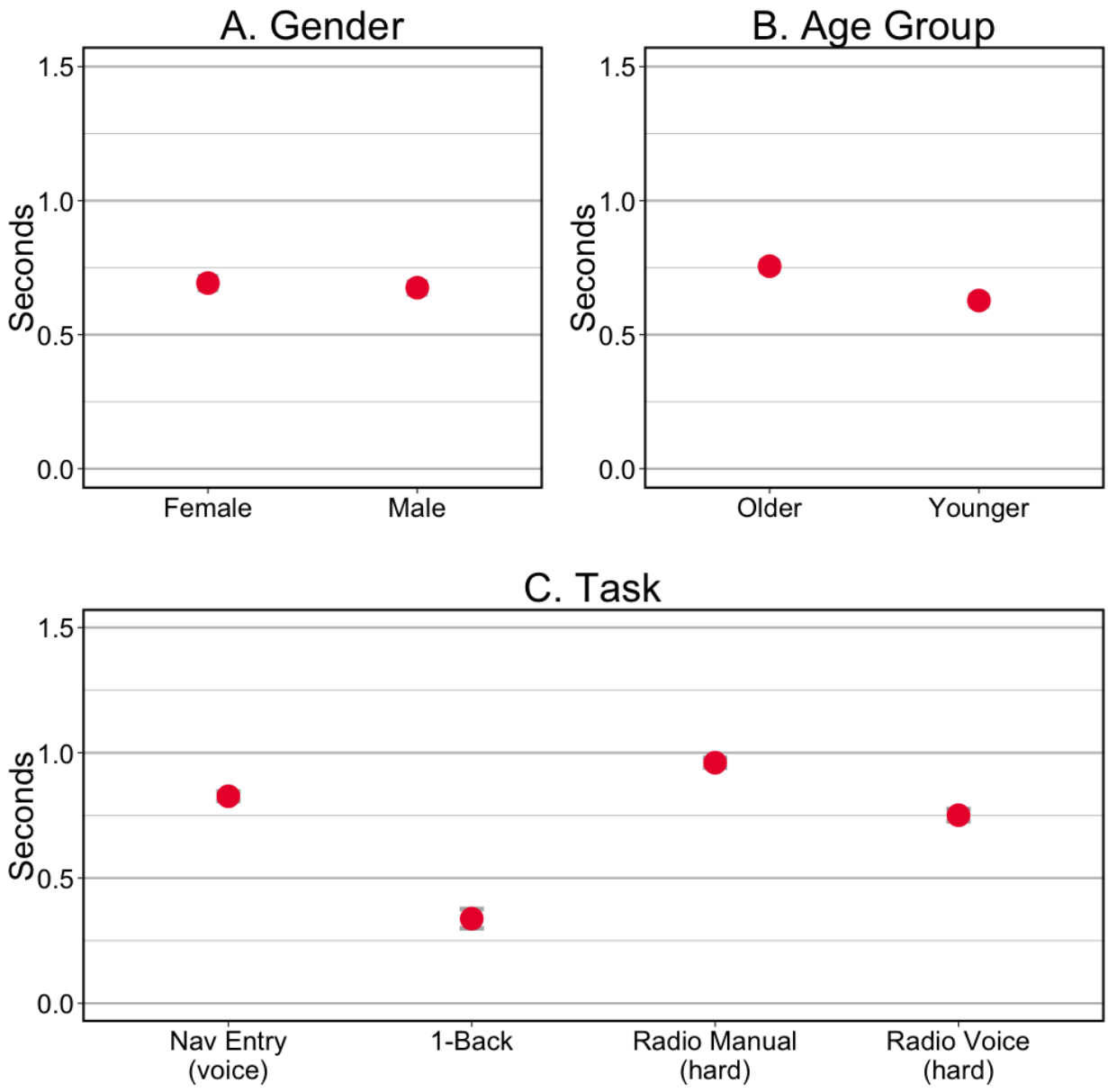


Figure C-30: Statistical summary plots for mean glance duration (**Second Trial**).

Mean glance duration was not affected by gender ($p = .825$). Mean glance duration was, however, affected by age group ($p < .001$). Mean glance duration differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$).

Percentage of Long Duration (> 2s) Glances

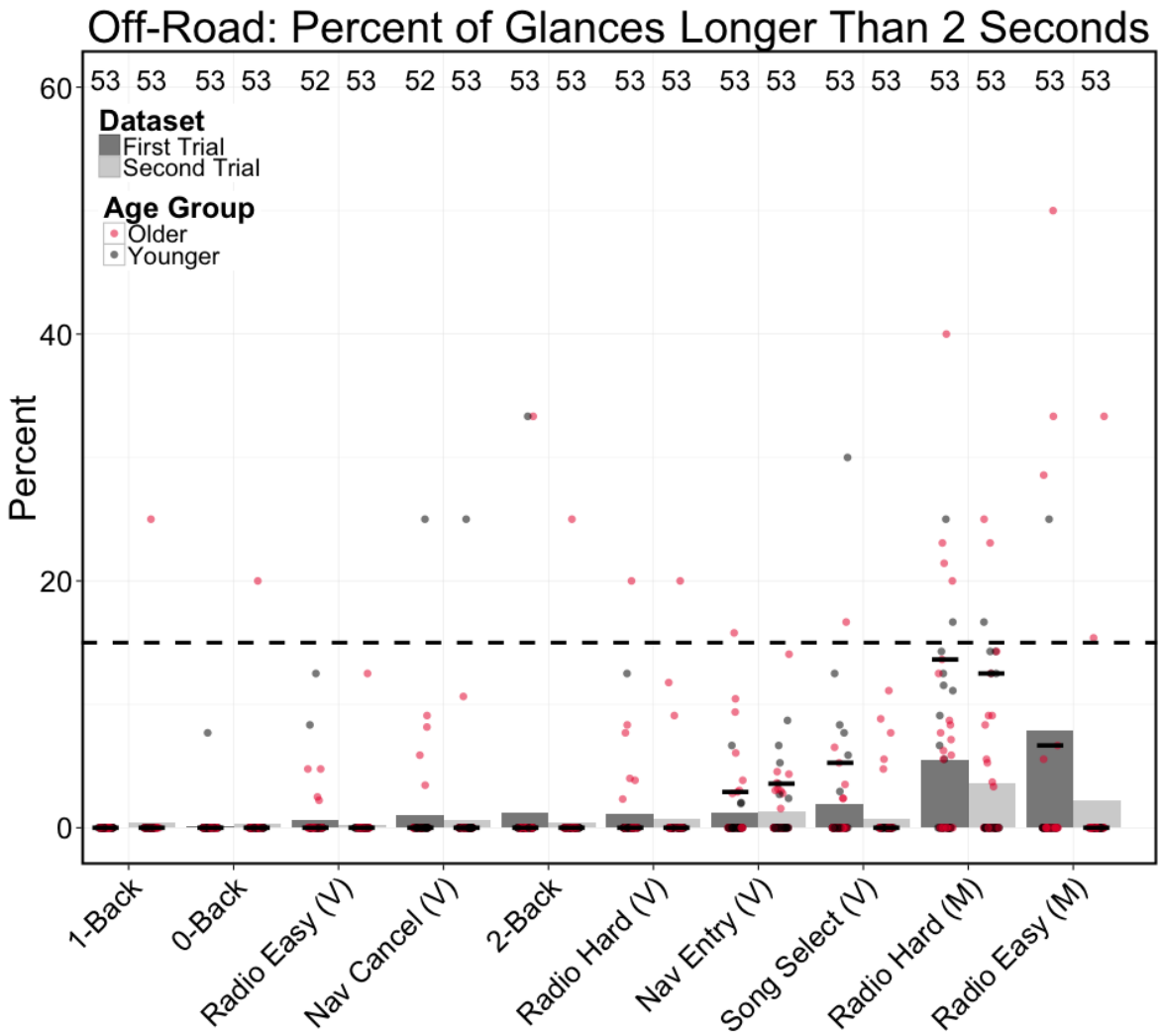


Figure C-31: Long glance rates during each task trial.

Again, glance rates during the Radio Manual tasks are likely elevated due to the low off-road glance frequency necessitated by these tasks.

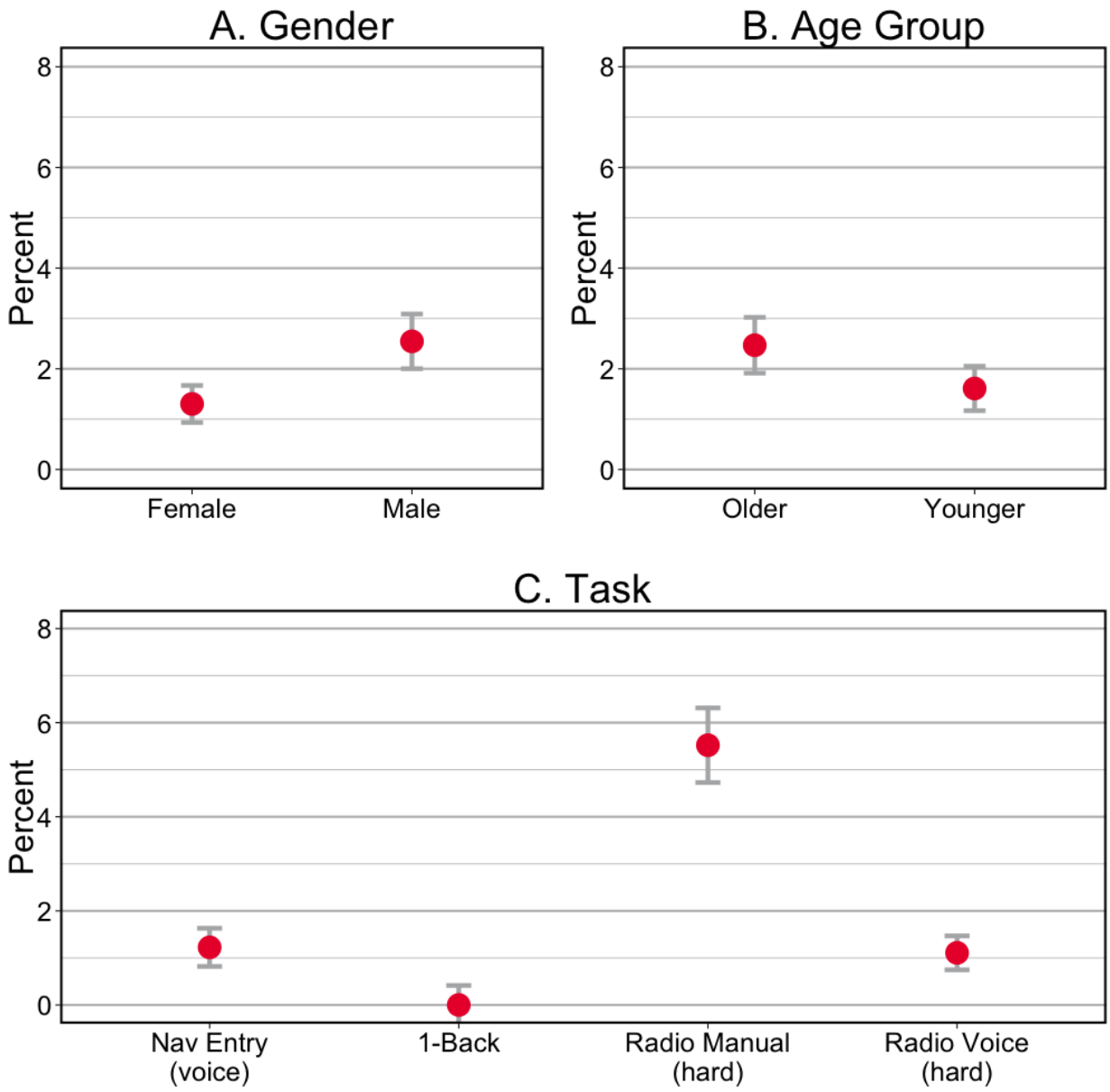


Figure C-32: Statistical summary plots for long glance rate (First Trial).

Long glance rate did not differ significantly between genders or age groups ($p = .128$ and $p = .094$, respectively). Long glance rate differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

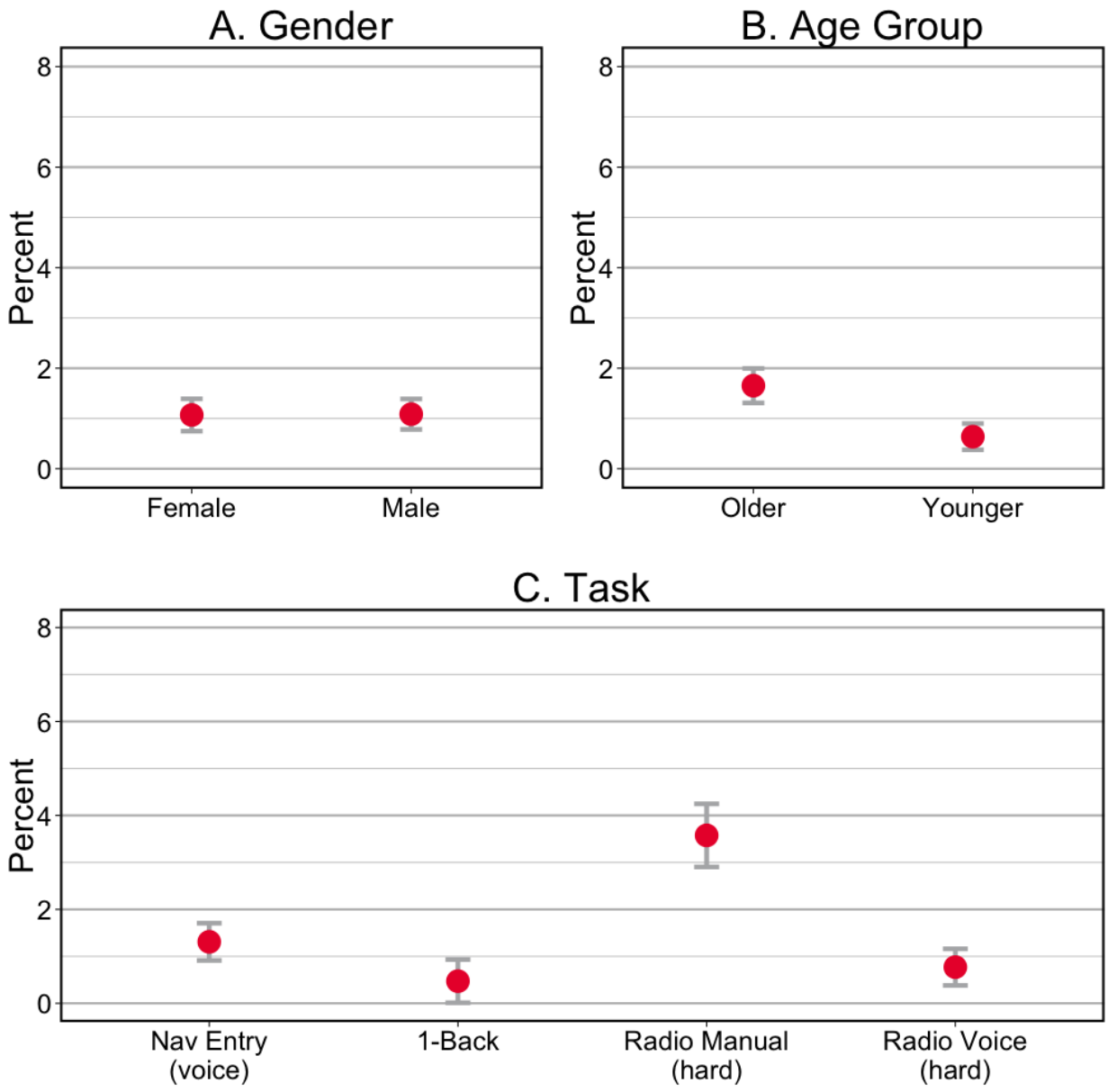


Figure C-33: Statistical summary plots for long glance rate (Second Trial).

Long glance rate did not differ significantly between genders, (p = .963), but did differ by age group (p = .001), with older subjects having a higher percentage of long glances than younger subjects. Long glance rate differed significantly between the radio tasks (p = .003), and between the radio manual and navigation entry tasks (p = .043).

Total Off-Road Glance Time

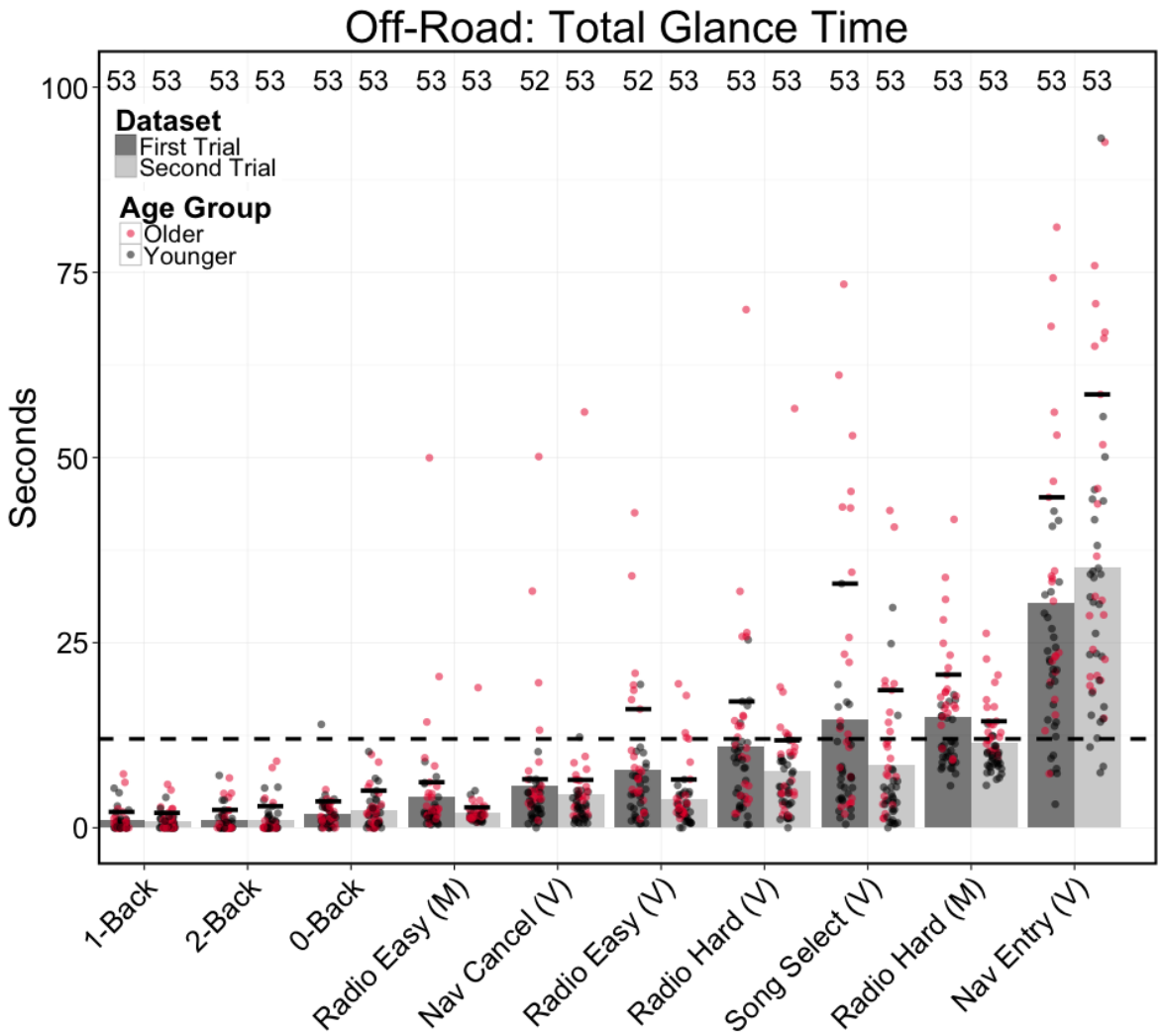


Figure C-34: Total off-road glance time during each task trial.

Note that off-road glance time increases substantially on the second trial of the Navigation Entry task. Thus, using the Second trial value in place of the mean values for both trials does not improve the criterion performance for this task. On the other hand, total glance time does decrease in the Second trial for several tasks. In the case of the manual Radio Easy and voice Radio Hard tasks, using the Second trial value instead of the mean for both trials might impact whether the formal NHTSA criterion is met in a sample with the specified age distribution.

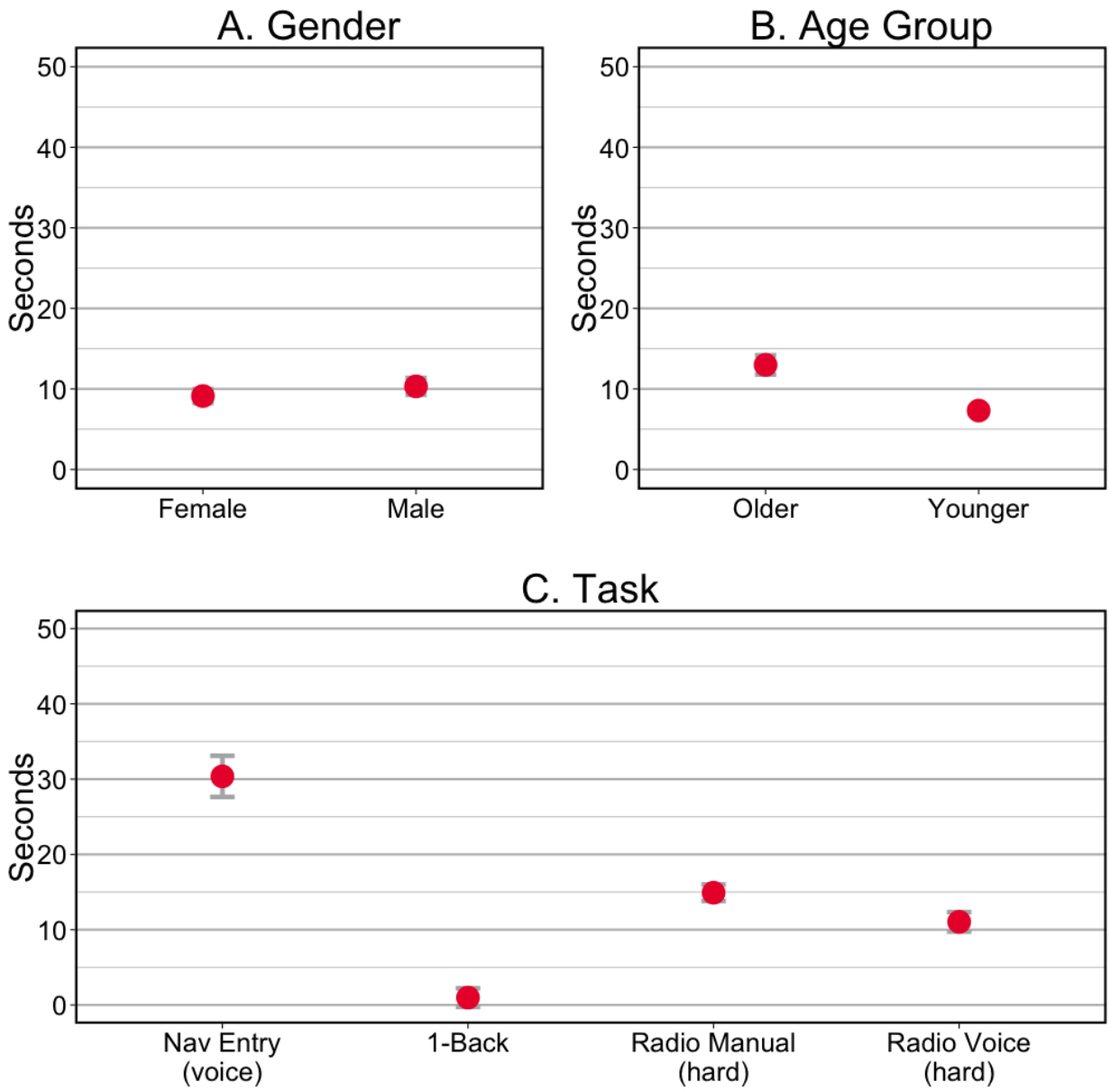


Figure C-35: Statistical summary plots for total glance time (First Trial).

Total glance time was not affected by gender ($p = .506$). Total glance time was significantly affected by age group ($p < .001$), with older participants spending more time glancing off-road than younger participants. Glance time also differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

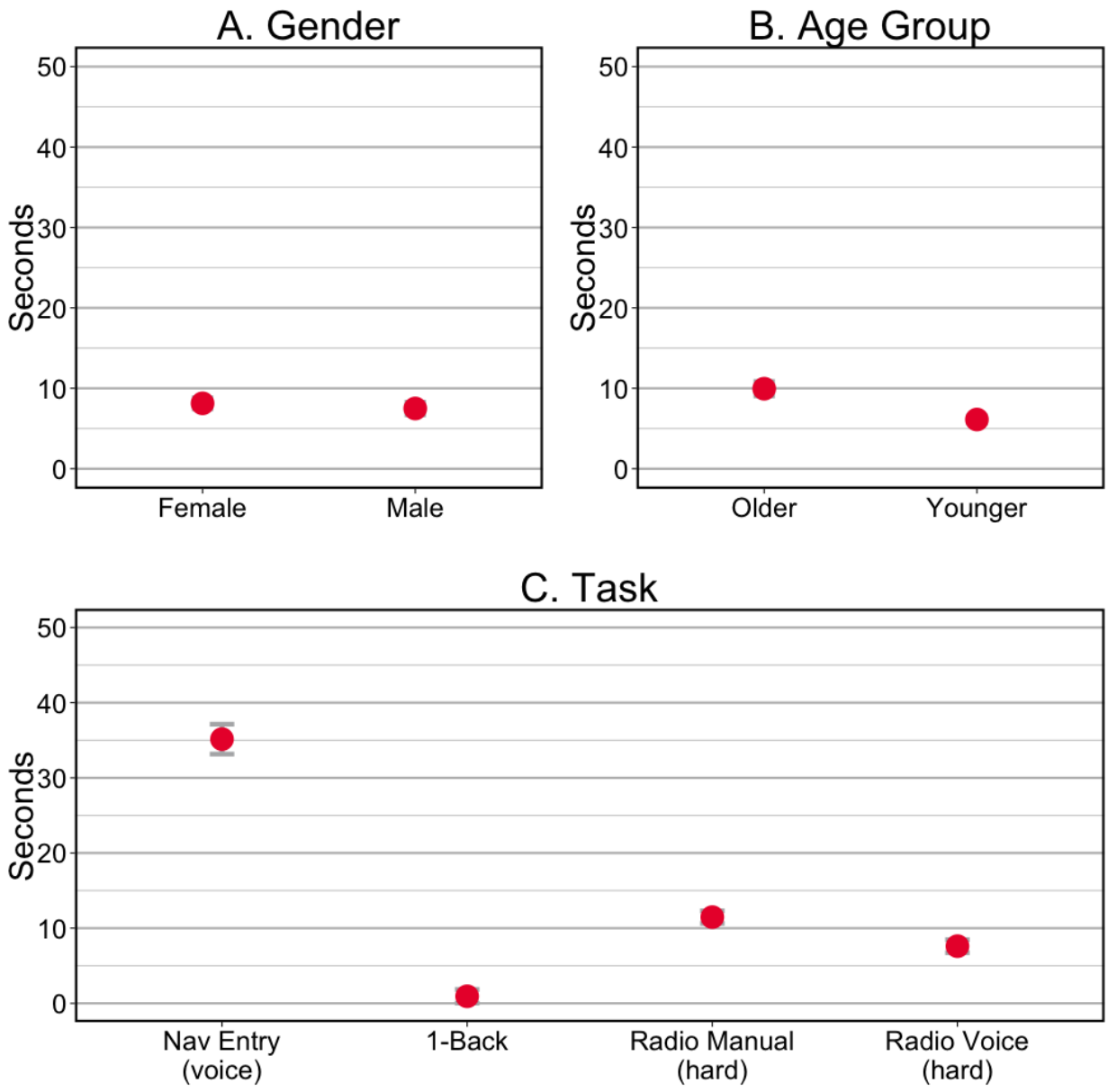


Figure C-36: Statistical summary plots for total glance time (**Second Trial**).

The same overall findings for age, gender and pattern of findings for the selected tasks is consistent between the First and Second trials. For the Second trial, total glance time was not affected by gender ($p = .360$). Total glance time was significantly affected by age group ($p < .001$), with older participants spending more time glancing off-road than younger participants. Glance time also differed significantly between the radio tasks and between the radio manual and navigation entry tasks ($p < .001$ for both).

Number of Glances

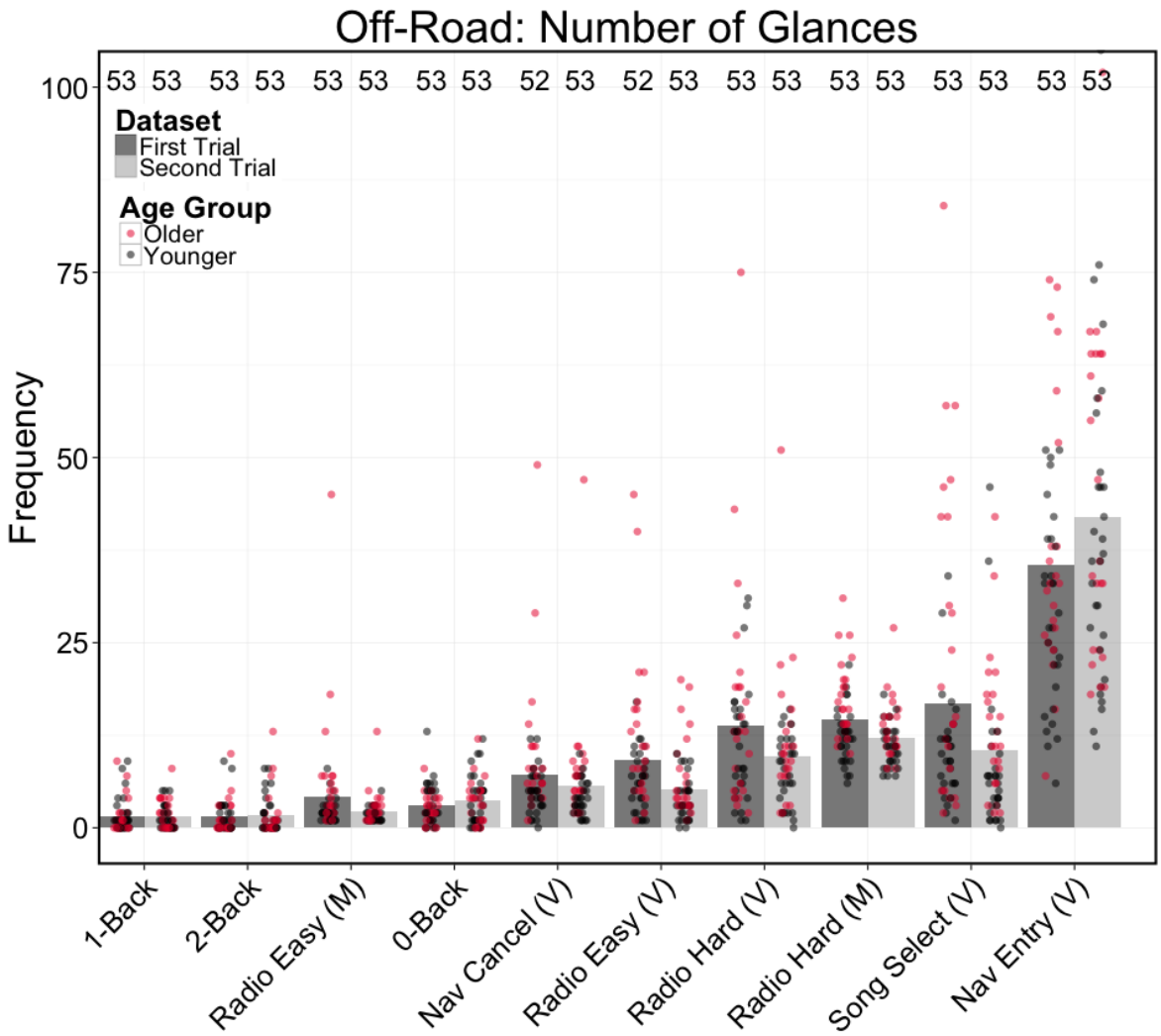


Figure C-37: Number of off-road glances during each task trial.

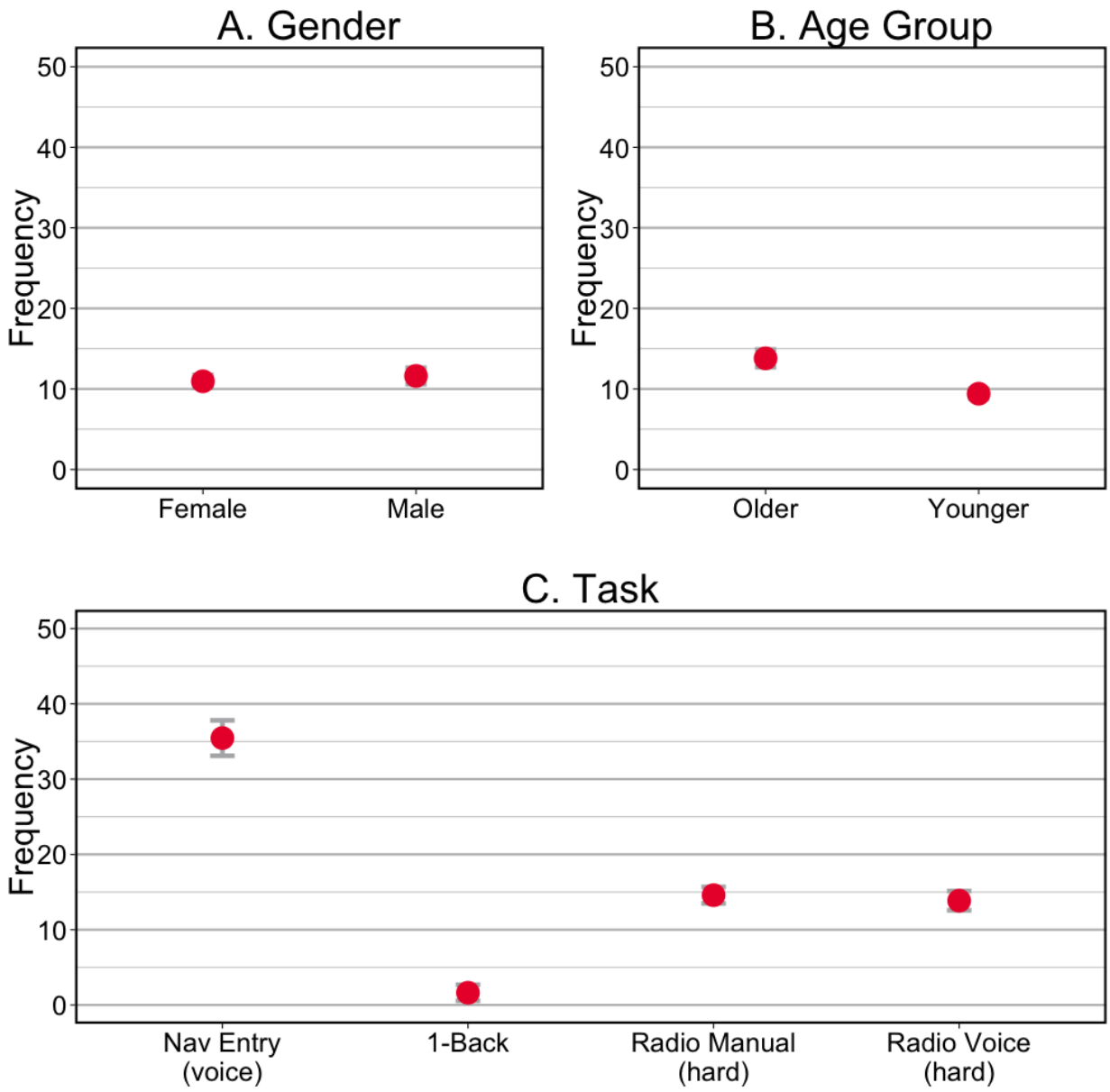


Figure C-38: Statistical summary plots for number of off-road glances (**First Trial**).

Number of glances was not affected by gender ($p = .915$). There was a significant effect of age group ($p < .001$), with older participants requiring more glances than younger participants. Number of off-road glances did not differ between the radio tasks ($p = .253$), but did differ between the radio manual and navigation entry tasks ($p < .001$).

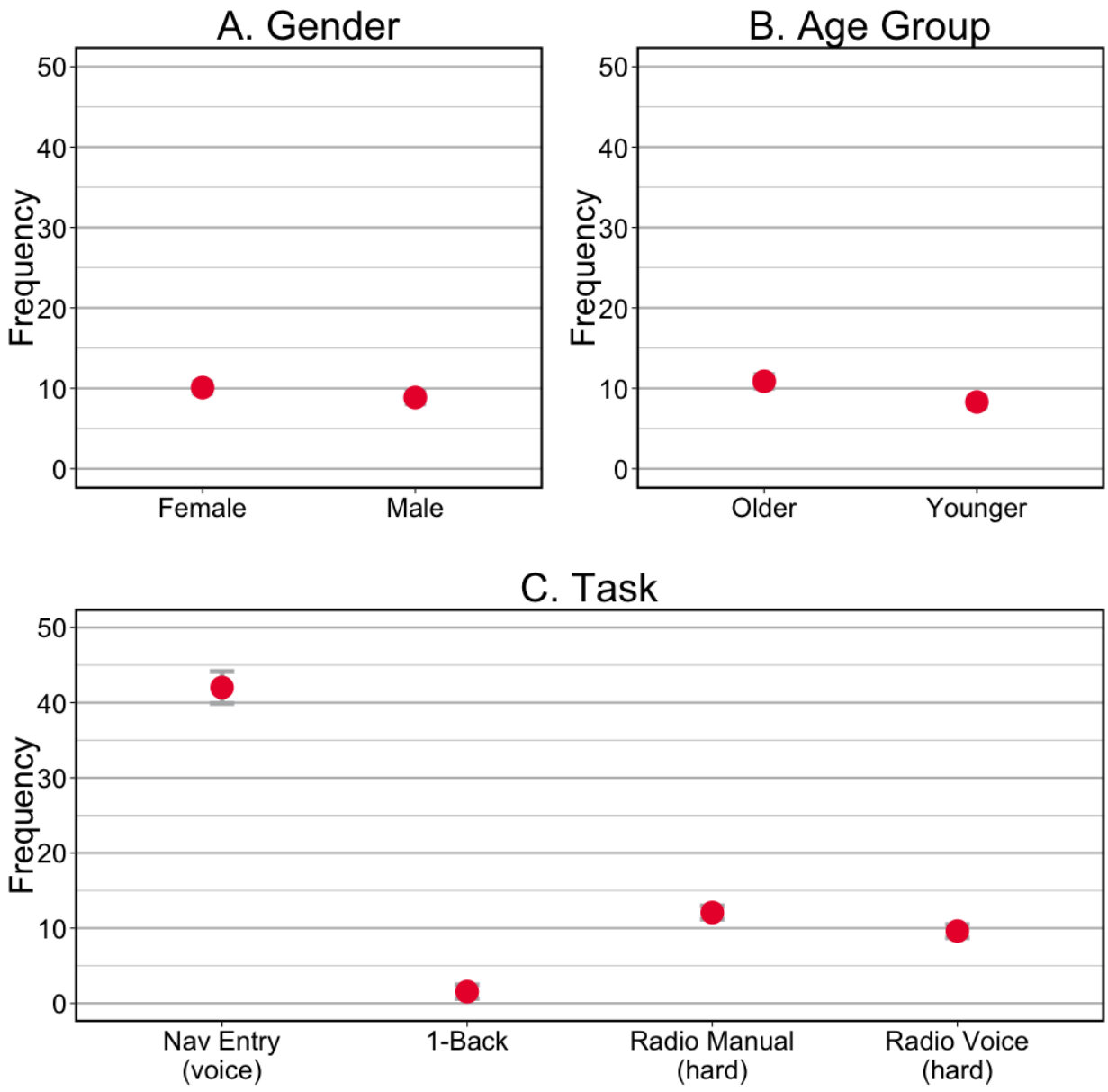


Figure C-39: Statistical summary plots for number of off-road glances (**Second Trial**).

The same overall findings for age, gender and pattern of findings for the selected tasks is consistent between the First and Second trials. For the Second trial, the number of glances was not affected by gender ($p = .138$). There was a significant effect of age group ($p = .036$), with older participants requiring more glances than younger participants. Number of off-road glances differed significantly between the radio tasks ($p = .002$), and between the radio manual and navigation entry tasks ($p < .001$).

Orienting Response

Orienting Response codes are shown for each set of tasks in Figures X and Y (see Appendix D for coding details). Younger participants show a slight reduction in their OR on the Second trials as compared to the First. In contrast, older participants show relatively little improvement in AOR during the Second trial.

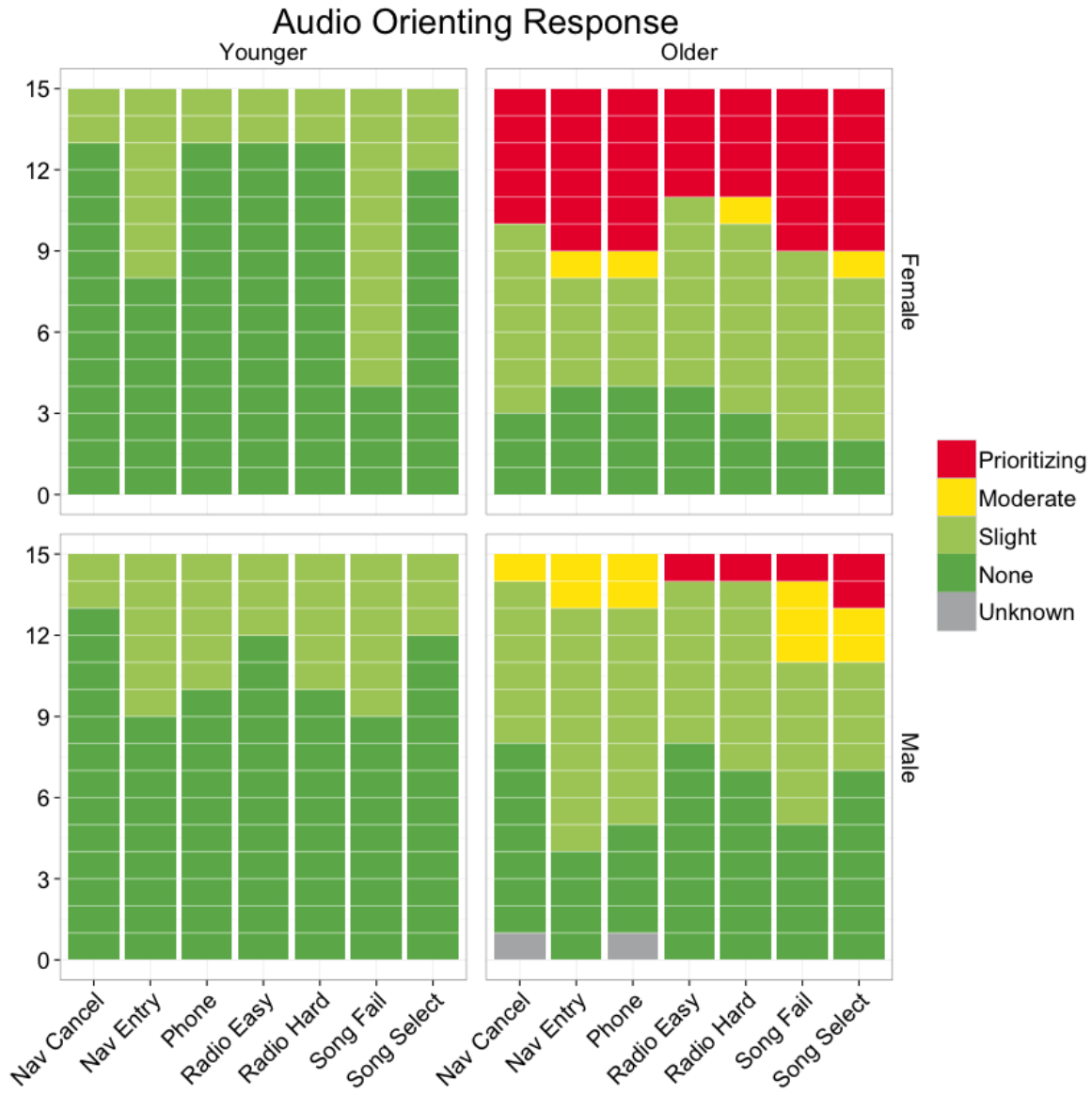


Figure C-40: Orienting Responses for the First trial of each task.

Note that one participant was unable to complete the Phone tasks, and one participant accidentally canceled a navigation command before the formal start of the task period, resulting in one missing data point for the Navigation Cancel task. As noted elsewhere, it should be

noted that this analysis does not explicitly distinguish glances for visual confirmation from glances associated with OR behavior, and it is recognized that this is a partial confounding factor in evaluating this behavior pattern.

Figure C-41: Orienting Responses for the Second trial of each task.

Note that one participant was unable to complete the Phone tasks.

Task Completion Data

Task Completion codes are shown for each task trial in Figures X and Y. Both younger and older participants were able to improve their task completion ability on the Second trial.

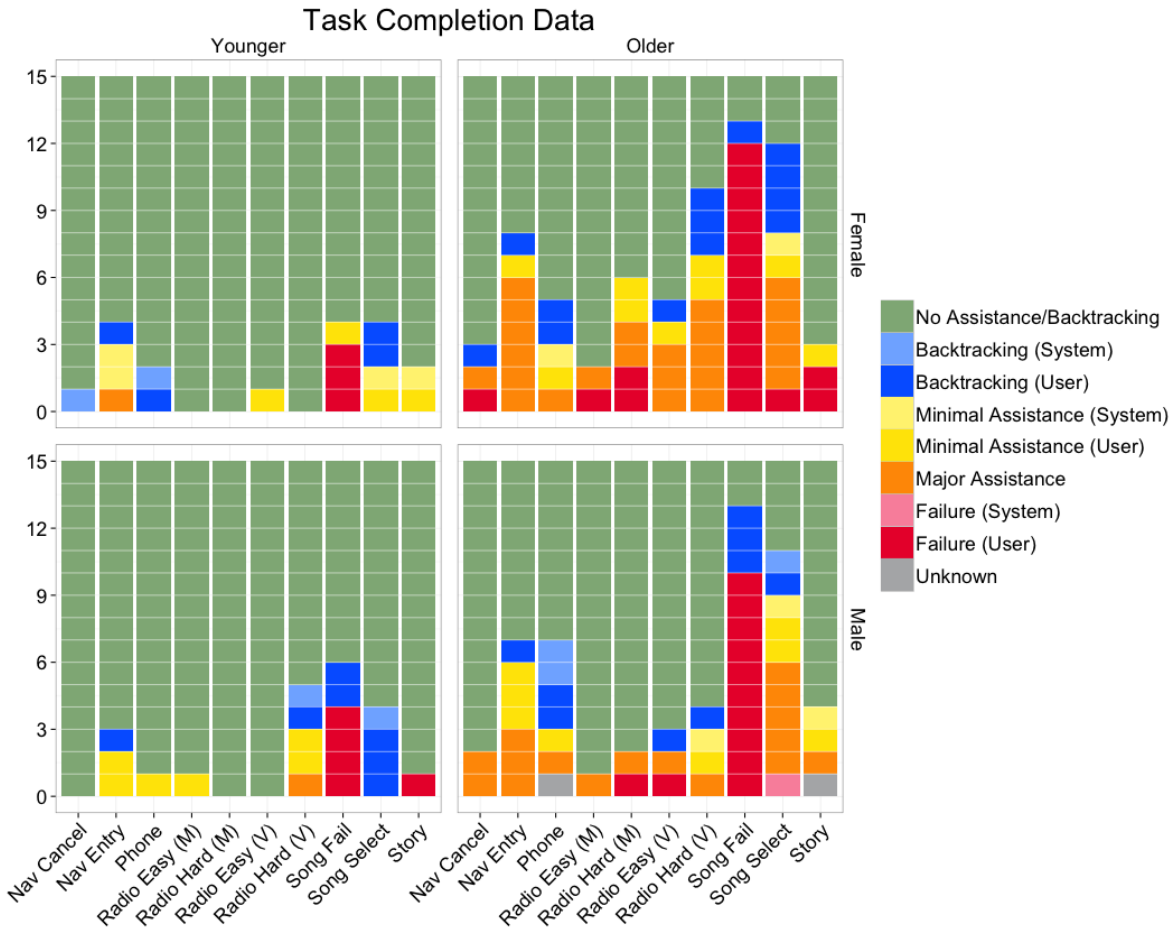


Figure C-42: Task completion codes for the First trial of each task.

Note that although the Song Fail task was designed to be impossible to complete, the codes shown here reflect the participant's ability to correctly execute the song search commands.

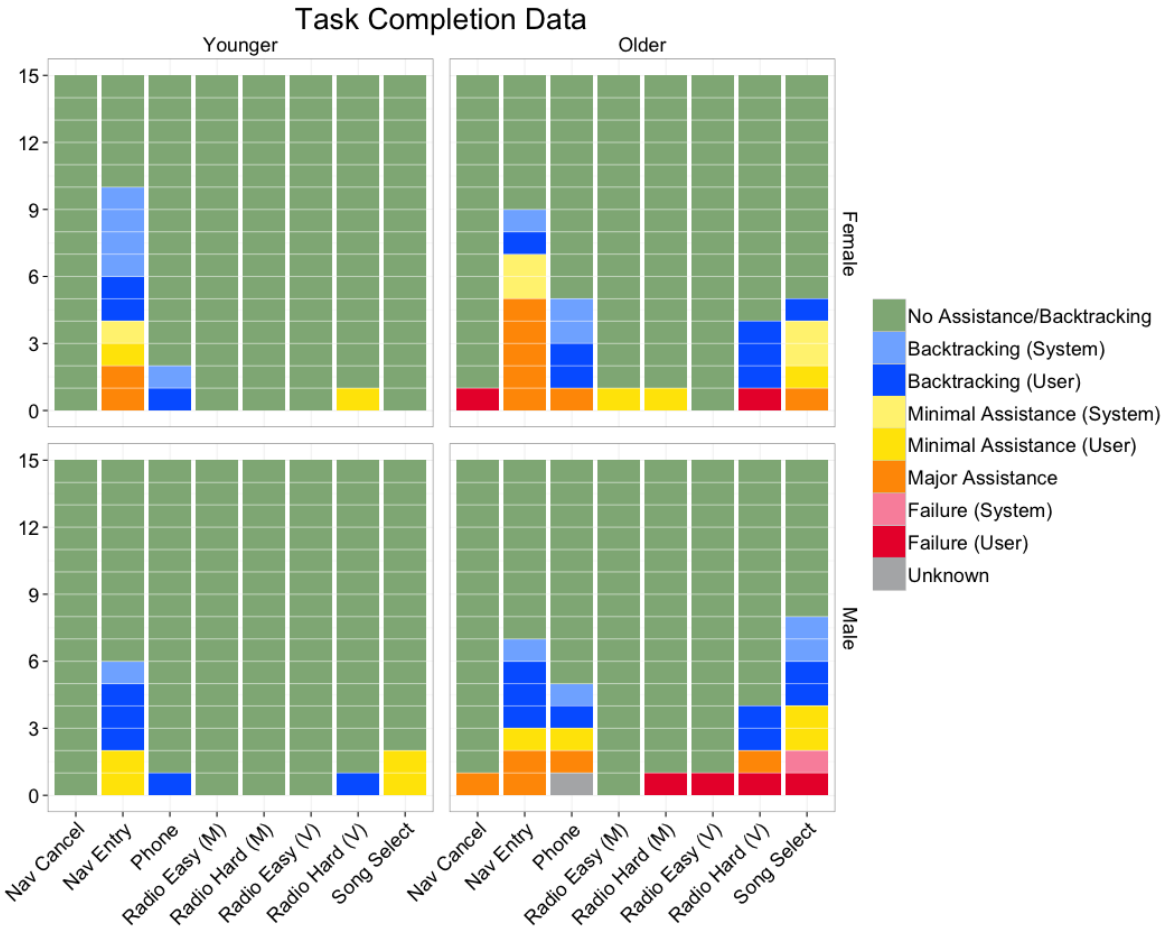


Figure C-43: Task completion codes for the Second trial of each task.

Glance Distribution Analyses

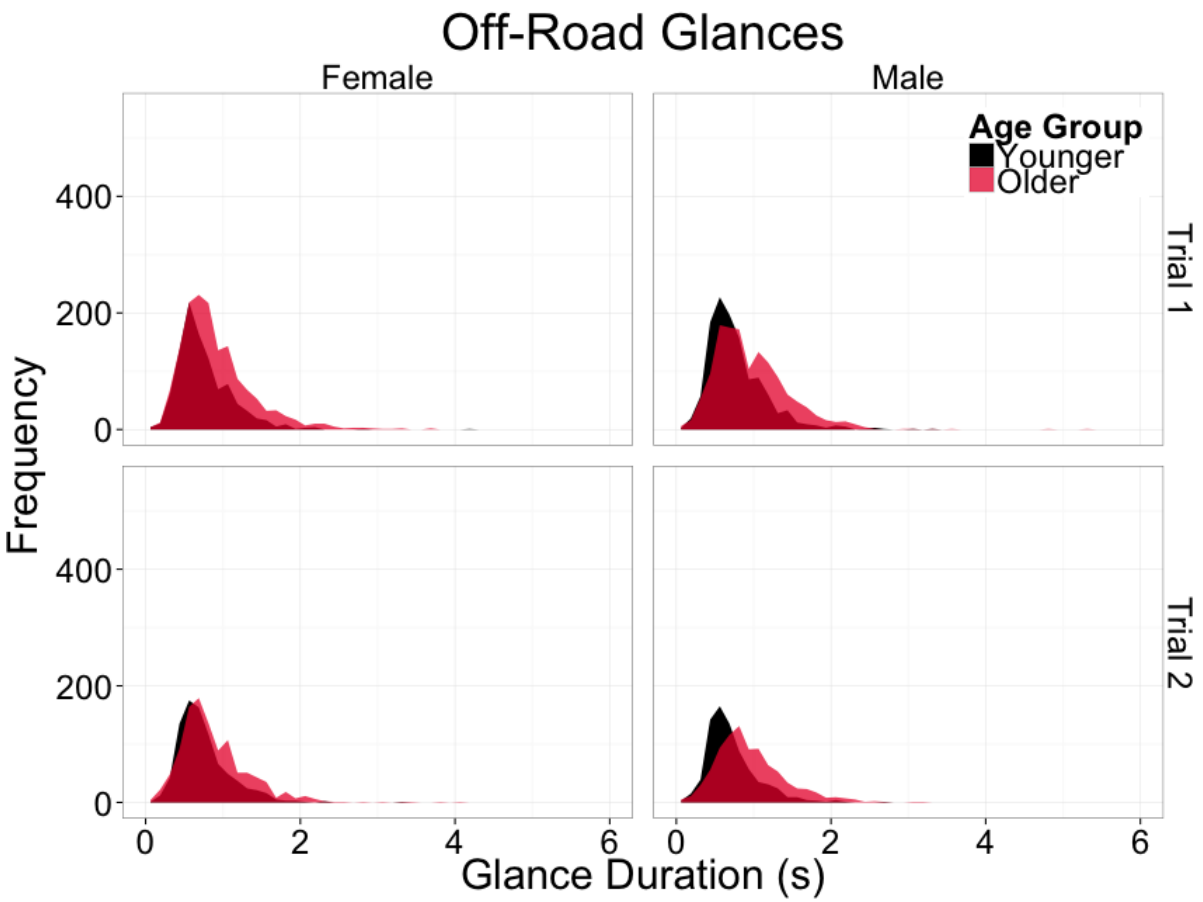


Figure C-44: Glance distributions for the First trial (upper panels) and Second trial (lower panels) of each task.

Considering all tasks as a group, there was a substantial and significant reduction in the number of glances between trials ($p < .001$), with a per-participant mean of 141 glances on the First trial and 100 on the Second trial.

APPENDIX D: ORIENTING RESPONSE CODING

Introduction

The Ford SYNC® voice interface, once activated with the push-to-talk button, is generally able to recognize the driver's voice regardless of where he/she may be looking. Nevertheless, we observed many drivers orienting their head and eyes as if they believed that the voice recognition system was housed somewhere near the center console display that was utilized by the Ford SYNC® . Drivers would sometimes speak "to" the center console display screen, turn their heads or entire bodies toward the device, or lean in toward where the microphone was (incorrectly) perceived to be. We believe that it may be useful to examine this Orienting response (OR) in greater detail as a number of participants appeared to orient their attention, including some direct glances, to the display at a level above what was required to actually acquire necessary display information.

Methods

A single coder watched muted video recorded from a camera mounted on the vehicle dashboard, facing the driver. The camera recorded the participant's face and upper torso, providing a clear view of the participant's posture and head orientation. This made it relatively easy to determine when the participant began orienting to the display screen. Participant's behaviors were coded according to the guide below. It should be noted that this analysis does not explicitly distinguish glances for visual confirmation from glances associated with OR behavior, and it is recognized that this is a partial confounding factor in the coding.

Coding Guide

Category	Code	Description
Unknown	0	Participant did not perform the task or its corresponding data are missing.
None	1	Participant exhibits no OR towards the center console display. This means there is no head tilting or leaning of the body towards the device.
Slight	2	Participant exhibits some mild OR towards the device. The participant leans his/her head towards the device periodically throughout the task, or briefly leans his/her body toward the device.
Moderate	2.5	Participant exhibits a fair amount of OR towards the device. This means the participant leans his/her head or body towards the device or speaks directly at the device for a sustained period of time.
Prioritizing	3	Participant exhibits a clear and sustained OR toward the device. This means that the participant fully leans his/her head towards the device or repositions his/her body toward the device. The participant may also appear to be speaking directly at the device while also glancing for prolonged periods of time at the screen.

Results

OR data are presented in the following tables for each participant and task trial. Plots of the OR are presented in the Primary Analysis section and the corresponding sections of the subsidiary analyses.

Participant ID	Nav entry 1	Nav cancel 1	Nav entry 2	Nav cancel 2	Song select 1	Song select 2	Song select 3
6	2	1	1	1	1	1	1
7	2	1	2	1	1	1	2
8	2	0	2	1	1	2	2
9	1	1	1	1	2	1	1
15	2	2	2	2	2	2	2
17	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1
20	1	1	2	1	1	1	1
21	2	2	2	2	2	1	1
24	1	1	2	1	1	1	2
25	1	1	1	1	1	1	1
26	1	2	2	1	2	2	2
27	1	1	1	1	1	1	1
29	2	1	2	2	1	1	1
30	2	1	1	1	1	1	1
31	2	2	2	2	2	2	2
34	2	1	2	1	1	1	2
37	2	2	2	2	2	2	2
38	2	1	2	1	1	1	2
39	1	1	1	1	1	1	2
41	2	2	2	2	2	2	2
42	1	1	1	1	1	1	1
43	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1
46	1	1	1	1	1	1	1
47	1	1	1	1	1	1	1
49	2	1	2	1	1	1	2

51	1	1	1	1	2	1	2
53	1	1	1	1	1	1	1
54	2	2	2.5	2.5	2.5	2.5	2.5
58	1	1	1	1	1	1	2
60	1	1	1	1	1	1	2
61	1	1	1	1	1	1	1
62	2	2	2	2	3	3	3
67	2	2	2	1	3	2	2
68	2	2	2	1	2	1	2
69	1	1	2	1	2	1	2
70	2	2	2	2	2	2	2.5
74	2	1	2	2	2	2	2
76	2	2	2	2	2	2	2
77	2.5	2	2	2	3	3	3
79	2	1	1	1	1	2	2
80	3	3	3	3	3	3	3
82	2	2	2	1	1	1	2
83	1	1	2	1	2.5	2	2
84	2	1	1	1	1	1	2
86	1	2	2	2	1	2	2
87	1	1	2	1	1	1	1
88	2	1	1	1	2	2	2
89	2	2	2	1	2	2	2
90	2.5	2.5	2.5	2.5	2.5	2.5	2.5
91	2.5	1	2	2	1	1	2
94	2	1	1	1	1	2	2
95	3	3	3	3	3	3	3
98	3	2	3	3	3	2.5	3
99	3	3	3	2	2	2	2
100	1	1	1	1	1	1	1
101	3	3	3	3	3	3	3
103	1	1	1	1	1	1	1
104	3	3	3	3	3	3	3

Listing Continued for Remaining Tasks:

Participant ID	Radiov 1	radiov_2	radiov_4	radiov_6	phone_1	phone_2
6	2	1	2	1	1	1
7	1	1	1	1	2	1
8	1	1	2	1	2	2
9	1	1	1	1	1	1
15	2	1	2	2	2	2
17	1	1	1	1	1	1
18	1	1	1	2	1	2
20	1	1	2	1	1	1
21	1	1	1	1	2	2
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	2	2	1	2	2
27	1	1	1	1	1	1
29	1	1	1	1	2	2
30	1	1	1	2	1	1
31	3	2	2	2	2	2
34	1	1	2	1	1	1
37	2	1	2	2	2	2
38	1	1	2	2	1	2
39	1	1	1	1	1	1
41	2	1	2	1	2	2
42	1	1	1	1	1	1
43	1	1	1	1	1	1
44	1	1	1	1	1	1
46	1	1	1	1	1	1
47	1	1	1	1	1	1
49	2	1	1	1	2	1
51	1	1	1	1	1	1
53	1	1	1	1	1	1
54	3	3	3	2	2.5	2

58	1	1	1	1	1	1
60	1	1	1	1	1	1
61	1	1	1	1	1	1
62	2	2	2	1	2	2
67	2	2	1	1	1	2
68	2	1	2	2	2	2
69	1	1	1	1	1	1
70	2	3	2	2.5	2	2
74	2	1	2	2	2	1
76	2	2	2	2	2	2
77	3	3	3	3	3	3
79	1	1	1	1	2	1
80	3	3	3	3	3	3
82	1	2	1	1	1	1
83	1	1	2	2	1	1
84	1	1	1	1	1	2
86	2	2	2	1	1	1
87	1	1	1	1	1	1
88	1	2	1	1	1	1
89	1	1	1	2	2	2
90	2	3	2	3	2.5	2.5
91	1	1	1	1	2	2
94	2	2	2	1	2	1
95	2	2	2.5	2	3	3
98	2	1	3	2	3	3
99	2	2	2	2	2.5	2.5
100	1	1	1	1	0	0
101	3	2	2	3	3	3
103	1	1	1	1	1	1
104	2	2	3	3	3	3

APPENDIX E: BASELINE PERIOD ANALYSIS

Introduction

The use of a single reference period immediately prior to a defined secondary task period is a common method by which dynamic measures such as physiology, glance behavior, and driving performance metrics can be considered relative to "single task" driving. One of the challenges for real-world studies is the reality that external events, such as truck passing close by to the experimental vehicle, or internal events, such as thoughts about personal conflicts, will influence the arousal level and driving performance of some percentage of participants during any given reference point. This can have a measurable impact on the estimated change in behavior associated with single task vs. dual task conditions as we have discussed previously (Reimer, Mehler, Wang, et al., 2012). In the design of the present study, we collected a series of baseline periods, one prior to each task block, and that could be combined for purposes of establishing a broad single task driving reference. The extent to which the use of this combined baseline may have influenced our findings as opposed to using individual baselines is considered in this Appendix.

There were a total of seven baseline periods in which participants simply drove, without having to focus on any secondary tasks. Each baseline was followed by a task block. Throughout the main analyses of this report (Primary Analysis and Appendices A-C), dual task driving periods are generally presented alongside a combined baseline period that represents the mean of the seven separate periods. The following section examines physiological data, driving behavior measures, and visual behavior as defined by NHTSA's guidelines for visual-manual distraction for each of the seven baseline periods individually. The intent here is to examine the extent to which this method of combining the individual baseline periods into a common single task driving reference period may have impacted the pattern of results as well as to characterize various aspects of drivers' behavior during the single task driving intervals that were formally analyzed.

Methods

Methods for this supplementary analysis are consistent with those of the Primary Analysis. Data for each baseline period are visualized separately. For each measure of interest, a Friedman test is employed to determine whether there were any significant differences between the baseline periods.

Additionally, total off-road glance time is further broken down by glance target. An analysis of the total driving time necessary to accumulate 12 seconds of off-road glance time is also presented.

Results

Consistency Across Baseline Periods

Results of statistical testing are presented in Table X. There were no significant differences across the baseline periods for heart rate, skin conductance level, or any of the NHTSA visual-manual distraction criteria. However, there were statistical differences in several measures of driving behavior, as shown in the table below. Corresponding plots of the mean values for each variable are shown in **Figures X-Y** at the end of this section.

Table E-1: Friedman tests on various dependent measures across the baseline periods.

Dependent Measure	P-Value	Significance
Heart Rate	0.082	NS
Skin Conductance Level	0.841	NS
Mean Glance Duration	0.289	NS
Long Glance Rate	0.702	NS
Total Off-road Glance Time	0.922	NS
Number of Glances	0.729	NS
Mean Velocity	0.413	NS
Variability of Velocity	0.016	*
Acceleration Events	0.048	*
Steering Wheel Angle	< 0.001	***
Minor Steering Wheel Reversals	0.428	NS
Major Steering Wheel Reversals	< 0.001	***

Off-Road Glance Behavior

We also evaluated the length of time necessary to accumulate 12 seconds of off-road glances during baseline driving. Table X presents summary statistics for this measure. Six younger participants drove for over 400 seconds before accumulating twelve seconds of off-road glance time. Table Y presents summary statistics with these outliers removed. Regardless of outlier removal, older participants accumulate off-road glance time significantly faster than younger participants ($p = .003$ with outliers, $p = .04$ without, ANOVA by ranks). The effect of gender is not significant ($p = .647$ and $p = .309$), nor is the interaction of age group and gender ($p = .732$ and $p = .885$).

Table E-2: Summary statistics for off-road glance accumulation time (in seconds). Tables present the mean (standard deviation) [range].

	Younger	Older
Female	203.08 (163.0) [87.7 - 691.9]	112.37 (65.2) [30.7 - 204.6]
Male	239.20 (216.8) [53.0 - 758.8]	96.90 (53.1) [41.0 - 202.9]

Table E-3: The same summary statistics as in Table X, but with six younger outlier participants removed.

	Younger	Older
Female	148.21 (60.3) [87.7 - 263.5]	112.37 (65.2) [30.7 - 204.6]
Male	122.06 (49.9) [53.0 - 210.0]	96.90 (53.1) [41.0 - 202.9]

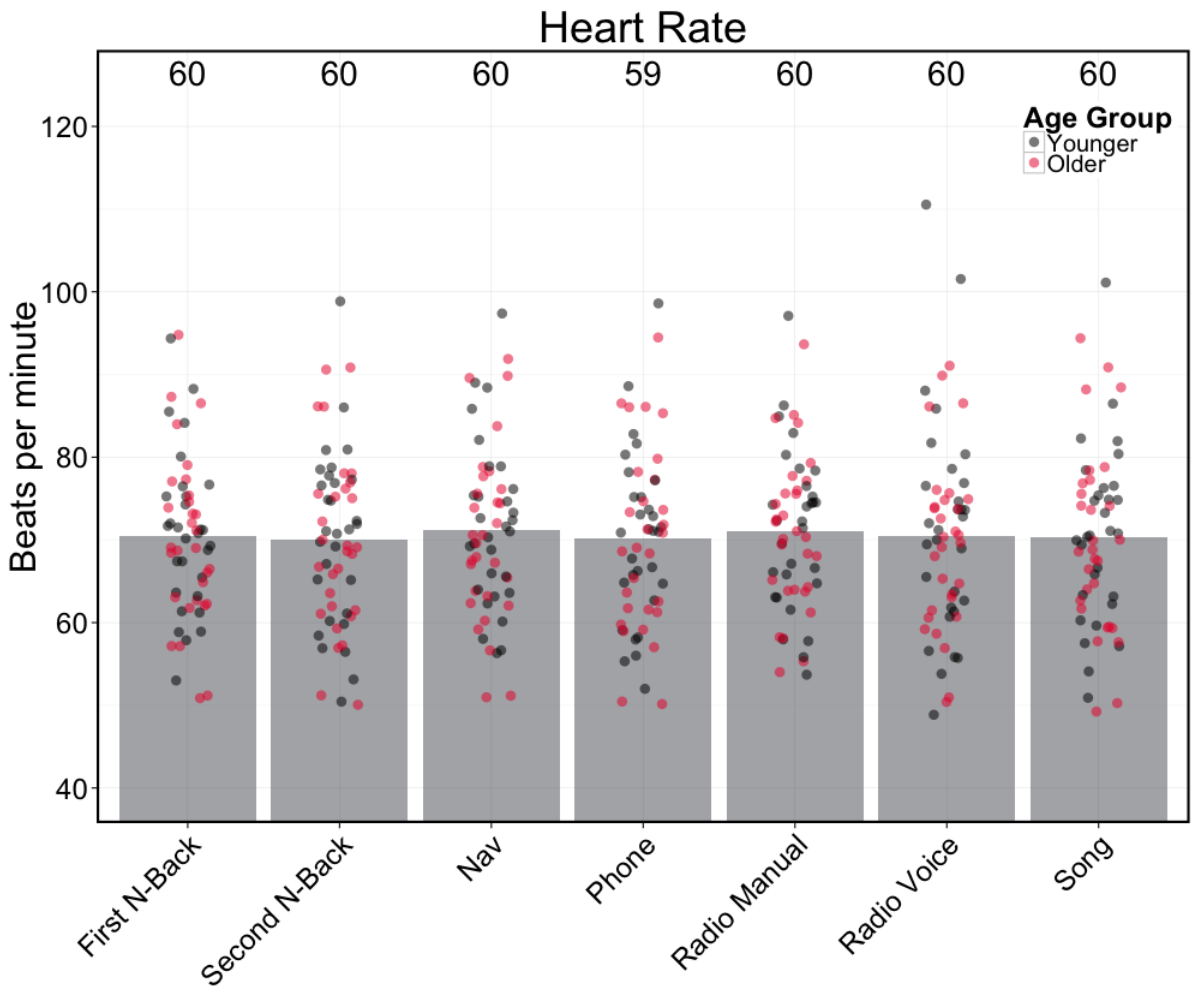


Figure E-1: Heart rate across the seven baseline periods.

There is some fluctuation in mean values but a Friedman test shows no statistically significant difference in heart rate across the baselines collected prior to each of the seven data collection blocks (p= 0.082).

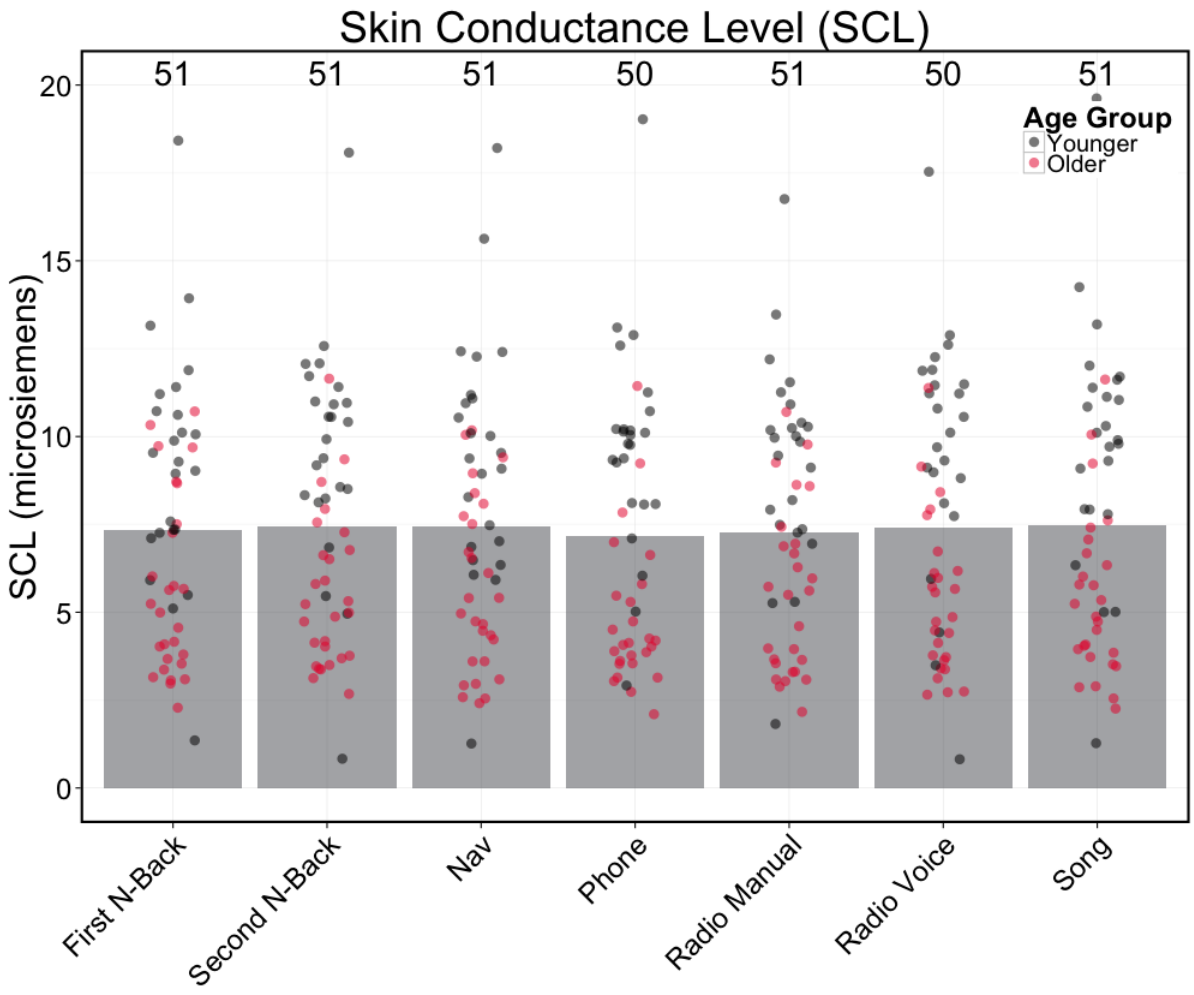


Figure E-2: Skin conductance level (SCL) across the seven baseline periods.

A Friedman test shows no significant difference in SCL across the baselines collected prior to each of the seven data collection blocks (p= 0.841).

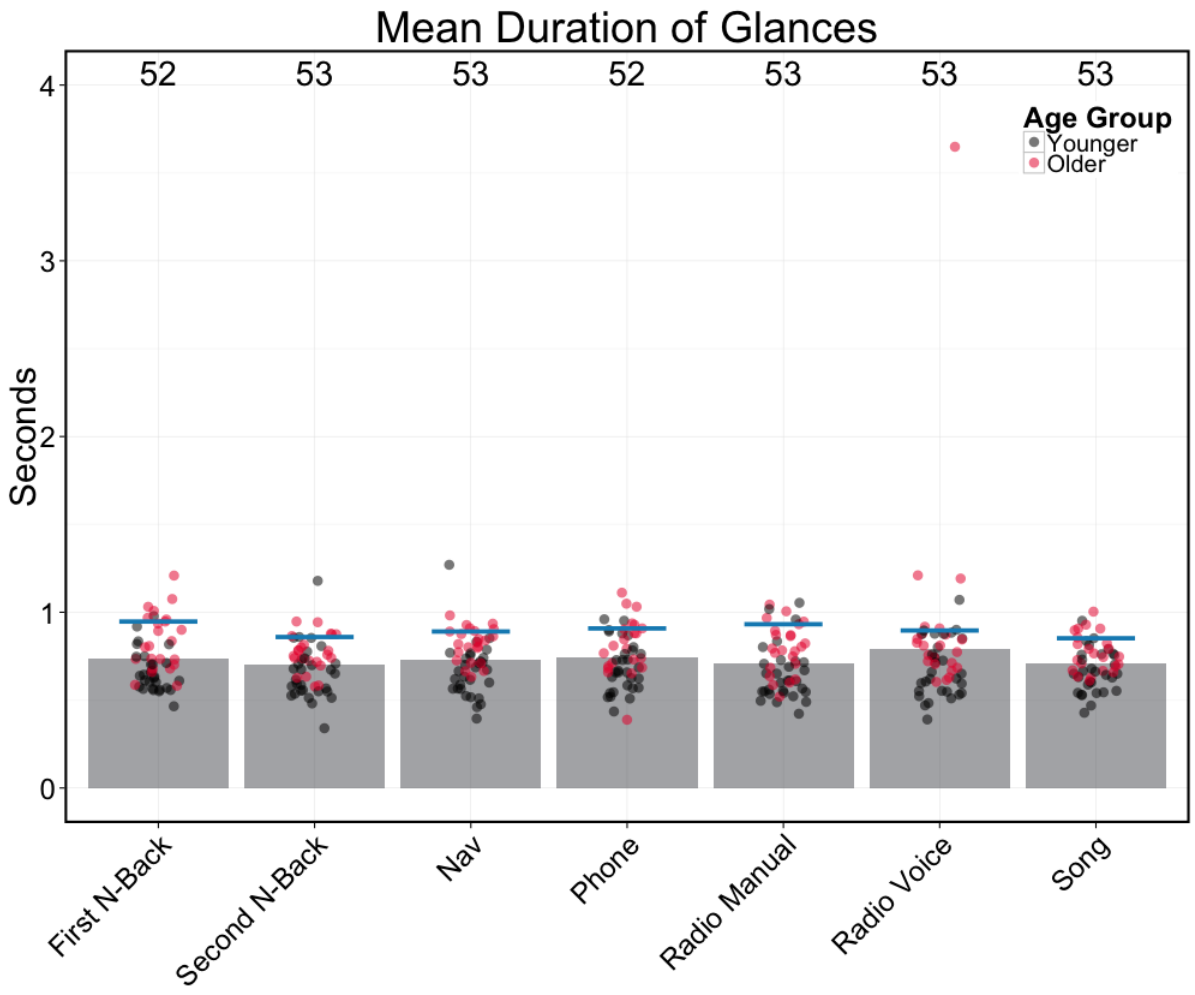


Figure E-3: Mean off-road glance duration across the seven baseline periods.

Note that the 85% of sample reference points (blue lines) for mean duration of glances are not in and of themselves criterion thresholds during single task driving as this metric is intended for measuring glance behavior during secondary tasks. Nonetheless, looking at this metric across the seven baseline periods does provide a useful way of considering the consistency of behavior across the periods. A Friedman test shows no significant difference in mean off-road glance duration across the baselines collected prior to each of the seven data collection blocks (p= 0.289).

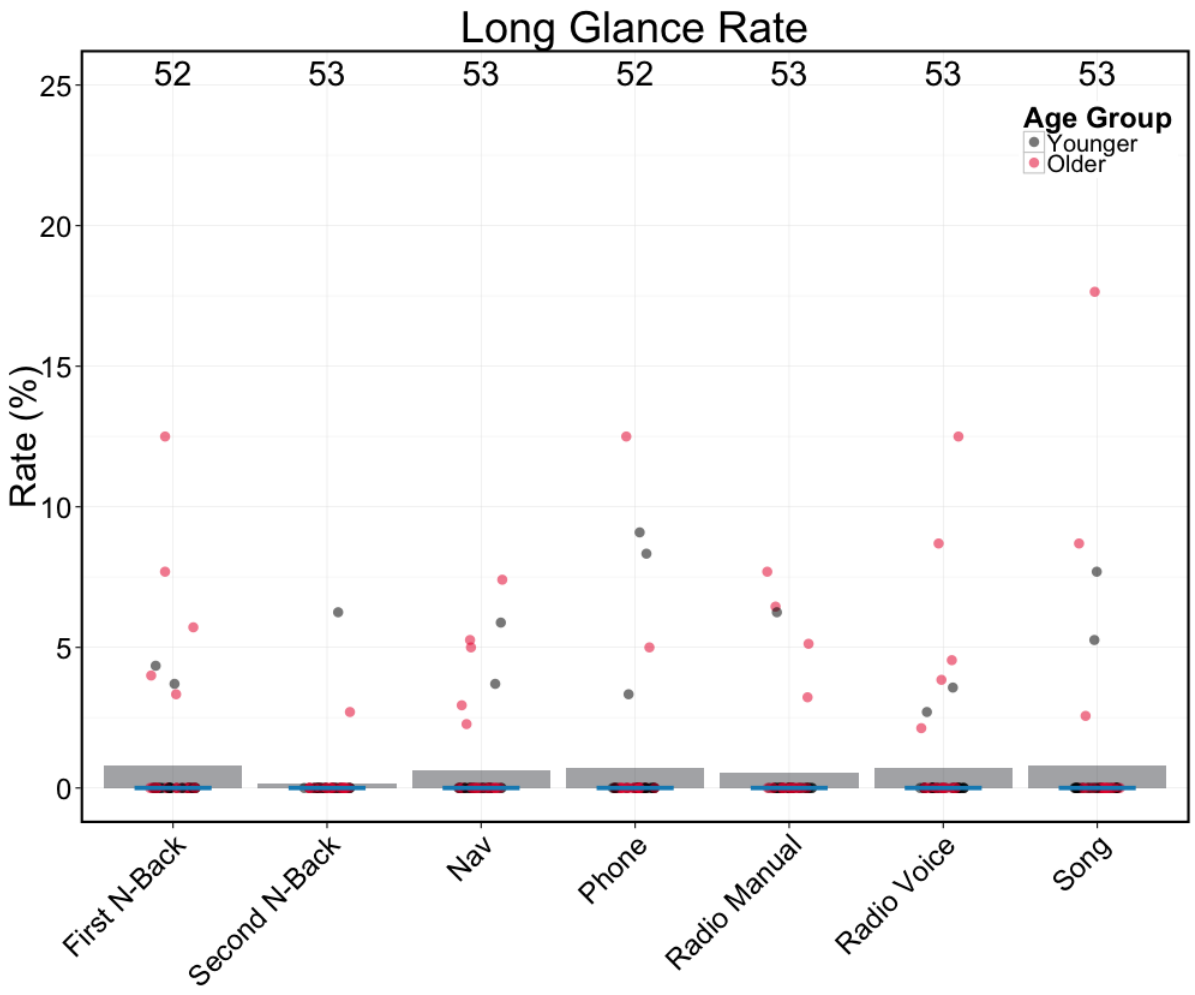


Figure E-4: Long glance rate across the seven baseline periods.

Note that the 85% of sample reference points (blue lines) for long glance rates are not in and of themselves criterion thresholds during single task driving as this metric is intended for measuring glance behavior during secondary tasks. Nonetheless, looking at this metric across the seven baseline periods does provide a useful way of considering the consistency of behavior across the periods. A Friedman test shows no significant difference in long glance rate across the baselines collected prior to each of the seven data collection blocks (p= 0.702).

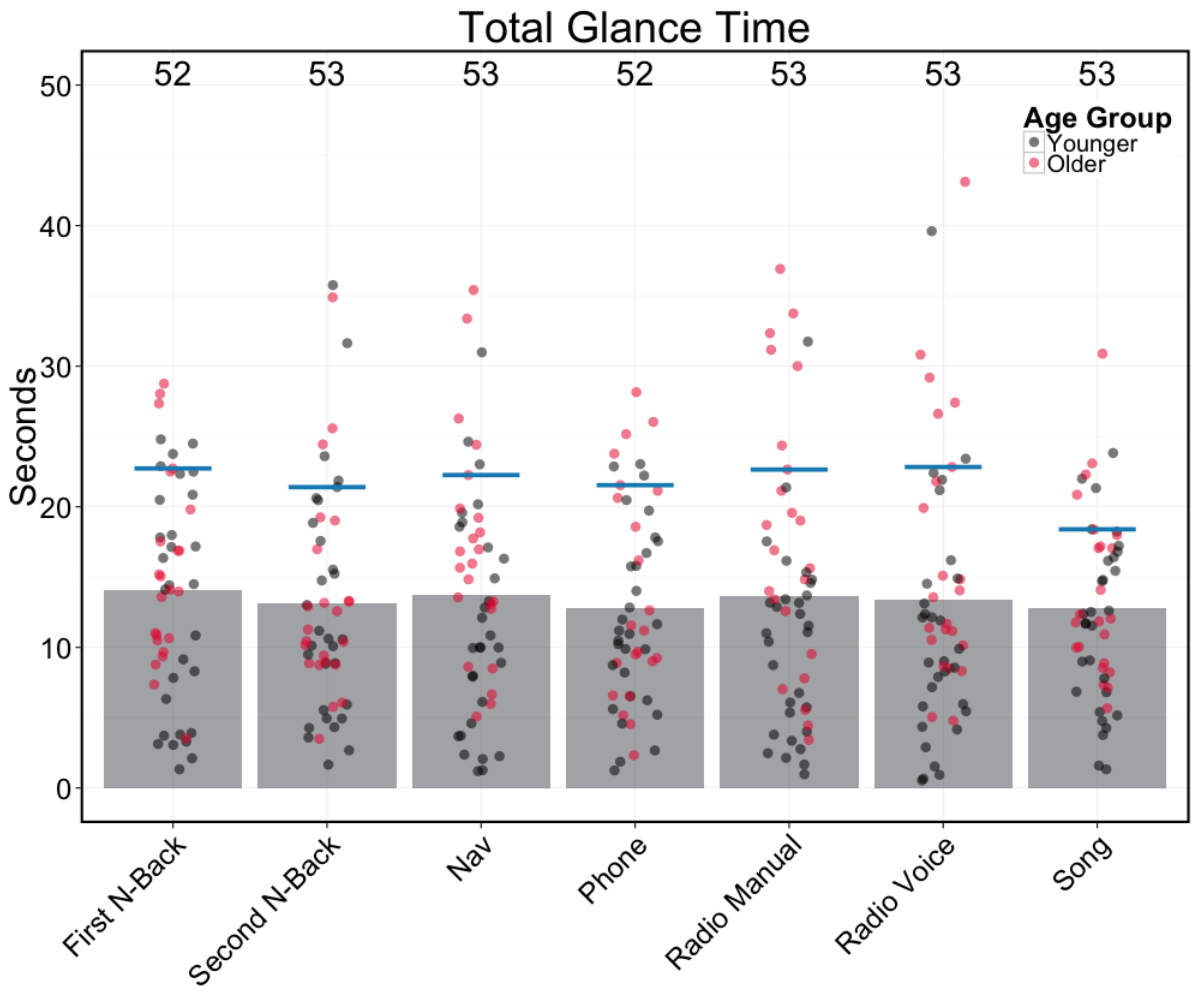


Figure E-5: Total off-road glance time across the seven baseline periods.

Note that the 85% of sample reference points for total glance time are not in and of themselves criterion thresholds during single task driving as this metric is intended for measuring time glancing away from the roadway during secondary tasks which should, by their intended nature, be relatively brief. Nonetheless, glance time away from the forward roadway across the seven baseline periods does provide a useful way of considering the consistency of behavior across the periods. A Friedman test shows no significant difference in total off-road glance time across the baselines collected prior to each of the seven data collection blocks (p= 0.922).

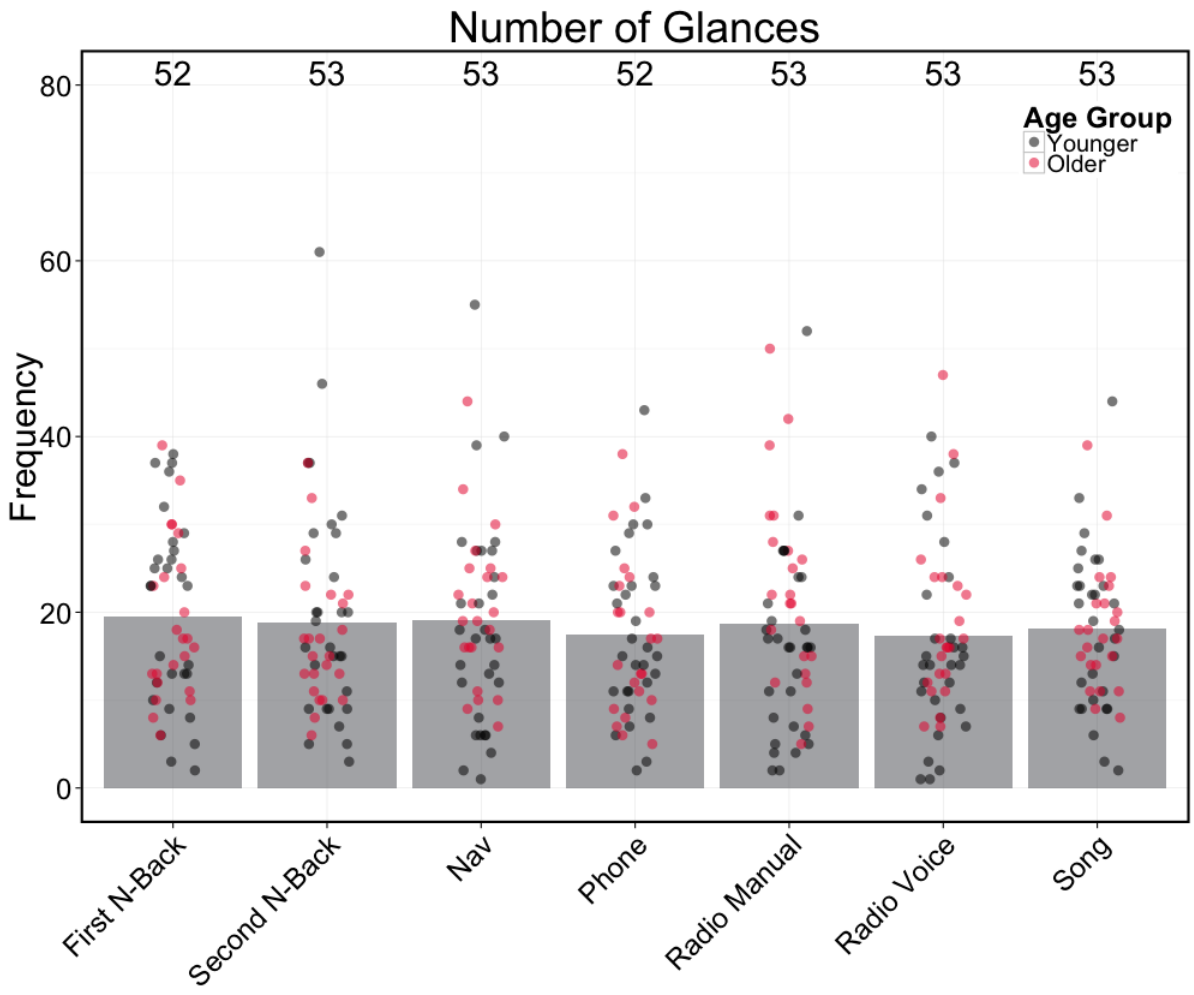


Figure E-6: Number of off-road glances across the seven baseline periods.

A Friedman test shows no significant difference in the number of off-road glances across the baselines collected prior to each of the seven data collection blocks (p= 0.729).

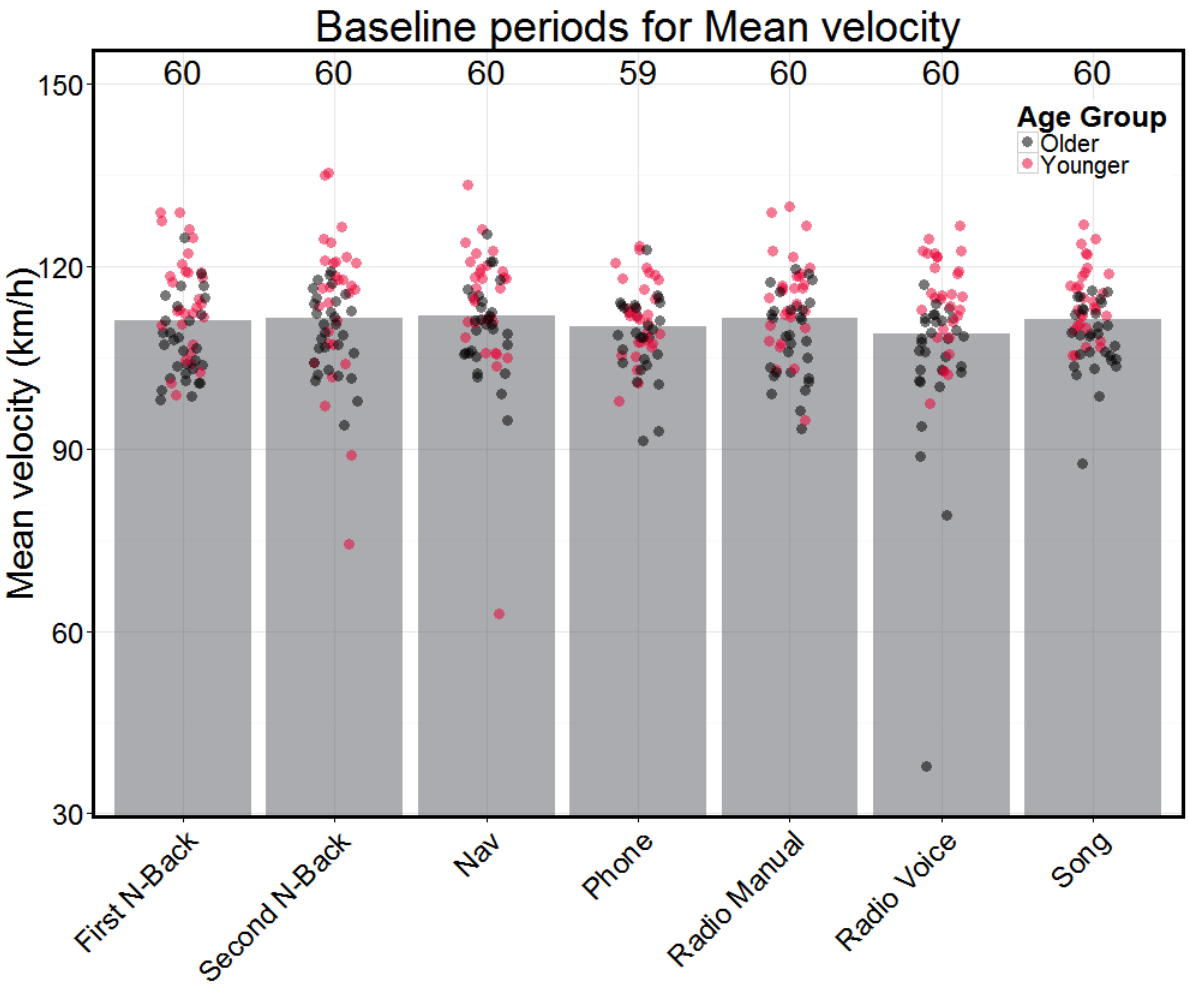


Figure E-7: Mean vehicle velocity across the seven baseline periods.

A Friedman test shows no significant difference in velocity across the baselines collected prior to each of the seven data collection blocks (p= 0.413).

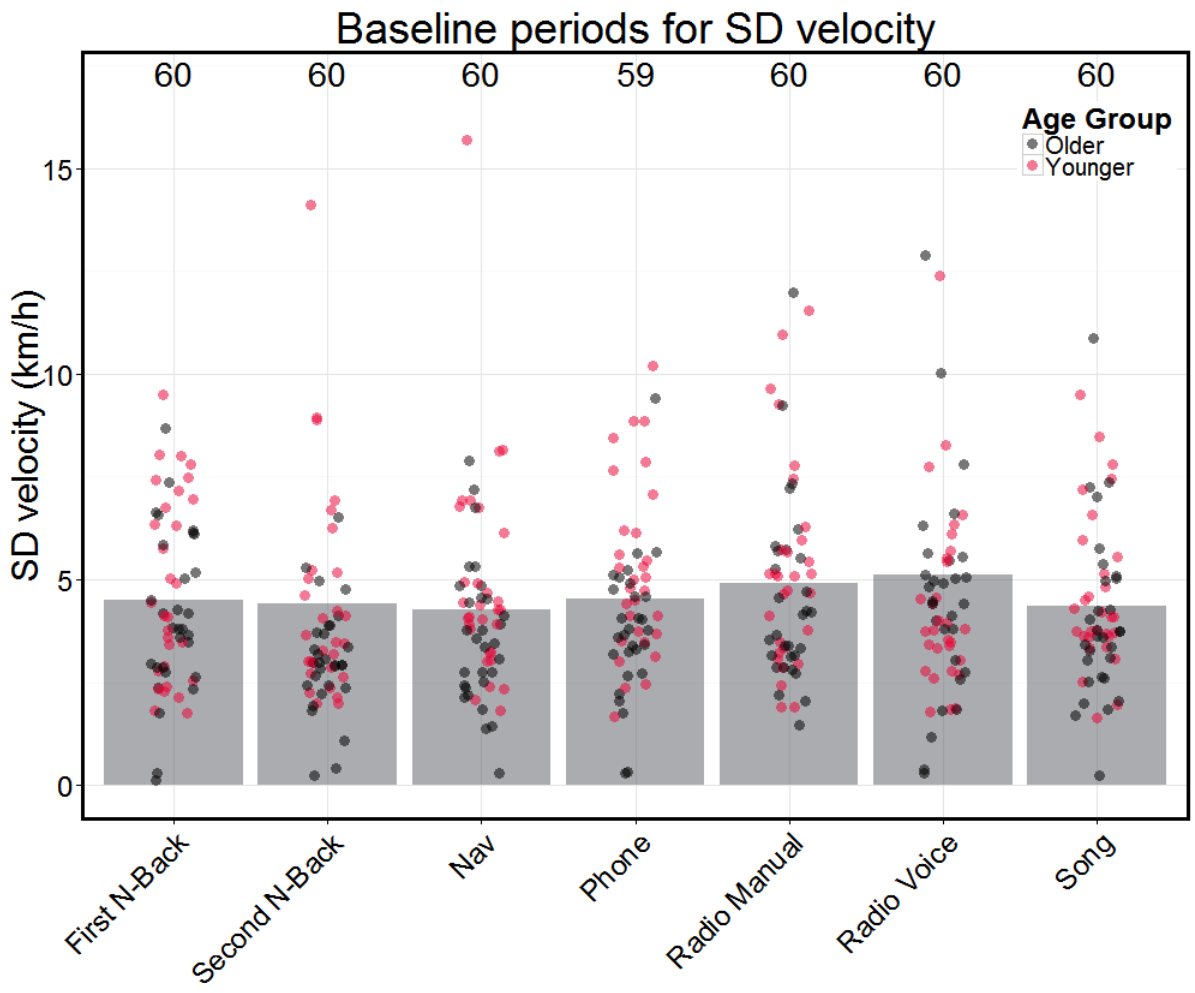


Figure E-8: Variability (standard deviation) of vehicle velocity across the seven baseline periods.

In contrast with the physiology and glance metrics, a Friedman test shows a significant difference in standard deviation in velocity across the baselines collected prior to each of the seven data collection blocks (p= 0.016).

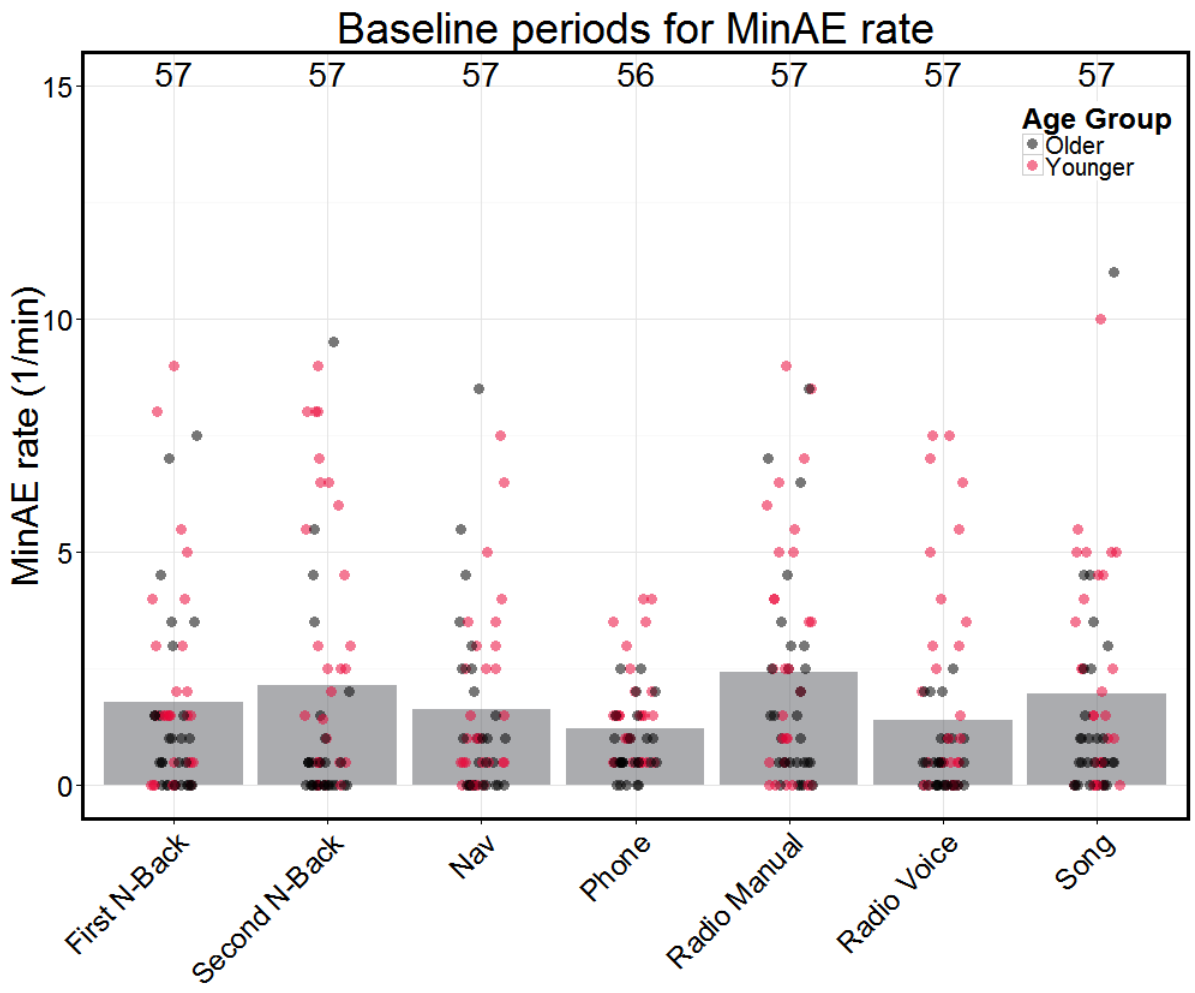


Figure E-9: Number of acceleration events per minute across the seven baseline periods.

A Friedman test shows a significant difference in minimal acceleration events across the baselines collected prior to each of the seven data collection blocks (p= 0.048).

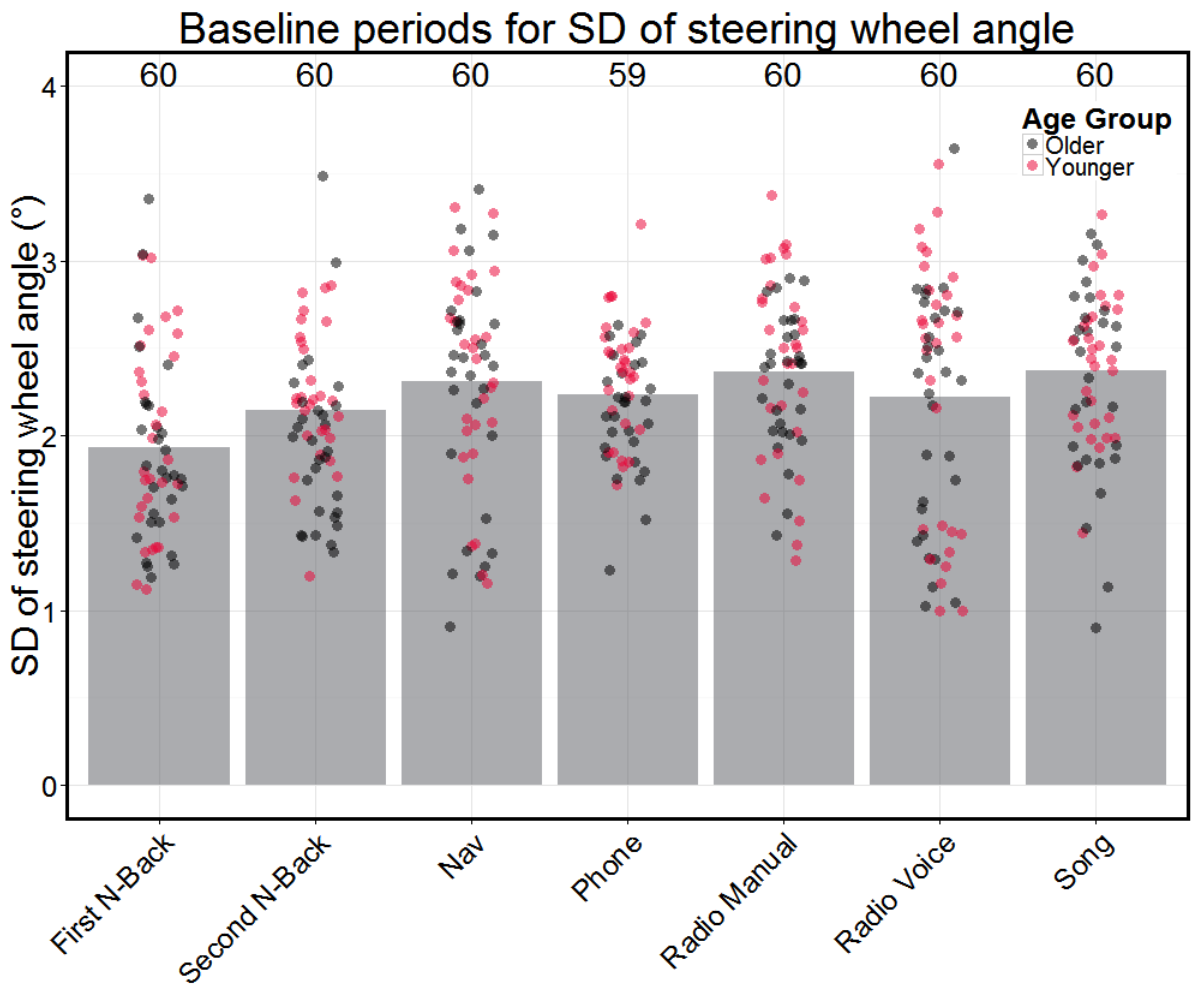


Figure E-10: Standard deviation of steering wheel angle across the seven baseline periods.

A Friedman test shows a significant difference in the standard deviation of steering wheel angle across the baselines collected prior to each of the seven data collection blocks ($p < 0.001$).

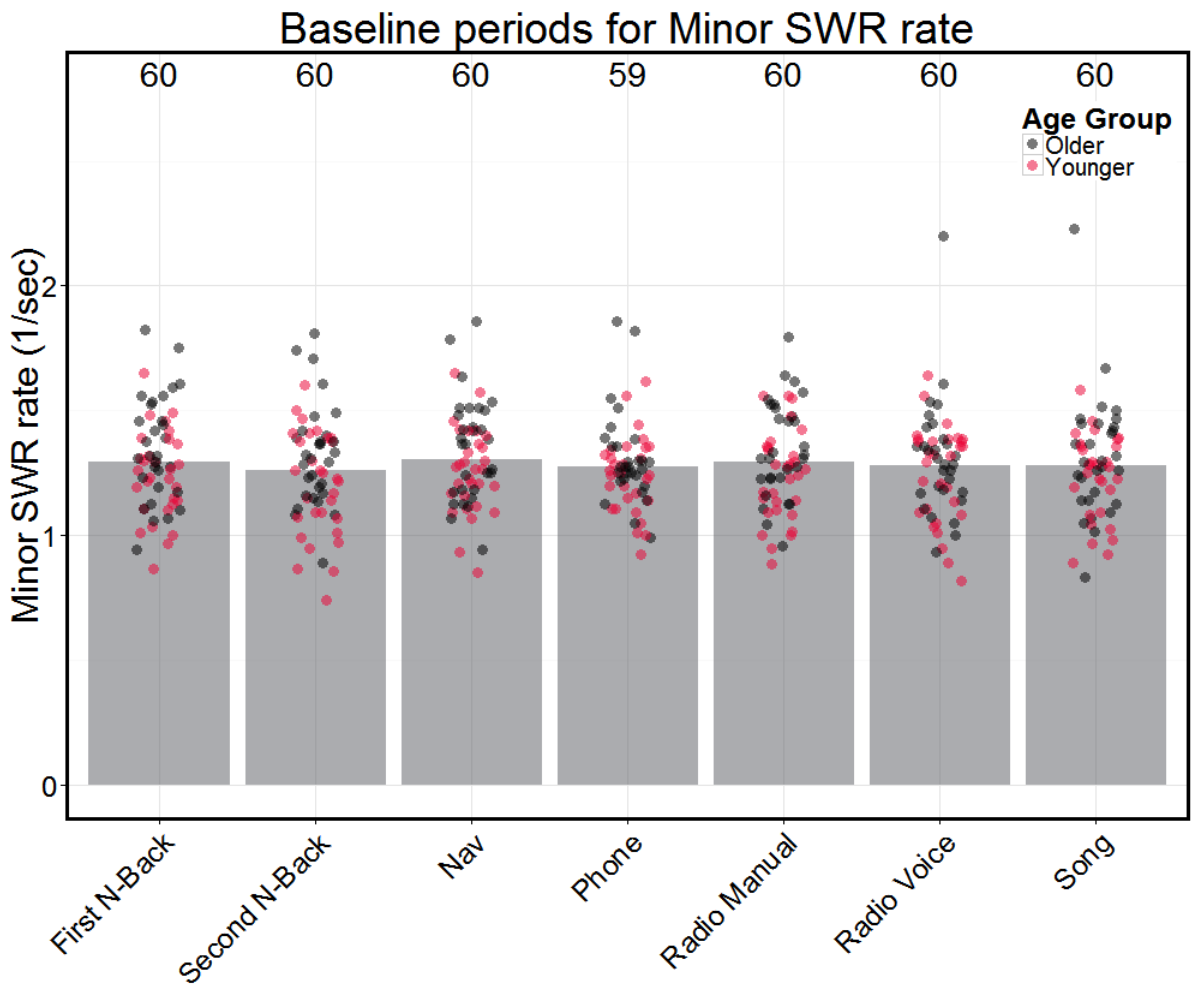


Figure E-11: Minor steering wheel reversal rate across the seven baseline periods.

A Friedman test shows no significant difference in minor steering wheel reversal rates across the baselines collected prior to each of the seven data collection blocks (p= 0.428).

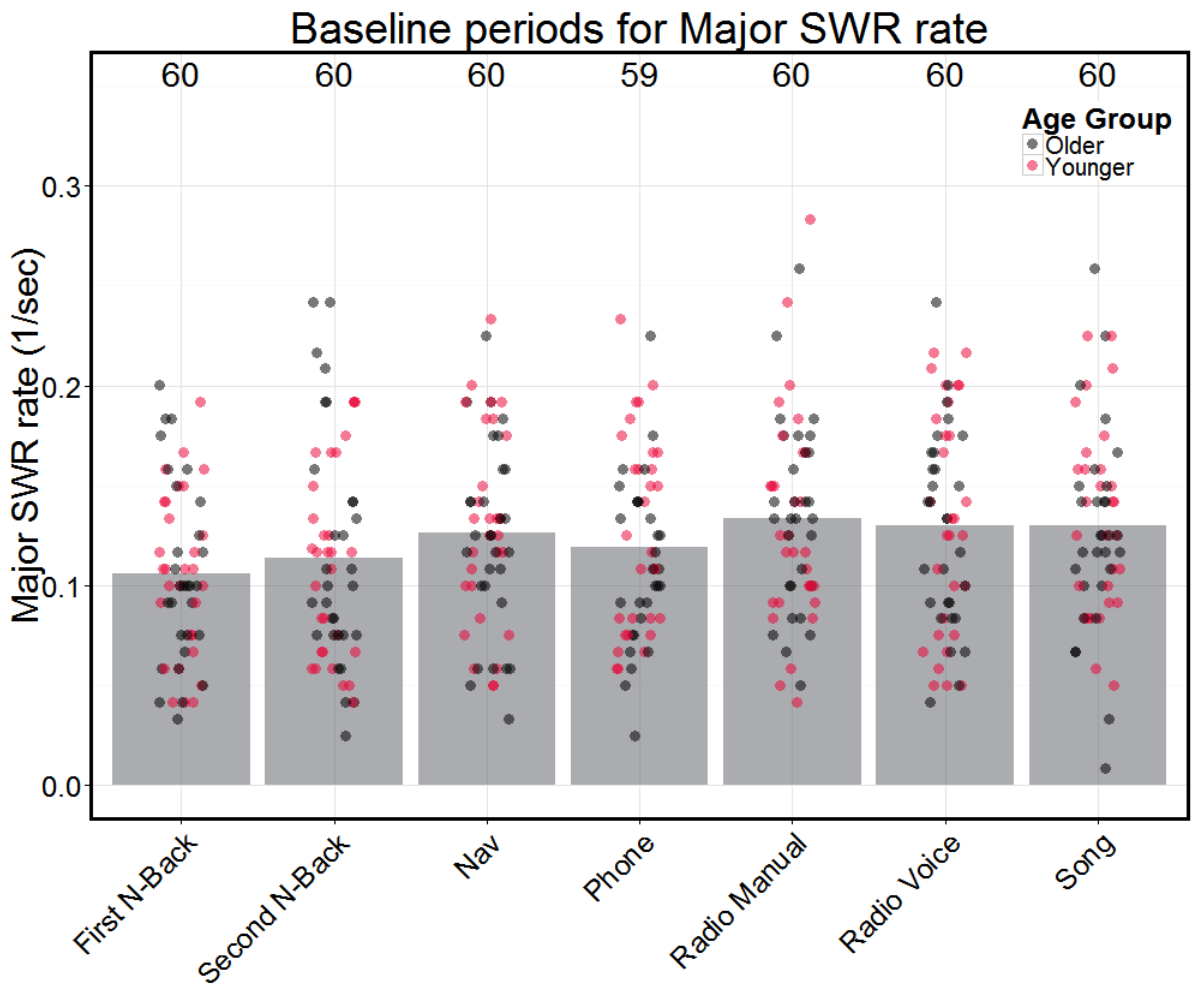


Figure E-12: Major steering reversal rate across the seven baseline periods.

A Friedman test shows a significant difference in major steering wheel reversal rates across the baselines collected prior to each of the seven data collection blocks ($p < 0.001$).

A Visualization of Glance Time by Object across the Seven Baseline Periods

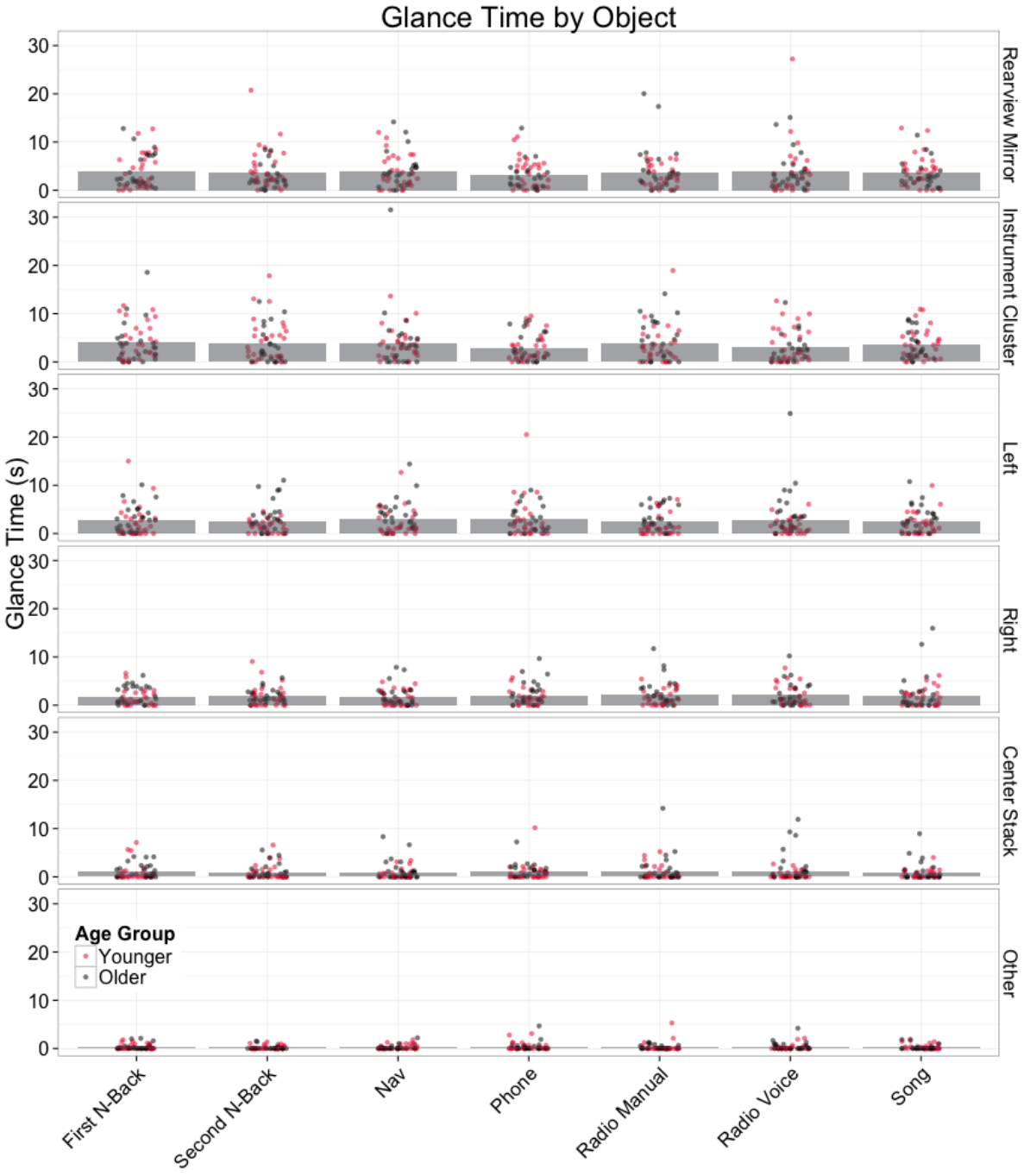
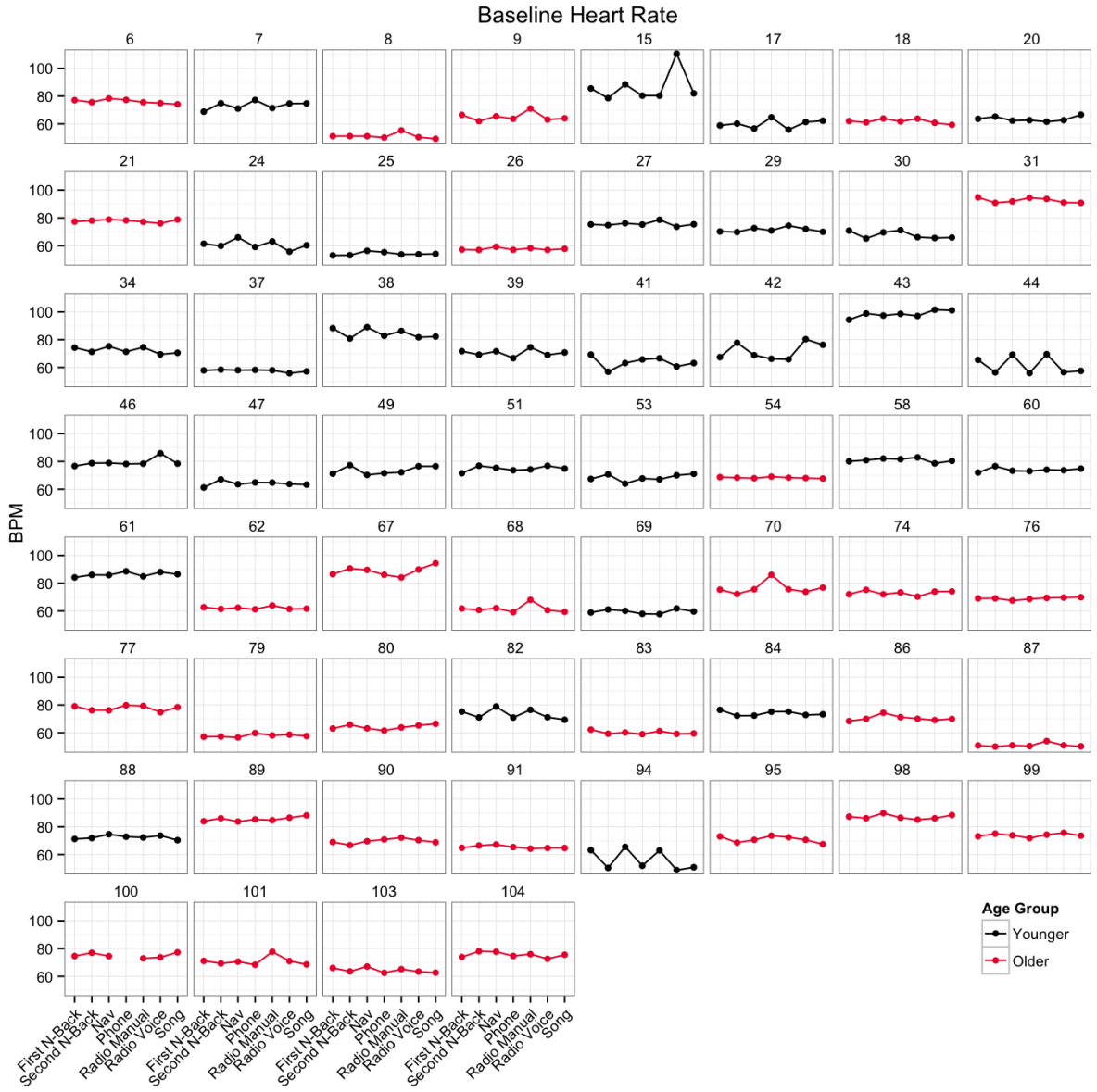
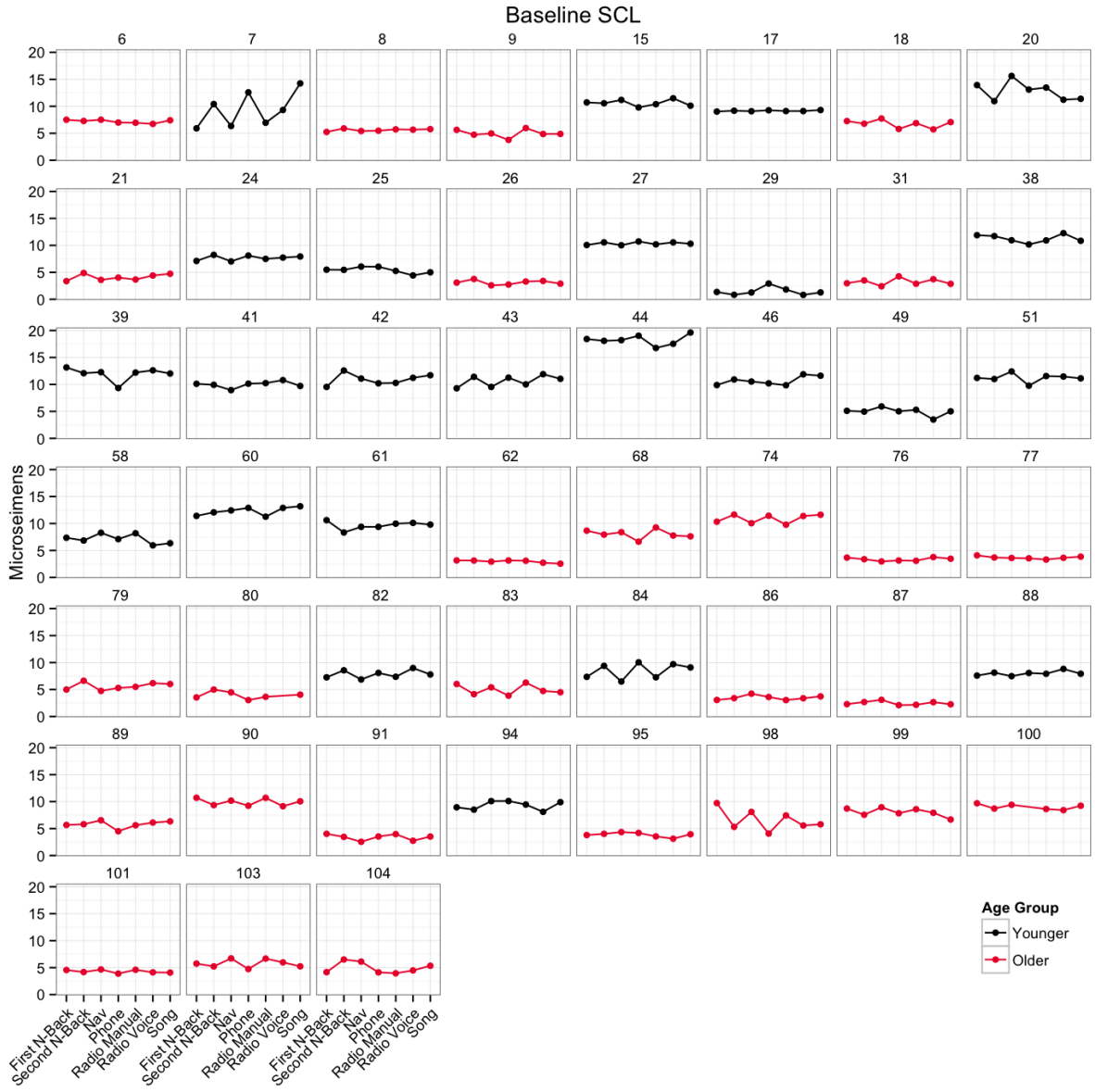


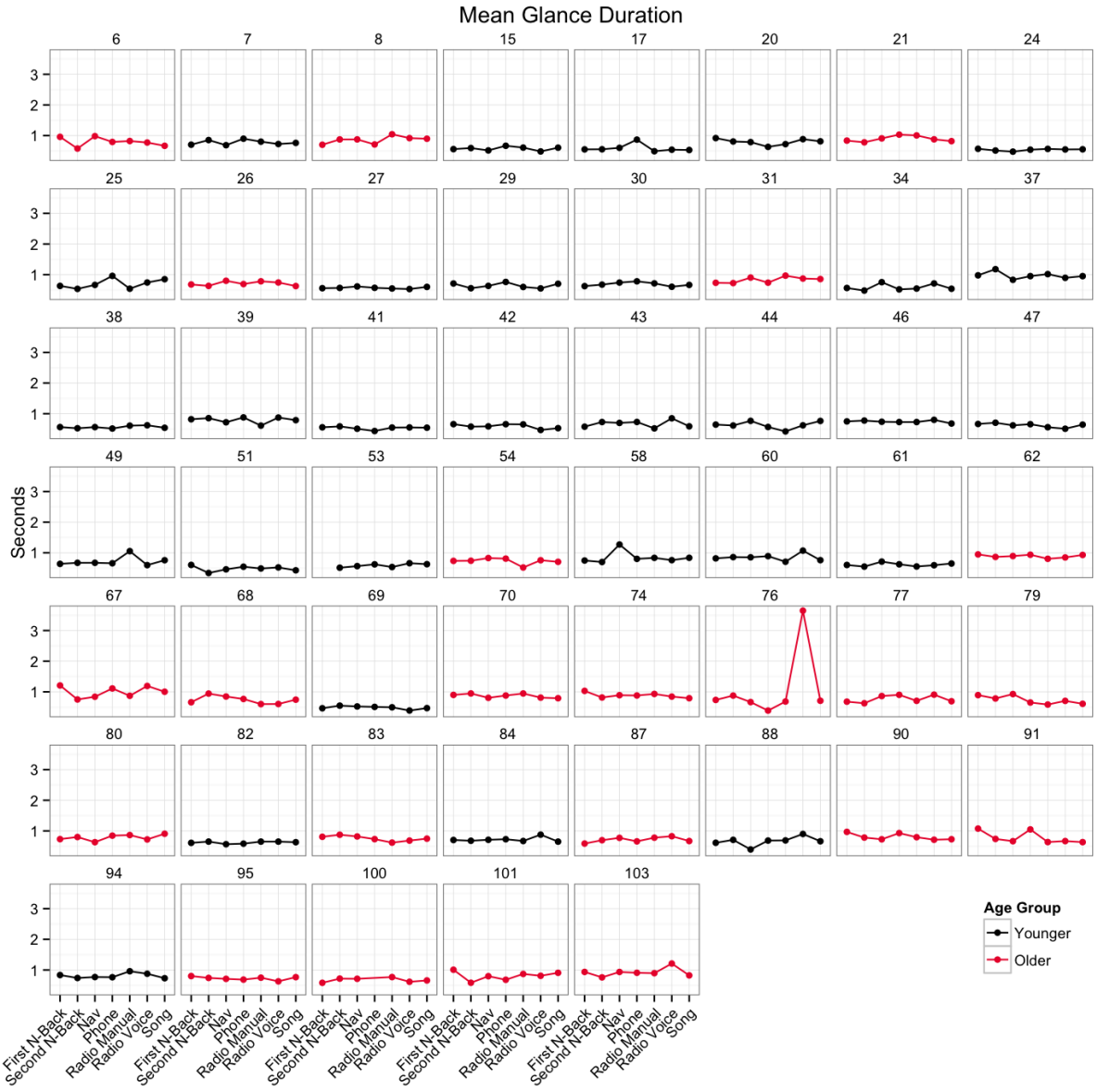
Figure E-13: Total glance time per object. "Instrument Cluster" refers to the steering wheel and dashboard instrumentation directly behind it. "Center Stack" refers to the area containing standard radio controls and the center console display screen associated with the voice command interface.

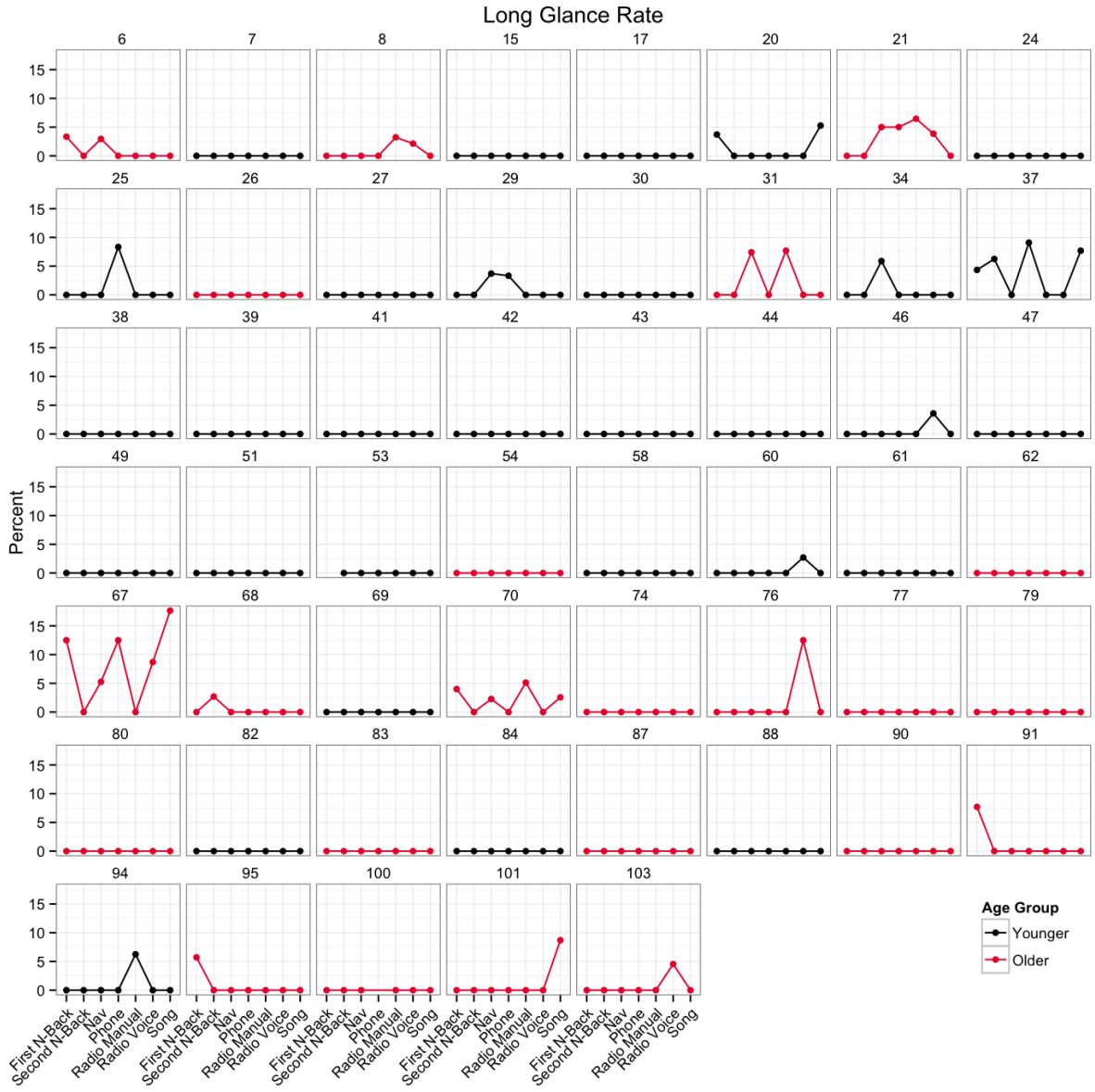
Individual Participant Data

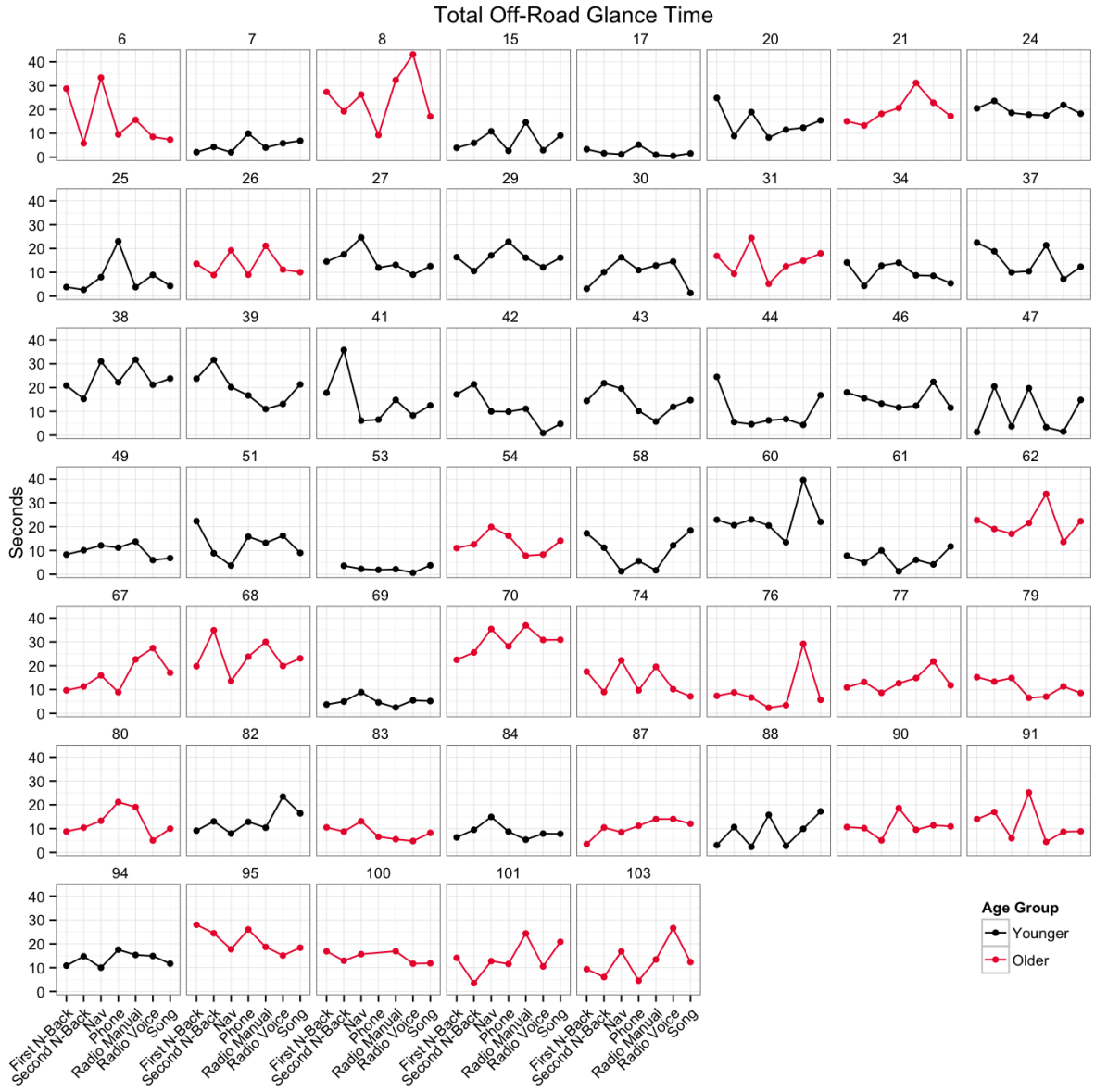
Individual participant data across the seven baseline periods for glance metrics, heart rate, skin conductance, and mean vehicle speed are presented in the following series of plots. Generally speaking, measurements across the seven baseline periods were highly stable within participants.

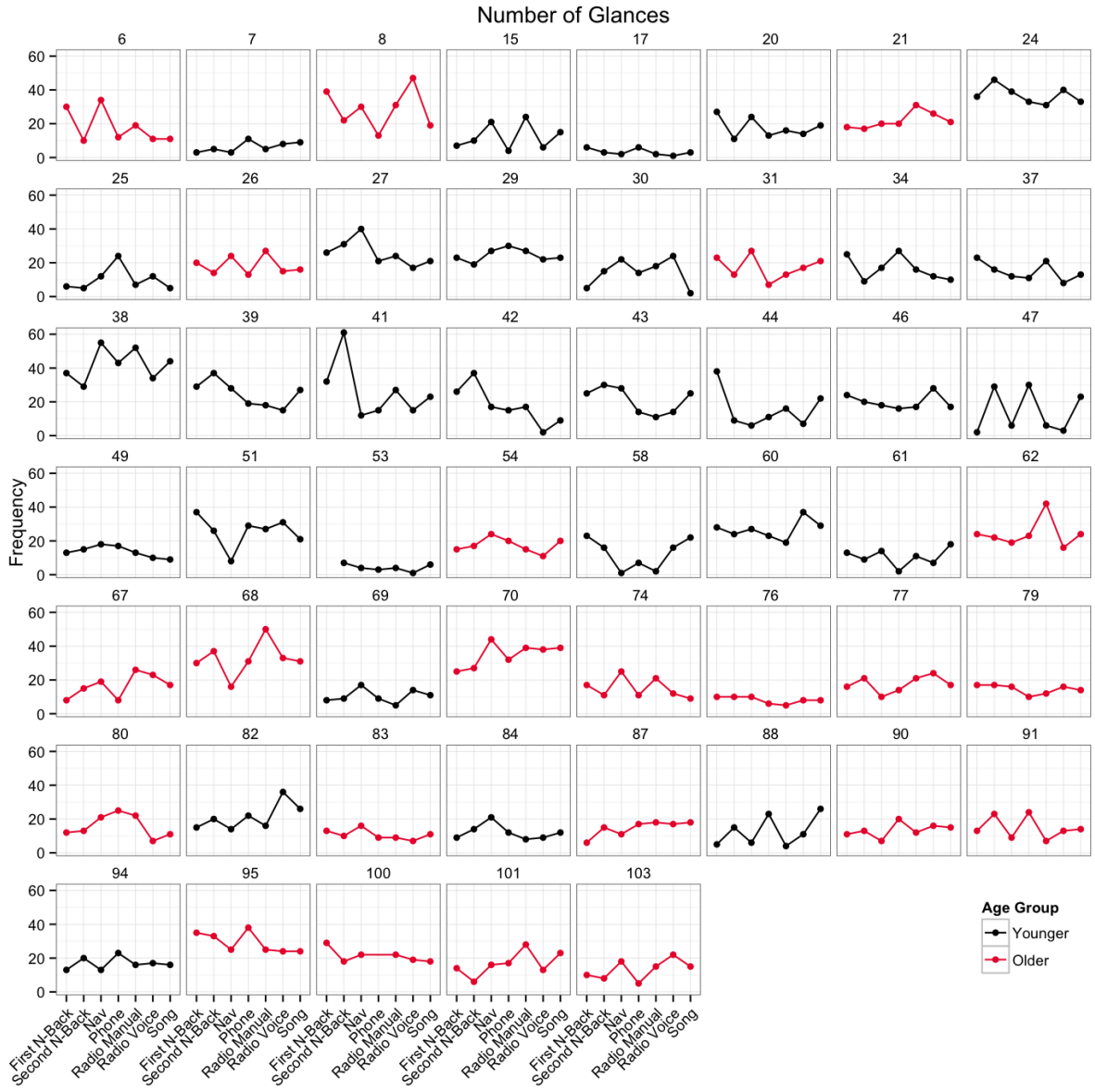


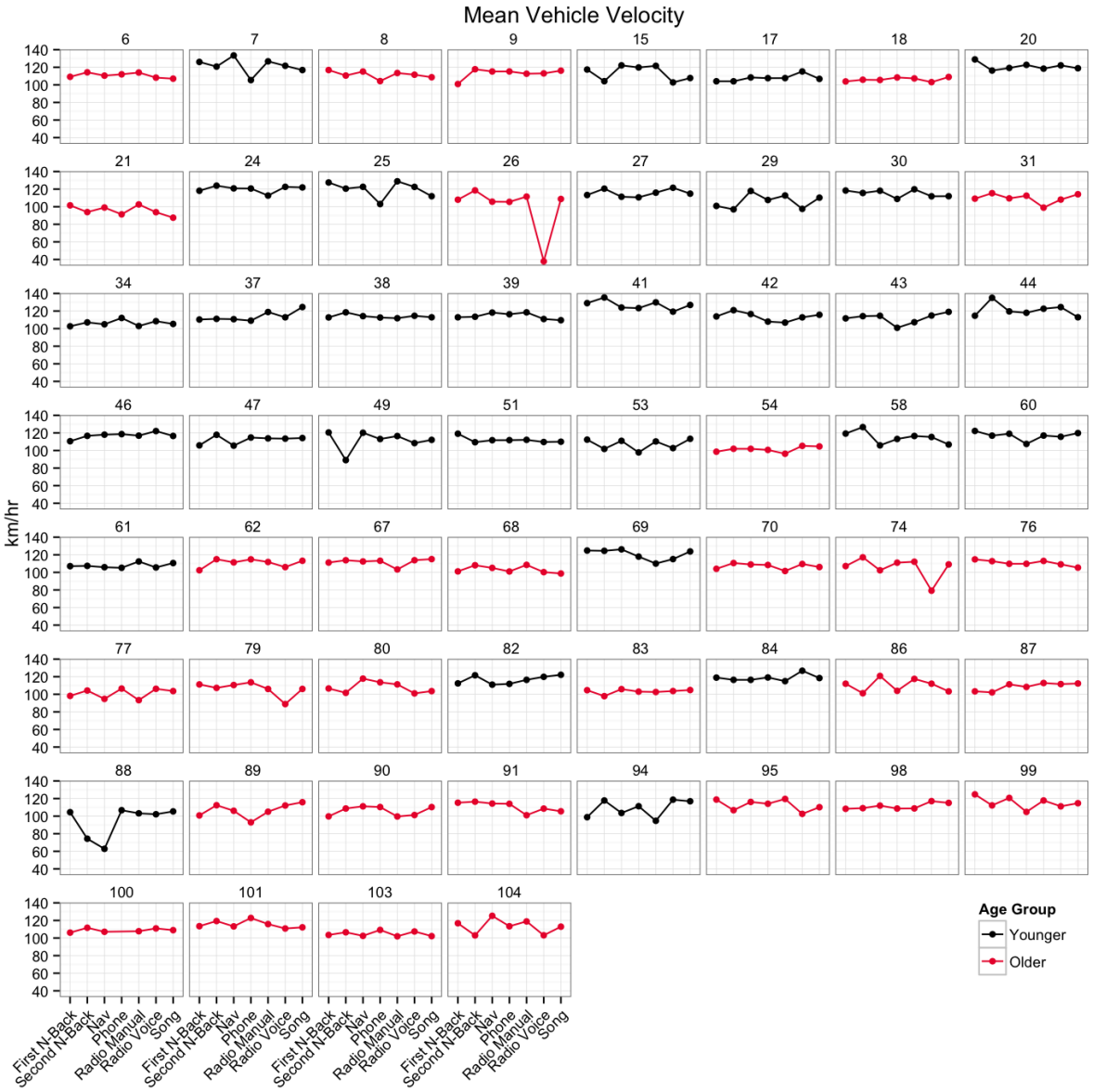

Baseline SCL
Microseimens
6
7
8
9
15
17
18
20
21
24
25
26
27
29
31
38
39
41
42
43
44
46
49
51
58
60
61
62
68
74
76
77
79
80
82
83
84
86
87
88
89
90
91
94
95
98
99
100
101
103
104
0
5
10
15
20
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song
Age Group
Younger
Older


Mean Glance Duration
6
7
8
15
17
20
21
24
25
26
27
29
30
31
34
37
38
39
41
42
43
44
46
47
49
51
53
54
58
60
61
62
67
68
69
70
74
76
77
79
80
82
83
84
87
88
90
91
94
95
100
101
103
Seconds
1
2
3
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song
Age Group
Younger
Older


Long Glance Rate
Percent
6
7
8
15
17
20
21
24
25
26
27
29
30
31
34
37
38
39
41
42
43
44
46
47
49
51
53
54
58
60
61
62
67
68
69
70
74
76
77
79
80
82
83
84
87
88
90
91
94
95
100
101
103
0
5
10
15
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song
Age Group
Younger
Older


Total Off-Road Glance Time
Seconds
Age Group
Younger
Older
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song


Number of Glances
Frequency
6
7
8
15
17
20
21
24
25
26
27
29
30
31
34
37
38
39
41
42
43
44
46
47
49
51
53
54
58
60
61
62
67
68
69
70
74
76
77
79
80
82
83
84
87
88
90
91
94
95
100
101
103
0
20
40
60
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song
Age Group
Younger
Older


Mean Vehicle Velocity
km/hr
Age Group
Younger
Older
First N-Back
Second N-Back
Nav
Phone
Radio Manual
Radio Voice
Song

APPENDIX F: GLANCE CODING GUIDELINES & PROCEDURES

Introduction

As discussed in the Primary Analysis (*Methods: Automated Eye-Tracking*), it was determined that there were a number of significant validity questions and issues with the data collected using the FaceLAB® eye tracking system. To ensure that we could analyze glance data with a high level of confidence, we developed a manual glance coding protocol designed to capture relevant glance behavior.

Methods

The methodology outlined here is based on similar procedures developed by the Crash Avoidance Metrics Partnership (CAMP) Driver Workload Metrics project (see also Smith, Chang, Glassco, Foley, & Cohen, 2005).

Video Recording

Driving sessions were recorded from up to six cameras simultaneously:

1. A right-side view of the driver, covering the head and torso from a rightward angle.
2. A forward view of the driver covering his/her head and upper torso, recorded from a camera mounted on the dashboard behind the steering wheel.
3. A view of the steering wheel and dashboard, recorded from a camera mounted over the driver's right shoulder.
4. A view of the forward roadway, recorded from a camera mounted on the dashboard.
5. A wide-angle view of the forward roadway, recorded from a camera mounted on the back of the rearview mirror.
6. A view out of the back window.

Research assistants could use any or all of these videos at their discretion to assist in coding of glance data. Cameras 2 and 3 were the most frequently used.

Annotator Software

The MIT AgeLab commissioned the creation of a customized software package, dubbed the "Annotator", to assist in the reduction of eye glance data (pictured in **Figure X**). The Annotator has several features useful for this type of work. Multiple video files can be loaded and played synchronously, playback can be controlled frame-by-frame or at arbitrary playback speeds, and new annotation categories can be created with great flexibility. This greatly improved the speed

of data acquisition, as the research assistant need only press one of the predefined keys to add an annotation at the video's current time code. The Annotator outputs a flat file containing times, key codes, and their associated annotations.

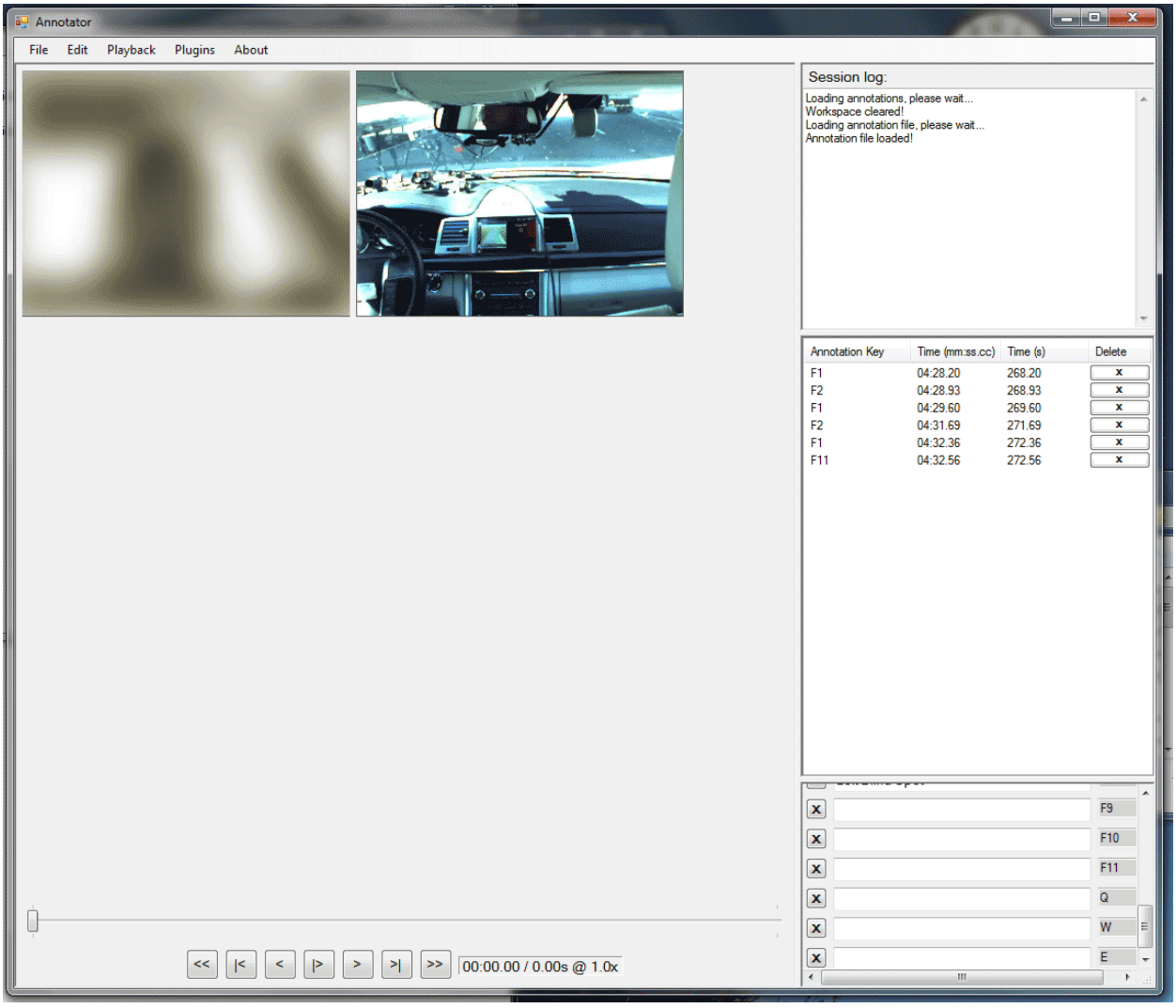


Figure F-1: The Annotator program used for manual glance coding. The program is organized into several panes: top left contains the videos (video of the participant has been distorted to protect his anonymity), bottom left contains playback controls, top right contains session log data, middle right contains a live list of the current video's annotations, and the bottom right contains a list of available annotations and their associated keys.

Coding & Mediation

Two research assistants separately coded each task trial, labeling the driver's glance target according to one of seven categories (see Glance Coding Guide, below). Data were then

compared to check for discrepancies between the coders. **Figure X** shows a glance comparison plot. A trial was considered discrepant if any of the following occurred: the coders started or ended their coding at different times, the coders described differing numbers of glances, the coders identified a different glance target for a glance, or the timing of a glance differed by more than 200ms. A third coder resolved any discrepancies, making a "final determination" as to which of the original two coders was correct.

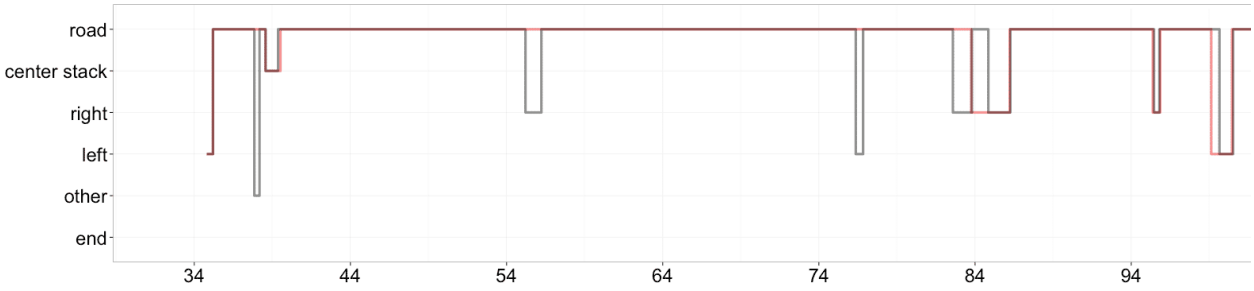


Figure F-2: A portion of a coder comparison plot for one task trial. Time in seconds is shown on the x-axis, and the glance target is shown on the y-axis. Line colors (red and gray) represent different coders. Note that the gray coder was prone to coding "left" and "right" glances, and that there is a timing discrepancy at around 96 seconds.

Data Storage & Reduction

Annotator output files were stored on the AgeLab's secure network. These files were converted and unified into a secure MySQL database format, thus allowing all eye glance data to be queried quickly and flexibly for subsequent analyses.

Glance Coding Guide

Driver glance behavior was coded into seven categories according to the following guidelines.

Keyboard Shortcut	Glance Location	Operational Definition
F1	Road	To code a glance as "road", the participant should be looking forward, or in the forward direction. The exact position of the eyes can vary, depending where on the road he or she is looking. A participant looking straight ahead, directly over the camera, is the easiest and most common way to code for road. There is, however, a somewhat wide range of where the participant can be looking that would be considered a road glance. For example, a participant following a passing car to their left that is ahead of their own car would be coded as a road glace. Similarly, a participant may appear to be looking to their right, but is actually looking forward and to the right, perhaps at a passing car. A good way to determine if a participant is looking at the road is if, no matter if the

		glance is slightly to the left or right, the participant can see what is in front of them. To code a glance as road can sometimes be difficult, given the range of forward-looking abilities. One important thing to keep in mind when coding in the Annotator is that for the most part, any glance off the road (i.e. center stack, instrument cluster etc.) will be followed by a glance to the road, even if it is a very brief glance.
F2	Center Stack	To code a glance as "center stack", the participant should be looking to their right, and slightly downward. This part of the car consists of the Ford Sync device system, and some of the buttons that are used to control it. The angle at which the participant is looking down will depend on their height. The participant will often look at the center stack when engaging in a task that requires the use of this system, such as a navigation entry task, a radio task, or song select task.
F3	Rearview Mirror	To code a glance as "rearview mirror", the participant should be looking up and to the right. There are instances where it can be difficult to determine if the participant is actually looking at the rearview mirror, or just slightly upward at the road. The angle at which a person will look *up* at the rearview mirror depends on the person's height; a short participant will look up at a more obvious and steep angle, whereas a tall participant will have to look up at less of an angle.
F4	Other	To code a glance as "other", the participant should be making a glance that does not meet the criteria for any of the other coding's. Some examples of where it would be appropriate to code a glance as other are if the participant turns his or her head around to speak with the person in the backseat, if the participant looks at their watch, if the participant looks up at the ceiling, if the participant turns their head past 90 degrees either to the left or right (looking at a blind spot), if the participant takes a drink or eats something.
F5	Instrument Cluster	To code a glance as "instrument cluster", the participant should be looking downward at the steering wheel, which contains the voice command button to control the Ford Sync device system. A participant will often make this glance when he or she must engage the voice command system. In some cases it can be hard for the coder to differentiate between a downward glance (at the instrument cluster) and a long blink, because participant's eyelids may cover the eyes. One exception, where one should not code instrument cluster for a glance to the wheel, is if the participant is looking down to turn on the windshield wipers. This would be coded as other. The angle at which the participant will look down depends on their height.
F6	Left	To code a glance as "left", a participant should be looking to their left, with their head turning no more than 90 degrees. Because it is extremely difficult to tell if a participant is looking directly at the left mirror, the code is simply "left", for any glance in that direction. Simply put, a glance to the left is a glance out of the left window of the car.
F7	Right	To code a glance as "right", a participant should be looking to their right, with their head turning no more than 90 degrees. Because it is extremely difficult to tell if a participant is looking directly at the right mirror, the

		code is simply "right", for any glance in that direction. Simply put, a glance to the right is a glance out of the right window of the car.
F8	End	Use the "end" code at the completion of the task period. This should correspond with the end time given in the participant data.

APPENDIX G: TASK PERFORMANCE CODING GUIDELINES

Introduction

In its Visual-Manual Driver Distraction Guidelines (2013), NHTSA provides the following guidance on defining errors during task performance:

> "Error means that a test participant has made a significant incorrect input when performing a testable task during a test trial. An error has occurred if the test participant has to backtrack during performance of the task or delete already entered inputs. If the device can accommodate an incorrect entry without requiring backtracking and extra inputs beyond those necessary to reach the desired end state of the task, then no error is deemed to have occurred. Error-Free Trial means a test trial in which no errors are made by the test participant while completing the task" (Section IV.B.5 & IV.B.6, p. 249)

NHTSA further recommends that when assessing the distraction potential of an in-vehicle task, only data from error-free trials should be considered. The results of an analysis that considers data only from error-free trials are presented in Appendix B. Task trials were assessed according to the following methods.

Methods

A participant's ability to complete a given task with or without some level assistance was assessed via audio recordings of the driving session. In the case of the Radio Manual tasks, task completion was coded according to notes taken during the driving session. Two coders classified each task into one of several task completion ratings (see Coding Guide). Discrepant ratings were mediated by a third, independent coder. Task trials rated "5" (error-free) were subsequently included in the error-free analysis (Appendix B).

Coding Guide

Rating	Definition
1	Participant failed to complete the task due to user error.
1a	Participant failed to complete task due to system error (voice recognition, etc).
2	Participant completed the task with substantial assistance or prompting from the experimenter (more than 1 interaction), repeatedly backtracked through the task's steps or restarted the task, or took a very long time to complete the task.
3	Participant completed the task with minimal prompting or assistance (1 interaction with the experimenter).
3a	Participant completed the task, but encountered a system error (voice recognition), and needed slight assistance to correct it.
4	Participant completed the task without prompting or assistance, but had to backtrack through the task's steps or restart the task to correct a user error.
4a	Participant completed the task without prompting or assistance, but had to backtrack to correct a system error (ie, voice recognition error).
5	Participant completed the task "error-free", without prompting or assistance from the experimenter and without backtracking through the task or restarting it.

Data

participant	Nav cancel 1	Nav cancel 2	Nav entry 1	Nav entry 2	Phone 1	Phone 2	Radiom 1	Radiom 2	Radiom 4
6	2	5	2	4	4	5	5	5	5
7	5	5	3	3	5	5	5	5	5
8	5	5	3	5	5	5	5	5	5
9	5	5	2	5	5	5	5	5	5
15	5	5	5	4a	5	5	5	5	5
17	5	5	5	5	3	5	5	5	5
18	5	5	5	5	5	5	5	5	5
20	5	5	5	4	5	5	5	5	5
21	5	5	5	5	4	3	5	5	5
24	5	5	4	2	5	5	5	5	5
25	5	5	5	5	5	5	5	5	5
26	5	5	3	4	3	5	5	5	5
27	5	5	5	5	5	5	5	5	5
29	5	5	5	5	5	4	3	5	5
30	5	5	5	4a	5	5	5	5	5
31	5	5	2	2	5	5	5	5	5
34	5	5	2	2	5	5	5	5	5
37	5	5	5	5	5	5	5	5	5
38	5	5	5	3	5	5	5	5	5
39	5	5	5	3	5	5	5	5	5
41	5	5	3	5	5	5	5	5	5
42	5	5	5	4	5	5	5	5	5
43	5	5	5	4a	5	5	5	5	5
44	5	5	5	5	5	5	5	5	5
46	5	5	4	5	5	5	5	5	5
47	5	5	5	5	5	5	5	5	5
49	5	5	5	5	5	5	5	5	5
51	5	5	5	4	5	5	5	5	5
53	5	5	5	5	5	4a	5	5	5
54	5	5	2	2	5	5	5	5	5
58	5	5	5	3a	5	5	5	5	5

60	5	5	5	4a	5	5	5	5	5
61	5	5	5	4a	5	5	5	5	5
62	5	5	4	5	5	5	5	5	5
67	5	5	5	4a	5	5	5	5	5
68	5	5	5	5	2	2	5	5	2
69	5	5	5	4	4	4	5	5	5
70	5	5	5	5	5	4	5	5	5
74	5	5	5	4	5	5	5	5	5
76	5	5	5	4a	5	5	5	5	5
77	5	5	2	2	4	4	1	5	1
79	5	5	5	5	4a	4a	5	5	1
80	4	5	4	2	5	4a	5	3	3
82	4a	5	5	5	5	5	5	5	5
83	5	5	5	4	5	5	5	5	1
84	5	5	3a	5	4a	5	5	5	5
86	5	5	5	5	5	5	5	5	5
87	5	5	5	3a	5	5	5	5	5
88	5	5	3a	4	5	5	5	5	5
89	2	5	5	2	4	4	5	5	5
90	2	2	2	2	4a	2	5	5	5
91	5	5	3	3	2	5	2	5	2
94	5	5	5	5	5	5	5	5	5
95	5	5	2	3a	3	5	5	5	5
98	1	1	2	2	5	4a	5	5	2
99	5	5	3	5	5	5	2	5	3
100	5	5	5	5	0	NA	5	5	5
101	5	5	2	5	3a	5	5	5	5
103	5	5	5	5	5	5	5	5	5
104	5	5	5	5	5	5	5	5	5

participant	Radom 6	Radiov 1	Radiov 2	Radiov 4	Radiov 6	Song 1	Song 2	Song 3	Story 2
6	5	5	5	5	5	5	5	5	5
7	5	5	5	5	5	5	5	4	5
8	5	5	5	5	5	2	3	5	5
9	5	3	5	3	5	2	5	1	5
15	5	5	5	5	5	5	5	5	5
17	5	5	5	5	5	5	5	5	5
18	5	5	5	5	5	3	5	1	5
20	5	5	5	5	5	5	5	5	5
21	5	5	5	5	5	2	5	1	5
24	5	5	5	5	5	5	5	5	5
25	5	5	5	3	5	5	5	1	5
26	5	5	5	2	2	2	5	1	5
27	5	5	5	5	5	5	5	3	5
29	5	5	5	2	5	5	5	1	5
30	5	5	5	5	5	5	5	5	5
31	5	2	5	3	5	3	3	1	3
34	5	5	5	5	5	5	5	5	5
37	5	5	5	5	5	4a	3	5	5
38	5	5	5	3	5	5	5	5	1
39	5	5	5	5	5	5	5	5	5
41	5	5	5	5	5	4	3	1	5
42	5	5	5	5	5	5	5	1	5
43	5	5	5	4a	4	5	5	4	5
44	5	5	5	4	5	5	5	5	5
46	5	5	5	5	5	4	5	5	5
47	5	5	5	5	5	5	5	5	5
49	5	3	5	5	5	5	5	5	5
51	5	5	5	5	5	4	5	5	5
53	5	5	5	5	5	3	5	1	5
54	5	5	5	3a	5	2	3	4	5
58	5	5	5	5	3	5	5	5	5
60	5	5	5	5	5	4	5	5	3a

61	5	5	5	5	5	4	5	5	5
62	5	5	5	5	5	4a	1a	1	3a
67	5	4	5	5	5	1a	4a	1	5
68	5	2	5	2	5	2	5	4	5
69	5	5	5	5	5	5	5	1	5
70	5	1	1	5	5	5	5	4	5
74	5	5	5	4	5	2	4a	1	5
76	5	5	5	4	5	4	5	1	5
77	5	2	5	4	4	5	5	1	1
79	1	5	5	5	5	4	4	4	5
80	5	5	5	2	5	4	4	1	5
82	5	5	5	5	5	5	5	5	5
83	5	4	5	5	4	2	5	5	5
84	5	5	5	5	5	5	5	1	3
86	5	5	5	5	5	5	5	1	5
87	5	5	5	5	5	4	5	5	5
88	5	5	5	5	5	3a	5	5	5
89	5	5	5	5	5	2	3a	1	5
90	5	2	5	3	1	3a	1	1	2
91	5	5	5	5	5	5	5	1	3
94	5	5	5	5	5	5	5	5	5
95	5	5	5	2	5	3a	3a	1	5
98	5	5	5	4	5	4	5	1	5
99	3	5	5	2	1	1	5	1	5
100	5	5	5	5	4	3	5	1	NA
101	5	5	5	5	4	2	2	1	1
103	5	5	5	5	4	5	4	1	5
104	5	5	5	2	5	5	5	1	5

APPENDIX H: DETAILED EXPERIMENT PROTOCOL & TASK SCRIPTS

Voice Based In-Vehicle Systems Study Experimental Checklist

Section 1 - Intake

Participant Code _____ **Protocol Configuration** _____

Date _____

RA (s) _____

Notes for the research assistant - Please review before each participant run.

As a research associate involved with this experiment, you are responsible for actively monitoring the participant, ensuring that all instructions detailed below are described clearly to the participant and that any questions are answered to the best of your ability. Please make sure to read instructions clearly. If, at any time, the participant has reservations about participating or continuing to participate in this experiment, you should encourage them to withdraw. **DO NOT ENCOURAGE PARTICIPATION!** If a question arises that you are unable to answer, seek assistance from a senior member of the research staff. **DO NOT GUESS**.

During the course of the study you should minimize any unnecessary actions, e.g. moving around the room, getting papers organized, extra key strokes, etc. while participants are completing tasks, physiological recordings are being made, etc. Low level noise and slight movements will impact participant arousal. In addition, due to the significant number of functional actions and active monitoring required of RAs at various points during this experimental protocol, RAs are not to use the lab computers or other computers or communication devices to monitor e-mail, work on other projects, etc. so that full attention can be devoted to active monitoring of the participant, equipment, and protocol. The sole exception would be the use of text messaging to communicate with another staff member regarding significant equipment or participant related issues. While the desire of RAs to multi-task for purposes of carrying out other MIT related work is appreciated, the nature of this particular protocol does not lend itself to such activities.

[Note: Emergency contacts and phone numbers appear here.]

Protocol Summary

The protocol will normally be carried out by two Research Associates (RA1 & RA2). RA1 will greet the participant at the AgeLab and take them through steps 1-5 in the lab. The participant will then be passed off to RA2 who will introduce the participant to the vehicle and handle the remainder of the study interaction. A third RA may assist as noted at end of list.

- RA1 - Inside Set-up before Participant Arrives (290)
- RA2 - Check Weather & Drive Conditions for acceptability; move vehicle to AgeLab parking area (as needed)

In-Lab Start Phase

1. When Participant Arrives - Consent Forms / Payment Form / Emergency Contact Form
2. Review of Eligibility (Interview & MoCA)
3. Pre-Experimental Questionnaire
4. N-Back Training
5. Workload Scale Rating Explanation

Bathroom Break

6. Physiological Sensor Attachment

Move to Vehicle

7. Set Participant Up in Vehicle / Eye Tracking Calibration / N-Back Practice
8. Training in MIT parking lot on first set of in-vehicle tasks
9. Start On-Road Run to I95 North & turn onto I495 South
10. Part I on-road tasks

Rest Stop & Bathroom Break

11. Recalibrate eye-tracking system (if needed)
12. Training at rest stop on second set of in-vehicle tasks
13. Return to highway and drive I495 North
14. Part II on-road tasks
15. Exit I495 onto I93 South
16. Phone task
17. Return to MIT

Back at MIT (RA1/RA3 may assist with inside tasks so RA2 may make second run/return car)

18. Post-Experimental Questionnaire

19. Supplementary Health Questionnaire
20. In Lobby - Payment / Documents Stored Safely
21. Transfer Computer Data from vehicle to lab at End of Day
22. Return Vehicle to Garage Parking (if last run of day)

Phase 1-1. Inside Set-Up Before the Participant Arrives (RA1)

Forms:

Consent Form
Payment Record Form
Emergency Contact Form
Montreal Cognitive Assessment (MoCA) Scoring Sheet
N-Back Training Sheet (2008)
Instructions on How to Fill-Out Workload Rating Scale
Pre-Experimental Questionnaire
Workload Rating Sheet
Detailed Task Rating Questionnaire
Post-Experimental Questionnaire(s)
Supplemental Health Questionnaire
Data Set Summary (2 copies – one each for in-lab (RA1) and on-road portions (RA2))
Protocol section 1 (this form)
Protocol sections 2-6, A-E, X_1, X_2 in folder

1.	Ensure that all required forms are in the participant packet (see above)
2.	Check that you have water available to offer to participant later.
3.	Check that the charger is plugged into the front of the physio unit (MEDAC System/3) and the green light above the charge plug is on.
4.	Turn on PC in Room 290 if not already on and log-in to your normal MIT account.
5.	Start NeuGraph by selecting **NeuGraph** icon on the desktop.
6.	*AgeLab MIT* should come-up as the default user. Select **[Login]** button. (No password required.) (FYI [password is agelab123])
7.	Select **[Select Participant]** button.
8.	Double Click on name **"2012b Baseline"** and then select **[Return to Main Menu]** Leave computer running. These steps will save time when it comes to actually check signal quality later.

Phase 1-2. When the Participant Arrives

1.	Record time participant arrives.	Time _____

Narrative for When the Participant Arrives

"Welcome to the MIT AgeLab. My name is ***insert name here.*** "

"I will be working with you throughout the experiment today."

(or) (normal circumstances with two RAs)

"I will be working with you during the first part of the study today and insert name here, who will join us later, will take over and help you through the completion of the study."

"Do you have a cell phone with you? (*If yes*) – Would you please turn it off for the duration of your time here? Thanks. "

(If unwilling to turn-off cell phone, then they cannot participate and do not qualify for payment since incoming phone call interruptions will impact study results.)

Phase 1-3. Study Overview

"Before we begin, I'd like to describe the basic outline of the study. After hearing about the study, if you are still interested in participating, I will ask you to read and sign an informed consent form. The informed consent provides you with a written description of the study, eligibility requirements, compensation, risks of participation, and your rights as a research participant. If you agree to participate, please remember that you are still free to end your participation at any time by alerting me or another member of the research staff that you wish to do so."

"The study that you are considering participating in is part of a larger on-going research project called "Detecting Driver Stress" and in this particular phase we are looking at the amount of effort or workload that is associated with carrying out different tasks while driving."

"We will ask you do a series of tasks during today's drive. These tasks will include operating the radio using traditional manual controls as well as using a voice command interface to do a number of things including operating the radio, entering addresses into the navigation system, selecting songs stored on a portable storage device, and dialling a pre-saved phone number. In addition, you will be asked to do a number task that we will train you on here in the lab."

"The vehicle being used in this study is instrumented with several cameras to record what is happening outside as well as inside the vehicle. There are sensors that detect how you are operating the vehicle. A microphone will record all audio, including conversations, during the course of the study. During the drive, you will be asked to perform a number of tasks by an automated system in the car. A research associate will sit in the back of the vehicle and monitor the recording equipment. During the study, the research associate is not permitted to have casual conversations. However, if you have any questions about the vehicle, research procedure, tasks, directions or anything else related to the study please feel free to ask."

"The drive will be divided into two segments with a break in the middle. At the break, you will be getting off the highway and stopping the car at a designated location. Because we will be taking a break part way through the drive, we will introduce you to approximately half the tasks initially and train you on how to do the other half of the tasks during the break. This will reduce the number of new things you need to learn at one time."

2.	Provide participant with the overview above.	

Phase 1-4. Consent Forms

"This informed consent form describes the different stages of the experiment, risks to you, compensation, confidentiality and your rights as a participant. As you read it, please pay particular attention to the procedures section (*point to it*), and the risks and discomforts section (*point to it*). I'd like to emphasis a few points in this specific section. You will be solely responsible for any traffic tickets you may receive. If you feel uncomfortable with driving during any part of the experiment, you are free to stop the experiment. If this happens, inform the research associate and pull off to the side of the road at the nearest safe location."

"Please read through each section thoroughly and decide if you would still like to participate. As you read over the form, I would be happy to answer any questions you have."

(Sit with the participant and answer any questions as they read the consent form)

"Now that we have reviewed the different parts of the protocol, would you still like to participate?"

*(If **no**)* - "Thank you for coming in."

*(If **yes**)* - "Ok, the last page has a place for you to sign and date the form. Please be sure to also print your full name."

"I will also sign and date the forms and provide you with copies in a few minutes."

3.	Consent form. Sit with the participant and answer any questions as they read the consent form.	

Phase 1-5. Driver's License

"I now need to verify that you have a valid driver's license. May I have your license?"

"Perfect, I'm going to hold on to your license and make a copy of it while you fill out the questionnaire in a few minutes. I will give it back to you along with a copy of the consent form."

(If the license is not valid) - "I am sorry but your driver's license has expired and we won't be able to run the experiment today." *(Participant does **not** get paid.)*

4.	Valid driver's license.	yes / no

Phase 1-6. Payment and Emergency Contact Forms

"Now I need to collect some information required by MIT to pay you for participation. It is kept separate from our recruitment database for confidentiality. A research associate will only have a record of this information until it is passed on to MIT's Accounting office to process, at which point no reference to your social security number will be kept by the MIT AgeLab. You will be paid a minimum of $70 at the end of today's visit and will have the opportunity to earn a $10 incentive based upon your performance on a number of tasks during the drive. MIT reports all payments of over $100 to the IRS as per federal requirements."

(Note to RA if participant needs more information direct them to the IRS website. www.irs.gov *)*

5.	Fill out MIT **payment form**. This is filled out by the experimenter – if the address is correct c the license you can copy name and address to the form while th participant is filling out the survey	

"Now we need to fill out an emergency contact form. Who would you like us to contact in the case of an emergency?"

6.	Fill out MIT **Emergency Contact** form.	
7.	Place consent, payment form, emergency contact form, emergency contact form and driver's license on a clipboard and verify that you have completed the steps.	

Phase 1-7. Review of Initial Screening Criteria

"I now need to ask you a series of questions to verify your eligibility. Many of these questions can be answered with a simple yes or no. Please answer each question as best as you can. Answering any question is voluntary. If you feel uncomfortable with any question, feel free not to answer it. Remember that participants from different backgrounds are participating in this study, so some of the questions may not apply directly to you. "

(If a participant does refuse to answer a question, thank them for coming in but explain that all questions do need to be answered if they want to be considered for inclusion.)

C1. (Is the participant: MALE / FEMALE)

		YES	NO
C2.	Are you between the ages of 20 and 29 or 60 and 69 years of age?	1	2
C3.	What is your Date of Birth __ ___/__ __/___ ___ ___ ___ MMDDYYYY)		
C4.	Have you had a driver's license for over three years?	1	2
C5.	Do you drive three or more times a week?	1	2
C6.	Would you be comfortable driving a full size sedan such as a Ford Lincoln as part of the study?	1	2
C7.	Are you in reasonably good health for your age?	1	2
C8.	(Does the participant appear to understand and speak English?)	1	2
D1.	Have you been the driver in a police reported accident in the past year?	1	2
D2.	Do you wear glasses to drive?	1	2
D3.	Do you wear contacts to drive?	1	2
D4.	Have you ever participated in a driving study at MIT?	1	2
D5.	If yes, have you ever been trained in the n-back number task?	1	2
E1.	Have you had any major medical illnesses resulting in **any** hospitalization within the past 6 months?	1	2

E2.	Do you have a diagnosis of Parkinson's, Alzheimer's disease, dementia, mild cognitive impairment (MCI), or any other neurological problems?	1	2
E3.	Are you currently been treated for a psychological or psychiatric disorder?	1	2
	Have you ever had any of the following:		
E4a.	Heart failure?	1	2
E4b.	Angioplasty or coronary artery bypass grafting (CABG)?	1	2
E4c.	A pacemaker (to control heart rate)?	1	2
E4d.	A stroke or transient ischemic attack (TIA)?	1	2
E4e.	A diagnosis of diabetes?	1	2

There are a few medications that I need to ask you about. Have you used any of the following in the past 12 months?

F1.	Anti-convulsant medication	1	2
F2.	Immunosuppressive drugs or cytotoxic drugs	1	2
F3.	Anti-depressant medication	1	2
F4.	Anti-psychotic medication	1	2
F5.	Anti-anxiety medication	1	2
F6.	Medications to treat a major medical condition such as cancer	1	2

In the past two days have you used any?

F7.	Medications that made you drowsy?	1	2

If the potential participant's status falls in any of the shaded regions, then they may be ineligible. Please seek supervisor approval before continuing. If no supervisor approval is available, reschedule participant.

Notes:

D2-D5 are **not** exclusion criteria; this data is being collected for evaluation purposes.

F2 - Intent is to screen for serious medical conditions – if immunosuppressive medication is for treatment of mild to moderate arthritis that does not markedly impact the individual's ability to drive, they may be included; check with supervisor before continuing.

F7 – If individual regularly uses medications that cause drowsiness, they are to be excluded. If used on a limited basis such as a cold medicine, individual may be rescheduled for a time slot when they have been off medication for 48 hours or more.

1.	Is the individual eligible based on data collected on this screening form? (If any of the light grey boxes are checked, they are not eligible unless status reviewed and approved by a supervisor.)	**Eligible / Ineligible**

Phase 1-8. Mental Status Screening (Montreal Cognitive Assessment - MoCA)

"The next step is a cognitive assessment; I will be guiding you through a series of tasks and questions on this worksheet"

This step requires the MoCA task scoring sheet (Version 7.1 Original Version).
(The instructions below are a copy of MoCA Version August 18, 2010 © Z. Nasreddine MD.)

1. Alternating Trail Making:

Administration: The examiner instructs the participant: *"Please draw a line, going from a number to a letter in ascending order. Begin here* [point to (1)] *and draw a line from 1 then to A then to 2 and so on. End here* [point to (E)]."

Scoring: Allocate one point if the participant successfully draws the following pattern: 1 −A- 2- B- 3- C- 4- D- 5- E, without drawing any lines that cross. Any error that is not immediately self-corrected earns a score of 0.

2. Visuoconstructional Skills (Cube):

Administration: The examiner gives the following instructions, pointing to the **cube**: *"Copy this drawing as accurately as you can, in the space below"*.

Scoring: One point is allocated for a correctly executed drawing.

- Drawing must be three-dimensional
- All lines are drawn
- No line is added
- Lines are relatively parallel and their length is similar (rectangular prisms are accepted)

A point is not assigned if any of the above-criteria are not met.

3. Visuoconstructional Skills (Clock):

Administration: Indicate the right third of the space and give the following instructions: *"Draw a **clock**. Put in all the numbers and set the time to 10 past 11".*

Scoring: One point is allocated for each of the following three criteria:

- Contour (1 pt.): the clock face must be a circle with only minor distortion acceptable (e.g., slight imperfection on closing the circle);
- Numbers (1 pt.): all clock numbers must be present with no additional numbers; numbers must be in the correct order and placed in the approximate quadrants on the clock face; Roman numerals are acceptable; numbers can be placed outside the circle contour;
- Hands (1 pt.): there must be two hands jointly indicating the correct time; the hour hand must be clearly shorter than the minute hand; hands must be centred within the clock face

with their junction close to the clock center. A point is not assigned for a given element if any of the above-criteria are not met.

4. Naming:

Administration: Beginning on the left, point to each figure and say: *"Tell me the name of this animal".*

Scoring: One point each is given for the following responses: (1) lion (2) rhinoceros or rhino (3) camel or dromedary.

5. Memory:

Administration: The examiner reads a list of 5 words at a rate of one per second, giving the following instructions*: "This is a memory test. I am going to read a list of words that you will have to remember now and later on. Listen carefully. When I am through, tell me as many words as you can remember. It doesn't matter in what order you say them"*. Mark a check in the allocated space for each word the participant produces on this first trial. When the participant indicates that (s)he has finished (has recalled all words), or can recall no more words, read the list a second time with the following instructions: *"I am going to read the same list for a second time. Try to remember and tell me as many words as you can, including words you said the first time."* Put a check in the allocated space for each word the participant recalls after the second trial. At the end of the second trial, inform the participant that (s)he will be asked to recall these words again by saying, *"I will ask you to recall those words again at the end of the test."*

Scoring: No points are given for Trials One and Two.

6. Attention:

Forward Digit Span: Administration: Give the following instruction: "*I am going to say some numbers and when I am through, repeat them to me exactly as I said them*". Read the five number sequence at a rate of one digit per second. Backward Digit Span: Administration: Give the following instruction: "*Now I am going to say some more numbers, but when I am through you must repeat them to me in the backwards order.*" Read the three number sequence at a rate of one digit per second.

Scoring: Allocate one point for each sequence correctly repeated, (*N.B.*: the correct response for the backwards trial is 2-4-7).

Vigilance: Administration: The examiner reads the list of letters at a rate of one per second, after giving the following instruction: "*I am going to read a sequence of letters. Every time I say the letter A, tap your hand once. If I say a different letter, do not tap your hand*".

Scoring: Give one point if there is zero to one errors (an error is a tap on a wrong letter or a failure to tap on letter A).

Serial 7s: Administration: The examiner gives the following instruction: *"Now, I will ask you to count by subtracting seven from 100, and then, keep subtracting seven from your answer until I tell you to stop."* Give this instruction twice if necessary.

Scoring: This item is scored out of 3 points. Give no (0) points for no correct subtractions, 1 point for one correction subtraction, 2 points for two-to-three correct subtractions, and 3 points if the participant successfully makes four or five correct subtractions. Count each correct subtraction of 7 beginning at 100. Each subtraction is evaluated independently; that is, if the participant responds with an incorrect number but continues to correctly subtract 7 from it, give a point for each correct subtraction. For example, a participant may respond "92 – 85 – 78 – 71 – 64" where the "92" is incorrect, but all subsequent numbers are subtracted correctly. This is one error and the item would be given a score of 3.

7. Sentence repetition:

Administration: The examiner gives the following instructions: *"I am going to read you a sentence. Repeat it after me, exactly as I say it* [pause]: ***I only know that John is the one to help today."*** Following the response, say: *"Now I am going to read you another sentence. Repeat it after me, exactly as I say it* [pause]: ***The cat always hid under the couch when dogs were in the room."***

Scoring: Allocate 1 point for each sentence correctly repeated. Repetition must be exact. Be alert for errors that are omissions (e.g., omitting "only", "always") and substitutions/additions (e.g., "John is the one who helped today;" substituting "hides" for "hid", altering plurals, etc.).

8. Verbal fluency:

Administration: The examiner gives the following instruction: *"Tell me as many words as you can think of that begin with a certain letter of the alphabet that I will tell you in a moment. You can say any kind of word you want, except for proper nouns (like Bob or Boston), numbers, or words that begin with the same sound but have a different suffix, for example, love, lover, loving. I will tell you to stop after one minute. Are you ready?* [Pause] *Now, tell me as many words as you can think of that begin with the letter F.* [time for 60 sec]. *Stop."*

Scoring: Allocate one point if the participant generates 11 words or more in 60 sec. Record the participant's response in the bottom or side margins.

9. Abstraction:

Administration: The examiner asks the participant to explain what each pair of words has in common, starting with the example: *"Tell me how an orange and a banana are alike"*. If the participant answers in a concrete manner, then say only one additional time: *"Tell me another way in which those items are alike"*. If the participant does not give the appropriate response *(fruit)*, say, *"Yes, and they are also both fruit."* Do not give any additional instructions or clarification. After the practice trial, say: *"Now, tell me how a train and a bicycle are alike"*.

Following the response, administer the second trial, saying: *"Now tell me how a ruler and a watch are alike"*. Do not give any additional instructions or prompts

Scoring: Only the last two item pairs are scored. Give 1 point to each item pair correctly answered. The following responses are acceptable:

Train-bicycle = means of transportation, means of travelling, you take trips in both;
Ruler-watch = measuring instruments, used to measure.

The following responses are **not** acceptable: Train-bicycle = they have wheels; Rulerwatch = they have numbers.

10. Delayed recall:

Administration: The examiner gives the following instruction: *"I read some words to you earlier, which I asked you to remember. Tell me as many of those words as you can remember."* Make a check mark (√) for each of the words correctly recalled spontaneously without any cues, in the allocated space.

Scoring: **Allocate 1 point for each word recalled freely without any cues.**

11. Orientation:

Administration: The examiner gives the following instructions: "Tell me the date today". If the participant does not give a complete answer, then prompt accordingly by saying: *"Tell me the year, month, exact date, and day of the week]."* Then say: *"Now, tell me the name of this place, and which city it is in."*

Scoring: Give one point for each item correctly answered. The participant must tell the exact date and the exact place (name of hospital, clinic, office). No points are allocated if participant makes an error of one day for the day and date.

TOTAL SCORE: Sum all subscores listed on the right-hand side of administration / scoring sheet. Add one point for an individual who has 12 years or fewer of formal education, for a possible maximum of 30 points. A final total score of 26 and above is considered normal.

2.	Enter Total Score at right:	Score: _____
3.	Based on MoCA score above, is participant: **(25<= is ineligible)**	**Eligible / Ineligible**

Note: *This initial automatic cutpoint was revised after a review of MoCA scores from a study initiated prior to the current study. Following the revised guidelines, if a participant obtained a score between 23 and 25 (i.e. less than 26), the case was individually reviewed by the RA with a senior staff member prior to approval to allow the participant to move on to the parking lot training portion of the protocol. Participants obtaining scores less than 23 were automatically withdrawn from the study at this point. See additional discussion of this issue in the main body of the report.*

Phase 1-9. Verification of Eligibility Review

4.	If participant was ineligible in any section, then they are ineligible for the study. Indicate if they are:	**Eligible / Ineligible**

(If they are ineligible, respond as outlined below:)

"It appears as though you do not meet all of the eligibility requirements for this study. "

*(Unless it is **very obvious** that the mistake is on the participant's side)* - Since it appears as though this is due to an error on our part, I am going fill out a payment form and give you $70.

(If the mistake is in some way deceitful) - Since it appears as though you answered these questions differently during the scheduling process, I will be unable to pay you for this visit.

Phase 1-10. Checklist for Participant Consent & Verification

Experimenters are to complete the checklist below to confirm that they have gone covered each of the critical steps specified:

5.	Explained the steps of the protocol and sections of the consent form. Highlighted features with a pen while you move through them with the participant.	(YES / NO)
6.	Driver's license valid and name correct.	(YES / NO)
7.	Payment form is complete.	(YES / NO)
8.	You have the driver's license to be copied.	(YES / NO)
9.	You have the consents, payment form, and emergency contact form	(YES / NO)
10.	Consents are signed by both you and the participant	(YES / NO)
11.	Verification of eligibility is complete	(YES / NO)

Phase 1-11. Pre-Experimental Questionnaire

Completing Questionnaire Narrative

"Now I need to have you fill out a questionnaire."

(Hand participant the pre-experimental questionnaire.)

"While you are doing this, I am going to go make a copy of the consent form and your driver's license. I will be back in a few minutes."

(Copy items)

(Look through blinds to see if participant appears to have finished. If unsure, enter and ask how is it going? Do they have any questions? If not done, leave again so then can finish. Recheck as needed.)

(When participant has finished the questionnaire, return license and copies of forms.)

"Here is your license and a copy of the consent form for your records."

27.	Participant was given a copy of the consents	(YES / NO)
28.	Participant was given their license	(YES / NO)

Phase 1-12. N-Back Training

"Part of the experiment will involve performing a set of number tasks. You are going to learn how to perform a few versions of these tasks and practice each with a few trials. This sheet provides an overview of the task."

(Direct the participant's attention to the **N-back Instructions** sheet.)

"Please follow along as I explain each version."

"Please follow along as I explain each version. The first version is called the **zero-back**. During this task, I will read a list of ten single digit numbers. As I read each number, you are to repeat out loud the last number that you've heard. For example, if I were to say the number 3, you would say 3; then if I said 2, you would say 2; then if I said 6, you would say 6, and so on. Try to be as accurate as you can be."

(Point to the appropriate "I say" and "you say" squares on the sheet as you read)

I say	3	2	6	7	1
You say	3	2	6	7	1

"Let's practice with an actual set of numbers:"

Score: /10

7	4	6	8	9	0	5	2	1	3

(If the participant misses more than 1 response, repeat up to four more trials. Write the numbers in
the trial above on a separate sheet backwards and then in the same order as they appear alternating up to twice. Present one trial at a time trying to improve the participants understanding
to the point where they respond correctly to seven of ten stimuli.)

"The second version of the task is called the **one-back**, which simply means that as I read each list of ten numbers, you are to repeat out loud the number before the last number that you heard. For example, if I said 3, you would say nothing, then if I said 2, you would say 3, then if I said 6, you would say 2, and so on. Try to be as accurate as you can be."

(Point to the appropriate "I say" and "you say" squares on the sheet as you read the above.)

I say	3	2	6	7	1
You say		3	2	6	7

"Let's practice with an actual set of numbers:"

Score: /9

5	2	0	7	1	4	6	3	9	8

"Let's try that again. Just repeat out loud the number before the last number that you've heard. For example, if I were to say the number 1, you would say nothing, then if I said 2, you would say 1, then if I said 3, you would say 2, and so on. Try to be as accurate as you can be."

"Let's practice:"

Score: /9

1	7	3	8	9	0	5	4	6	2

(If the participant misses more than 2 in the last practice trial repeat up to four more trials. Write the numbers in the two trials above on a separate sheet backwards and then in the same order as they appear. Present one trial at a time trying to improve the participants understanding to the point where they respond correctly to seven of ten stimuli.)

"The final version of the task is called the **two-back**, which simply means that as I read each list of ten numbers, you are to repeat out loud the number that was read two numbers ago. For example, if I were to say the number 3, you would say nothing, then if I said the number 2, you would say nothing, then if I said 6, you would say 3, then if I said 7, you would say 2, and so on. Try to be as accurate as you can be."

(Point to the appropriate "I say" and "you say" squares on the sheet as you read the above.)

I say	3	2	6	7	1
You say			3	2	6

"Let's practice with an actual set of numbers:"

Score: /8

9	0	6	7	1	4	2	3	5	8

"Let's try another example. Just repeat out loud the number that was read two numbers ago. For example, if I were to say the number 1, you would say nothing, then if I said 2, you would say nothing, then if I said 3, you would say 1, then if I said 4, you would say 2, and so on. Try to be as accurate as you can be."

"Let's practice:"

Score: /8

6	5	3	4	7	2	1	8	0	9

"Let's try another one. Just repeat out loud the number that was read two numbers ago. For example, if I were to say the number 0, you would say nothing, then if I said 9, you would say nothing, then if I said 1, you would say 0, then if I said 5, you would say 9, and so on. Try to be as accurate as you can be. "

"Let's practice:"

Score: /8

0	9	1	5	8	2	4	6	3	7

(If participants misses more than 4 in the last practice trial repeat up to six more trials.)

EXTRA 2-BACKPRACTICE SETS (use as needed**)**

Score: / 8

8	9	3	2	4	1	7	6	0	5

Score: / 8

9	0	8	1	2	7	4	3	5	6

Score: / 8

7	3	6	4	2	8	5	1	9	0

Score: / 8

5	0	6	7	1	4	2	3	9	8

Score: / 8

6	5	3	4	7	2	1	8	0	9

Score: / 8

0	9	1	5	8	2	4	6	3	7

1	Did the participant complete the 0-back training?	(YES / NO)
2	Did the participant complete the 1-back training?	(YES / NO)
3	Did the participant complete the 2-back training?	(YES / NO)

Phase 1-13. Instructions on How to Fill-Out Workload Rating Scale

Hand participant "*Instructions on How to Fill-Out Workload Rating Scale*" and ask them to read. Answer questions as needed.

> "At the mid-point and at the end of the study today we are going to ask you to rate how much effort was involved in caring out each of the tasks. Please read through the instructions on this sheet which explain how we would like you to make this rating. Let me know if you have any questions about how to make these ratings."

Phase 1-14. Bathroom Break Opportunity

> "We are now going to take a short break. This will be a good time to visit the rest room since you will be in the car for approximately 2 hours before the next opportunity."
>
> "We also have some bottles of water here if you are thirsty. Would you like some water?"

Phase 1-15. Physiology Sensor Attachment

Sensor Attachment Narrative

SEE DOCUMENT EKG & EDA Sensor Attachment Protocol (Pictorial Summary) FOR DETAILS OF STEPS BELOW.

The narrative below is meant to be a guide. RA's may vary the language as appropriate.

> Now we are ready to attach the physiological sensors. We'll use an alcohol pad to clean a spot on your left side (point to your left side) and an area below either side of your collarbone (point to just below your collarbone on both left and right). This helps us get a better reading from the EKG sensor, which measures your heart rate. These sensors will be placed on the areas where the skin is cleaned. We will use some paper medical tape on a couple of locations on your skin and clothes to organize the wires. It doesn't damage your clothes or hurt when removed.
>
> If you would feel more comfortable having a female (male) research assistant attach these sensors, this can be arranged. If you have any questions about the sensor attachment, please feel free to ask me at any point. Are you ready to begin or would you like me to get a female (male) research assistant?

If they want an RA of another gender, tell them to take wait for a few moments and you will arrange this. Leave the room and arrange for assistance.

> As I mentioned before, I'm going to wipe your skin at the locations I described earlier with an alcohol pad before placing the EKG sensors. Would you raise your shirt/blouse on the left side a little for me? Thanks.

Use an alcohol pad to clean the participant's skin on the left side at approximately the level of the bottom rib. Then clean the area below the left & right collar bones and, on the non-dominant side. (In studies using the PPG to measure blood flow from the earlobe, one would clean the earlobe and just behind the ear over the mastoid bone at this point.)

> Now I am going to attach the EKG sensors. These monitor heart rate.

Attach snap leads to the EKG electrodes before removing the electrodes from the plastic sheet. Attach the EKG snap with **blue dot** below the RIGHT collarbone, the lead with the **black** snap below the LEFT collarbone, and plain **red** snap on left side near the bottom rib. If the participant has hair on their chest, the sensors can be placed on or above the collar bone.

NOTE: for studies that require participants to interact with device interfaces on the right side of the steering wheel, such as this study, the electrodermal sensors are always attached on **left hand**. *For studies that do not require use of hands except for steering, then it is preferable to use the non-*

dominant hand since people tend to be slightly more reactive on their non-dominant hand. Even though handedness will not change sensor placement in this study, record if they are right or left handed as this may be a meaningful variable for some participants.

> Are you right handed or left handed?
>
> This next sensor monitors the perspiration on your fingertips. This kind of sweat tends to increase with stress and decrease with relaxation. These sensors will be attached to the ring and middle fingers of your **left hand**.

Attach skin conductance sensors on the ring and middle fingers of the **left hand**. See details below and pictorial summary document.

> Can you make your left hand into a fist for me? And now move it across your body so it just touches your right shoulder? Good. I am going to place some more paper tape on you to hold the wires in place.

Apply tape to back of hand to hold down skin conductance wires as shown in the pictorial document.

	Check with participant if they want a **different gender** (male/female) research assistant to attach the sensors.	(YES / NO)
	Record if participant writes with right or left hand. (*However, sensors will always be placed on the **left hand** for this study.)*	Handedness: Right / Left
	Use an alcohol pad to **clean participant's skin** on the left side at approximately the bottom rib, and the area just below the left & right collarbones. [If PPG was being recorded, one would, on the non-dominant side, clean the earlobe and just behind the ear (over the mastoid bone).]	(YES / NO)
	Attach EKG snap with blue dot below RIGHT collarbone, black snap below the LEFT collarbone, and plain red snap on left side near the bottom rib. If the participant has hair on their chest, the sensors can be placed on or above the collar bone.	(YES / NO)
	Attach the gold **skin conductance** sensors on ring and middle fingers of the **left hand** (see pictorial document for details). The lead wires should fold up and back over the top side of the fingers and held in place using paper tape. To determine where paper tape should be placed on the back of the hand, have the participant make a fist and draw their arm up toward their right shoulder, then attach tape. Bending the fingers and elbow in this way corresponds to maximum pull that will occur on the lead wire; tape lead wire on the back of the hand, part way up the lower and upper segments of the arm and to top of shoulder.	(YES / NO)
	The lead wires should be brought together at the top of the left shoulder and taped in place	(YES / NO)

Phase 1-16. Physiology Sensor Verification (NeuGraph)

(The steps below assume that a participant file has already been created in NeuGraph.)

"I'm going to check that the physiological sensors are recording correctly. If there is any need to adjust the sensor connections, we will do this as I check the signals."

If NeuGraph is NOT yet running and participant name not yet selected:

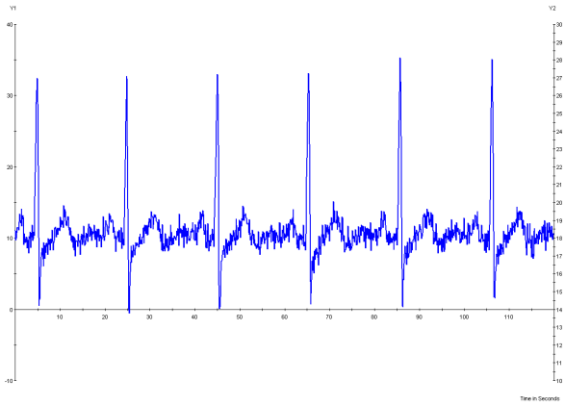
9.	Turn on PC in Room 290 if not already on and log-in to your normal MIT account.
10.	Start NeuGraph by selecting **NeuGraph** icon on the desktop.
11.	*AgeLab MIT* should come-up as the default user. Select **[Login]** button. (No password required.) (FYI [password is agelab123])
12.	Click on **[Select Participant]**.
13.	Double Click on name **"2012b Baseline"**. *(All data saved under this name and referenced by date and time.)*
1	Click on **[Return to Main Menu]**

If participant name has been selected:

1	**Unplug black charger cable** from the front of the unit.
1	Click on **[Select Protocol]**.
1	Click once on the protocol "***EKG Verification***" so it is highlighted.
1	Click on **[Run Protocol]** and then on **[OK].**
1	**Verify EKG** - Look for periodic upward spikes at a rate of approximately 1 to 2 per second (i.e. 1 per second equals 60 beats per minute). If the signal is inverted (see below) switch the active leads to correct the direction.) If you are getting a **flat blue line running at the top of the screen**, try disconnecting the skin conductance sensor and see if signal appears. (If Bruce is available check with him.) If necessary run with skin conductance sensor disconnected from unit to get good EKG signal. (Let Bruce know that this occurred.)
1	Click on red **X** in upper right corner of screen to exit and return to the main menu.

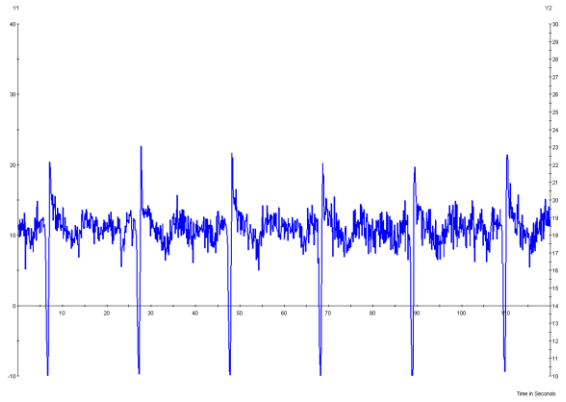
The "EKG Verification" protocol displays raw 250 sample per second signal in burst mode:

What we want to see:



Normal EKG with positive going r-spike.

What we don't want to see:

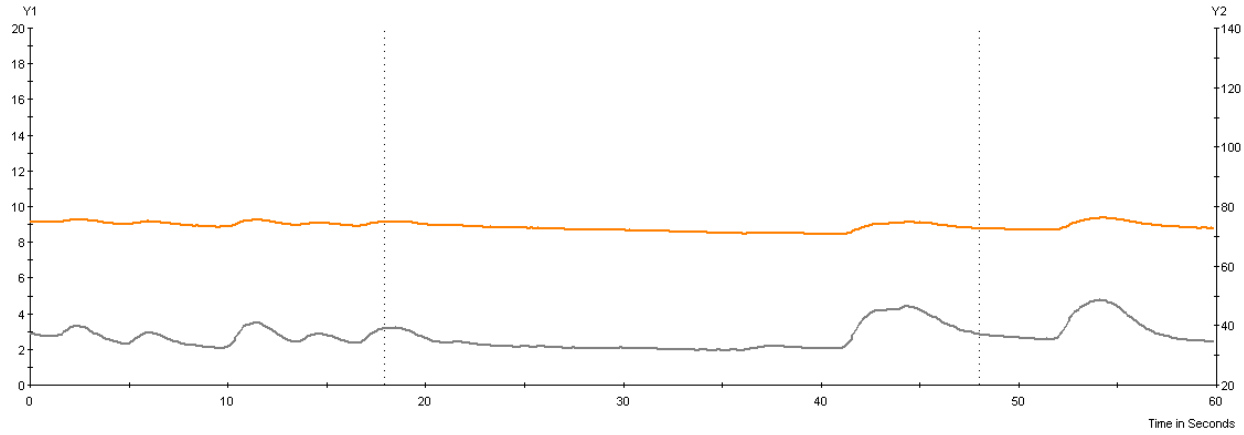


EKG with inverted r-spike (**FIX**).

Checking remaining signals.

1	Click once on '2012b ***Protocol***' to highlight.
1	Click **[Run Protocol]** and then **[OK]**
1	SCL (orange) should show a reading of at least 2.0 and SCR (gray) of at least 30. Ask participant to take deep breath, look for SCL to increase a minimum of 0.5 units; the SCR increase should be more dramatic and normally go over at least 40. Adjust sensors as needed if you do not seem to be getting a correct signal. If blue EKG signal is running as flat line at the top of the screen, see note on previous page.
2	Once you are done adjusting signals, click on **[Start Session]** and record approximately **30 to 40 seconds** of baseline / reference data. (This is intended to allow us to track what signal quality looked like in the lab.)
2	Click **[End Session]** and select option to **[Save Session]** data. Entry of Notes is optional – just use if there is something unusual to report.
2	If another participant will be run later, select option to return to **Main Menu**. If done for the day, select options to **Exit** software.
2	**Plug black charger** cable back into the front of the unit to charge physio unit.

Example SCL & SCR Tracings



The unit produces two electrodermal signals. Skin Conductance Level (SCL) is displayed in orange on the graph above. Skin Conductance Response (SCR) is shown in gray. You can test the electrodermal signal by having the participant take a deep breath. A deep breath should produce a clear rise in the gray SCR signal as seen on the right side of the screen above. Typical SLC values can generally be expected to be in the 2-25 micromho range with most participants falling in the 2-5 range under low stress conditions. The base SCR reading should be around 30 to 35 and should rise over at least 40 when the participant takes a deep breath. "Everything looks good."

Phase 1-17. Moving to Car

"I (or insert name here) will be meeting you back there in a few minutes and will then walk with you out to the test vehicle."

	Leave in a folder in the bin in room 288: • Consents, payment form, copy of license, emergency contact pre questionnaire(s), and your data summary sheet	
24.	Make sure to pass on to driving RA: • Protocol sections 1, 2 – 5, A-E, X_1, X_2 • ALL Mid and Post-Experimental Questionnaires including Supplemental Health • Data summary sheet for driving portion	
25.	RA1 fill out data summary sheet for intake portion.	
26.	Scan and upload all documents	

Section 2 Vehicle Setup

Participant Code _____ **Protocol Configuration** _____

Date _____

RA (s) _____

Notes for the research assistant - Please review before each participant run.

It is important to remember that when you are involved in data collection with the AgeLab on-road vehicle, safety is a priority. Good judgment and attention to detail is key to ensuring the safe collection of good experimental data. If a **non-critical** derivation in the protocol occurs that does not compromise participant safety (i.e. procedural, technical) correct things as best as possible and finish running the participant. As a matter of policy, any comments, notes, or observations about the experimental procedure or equipment should be recorded on this form. No detail is too small to record. **At the conclusion of the experimental session you should transcribe the major points to a data set summary form. You are also responsible for making a log entry noting success or failure as well as entering a short comment or description as appropriate.**

As a research associate involved with this experiment, you are responsible for actively monitoring the participant, ensuring that all instructions detailed below are described clearly to the participant and that any questions are answered to the best of your ability. Please make sure to read instructions clearly. If, at any time, the participant has reservations about participating or continuing to participate in this experiment, you should encourage them to withdraw. **DO NOT ENCOURAGE PARTICIPATION!** If a question arises that you are unable to answer, seek assistance from a senior member of the research staff. **DO NOT GUESS**.

If an undergraduate researcher consents the participant, the RA operating the vehicle should review eligibility materials before departing MIT.

If, during the course of an experiment, a situation arises where you feel as though the participant's or your safety is compromised, you need to use your best judgment to address the situation. For example, if you feel that the participant is not adequately in control of the vehicle, immediately advise them in a calm manner to pull off to the side of the road at a safe point. Call a contact to report the adverse event. Drive directly back to MIT. **Unless there is an equipment failure or planned pause in data collection, the DAQ should ALWAYS be recording data.** If an accident of any type occurs, try to handle the situation calmly. If it is safe to do so, retrieve the removable drive and **DO NOT RELEASE THIS TO ANYONE** until the matter is discussed with officials here at MIT. For purposes of emergency support, you should have a working cell phone with you in the vehicle at all times.

During the course of the study you should minimize any unnecessary actions, e.g. moving around the room, getting papers organized, extra key strokes etc. Low level noise and slight movements will impact participant arousal. In addition, due to the significant number of functional actions and active monitoring required of the RA in this experimental protocol, RAs are not to use the lab computers or other computers or communication devices to monitor e-mail, work on other projects, etc. so that full attention can be devoted to active monitoring of the participant, equipment, and protocol. The sole exception would be the

use of text messaging to communicate with another staff member regarding significant equipment or participant related issues. While the desire of RAs to multi-task for purposes of carrying out other MIT related work is appreciated, the nature of this particular protocol does not lend itself to such activities.

Points of contact: [*Note: Emergency contacts and phone numbers go here.]*

NOTE: Whenever this procedure instructs you to press an F key (F1, F12, etc.) you must make sure that the DAQ window on the DAQ computer is active, or nothing will happen.

Checking External Factors that May Impact the Experiment

Before beginning with a participant during a driving assessment visit, you need to determine if external factors such as traffic or weather are likely to adversely impact the experiment. Boston.com and weather.gov are two sources that provide real-time updates. If you feel that heavy traffic on I-93 North or South is occurring in an area that will impact data collection, you need to make a decision based upon the traffic reports if some alteration of the experimental procedure is needed or if there is a good chance that traffic will clear in time for data collection. In cases such as a reported accident an hour before you are scheduled to depart, there is a very good chance that the accident will be cleared before you get to that area. In the case of heavy rain, you need to decide if visibility will be impaired during the period when you will be collecting data. If you decide that there will be traffic, weather or other conditions are very likely to impact the experiment, you need to decide if a brief delay will help ensure a successful run or if you should reschedule the participant. You may choose to wait up to 30 minutes between the procedures in 290 and driving. **This option is available even if it will delay subsequent participants!** All efforts should be made to run the participant if traffic or weather may improve between the time you leave MIT and the start of data collection.

Support Materials:

The "on-road" RA is responsible for confirming that he/she has each of the items listed below. This includes checking the package of forms / questionnaires that may be handed off to the on-road RA by another RA.

Replenished Items

Intake Protocol (section 1) (to follow participant)

Post-Intake protocol sections in 3-ring binder

Workload Rating Scale

Detailed Task Rating Scale

Post-Experimental Questionnaire

Supplemental Health Questionnaire

Water & granola bars

Data summary Sheet (for driving portion)

Fixed Items

Clip board and pen

Address card(s) for Navigation Task

USB memory stick containing music

Phone

Protocol Summary:

23. Setting-up Vehicle and Eye Tracking System
24. Setting-up Participant in Vehicle
25. Back Out & Back into Parking Space
26. Create Head Model for Eye Tracker
27. In-Vehicle N-back Practice
28. Final Eye Tracking Configuration
29. Training in MIT Parking Lot on First Set of In-vehicle Tasks
30. Voice System Calibration

Phase 2-1. Checklist for Setting-up Vehicle and Eye Tracking System

	Task	**Notes / Checked**
1.	Position vehicle in the space behind the building with power plugged in to the outlet in front of the vehicle	
2.	Turn on climate control and set to 68 degrees on auto fan	
3.	Start and log into the computer – user: **AwareCar2**, password: **awarecardaq**	
4.	Get a folder for all materials	
5.	Make sure a clipboard and pen is available so the participant can do the questionnaires in the car	
6.	Check that stickers to cover BLISS light in each side mirror are in place.	
7.	Press the "engine" button once to put the car in accessory mode.	
8.	Make sure the audio in the car is on and set to Media – Line In. Test audio volume by playing an .mp3 from the desktop.	
9.	Check and note the mic volume. It needs to be set to 95%	Mic _____ %
10.	Open **n-backs** folder in **2012b_audio** on the **C Drive**. Then open the file shuffle log andmatch the n-back trials to the variation log. Refer to the log and write the number order into the protocol.	
11.	Start the DAQ	
12.	Select the configuration file to: **2-3 2012b_Intro.set**	
13.	**VERIFY** that the correct configuration file is selected.	(***YES*** / ***NO***)
14.	Turn on the IR Pod Switch and turn off the Physio Charger Switch.	
15.	Start faceLAB and select stereo head name: **MKS_test**. ***(note: THE DAQ NEEDS TO BE RUNNING FIRST)***	
16.	"Save As" the current world model "AwareCarII_easy" to "AwareCarII_easy_modified".	
17.	Use the calibration square to **Recalibrate** the stereo-head on faceLAB. Follow faceLAB instructions until finished. If necessary, follow the FaceLAB procedures for **Verify Calibration**.	

18.	Review Radio Pre-sets Pre-set FM 1 FM2 AM 1 92.9 92.9 1030 2 94.5 92.9 1030 3 100.7 92.9 1030 4 104.1 92.9 1030 5 106.7 92.9 1030 6 107.9 92.9 1030	
19.	Are all radio pre-sets correct?	(***YES*** / ***NO***)
20.	Set up radio Turn Radio on; set on **AM preset-4** (AM 1030) Change to FM2, set on **FM2 preset-4**. (FM 92.9) Change to FM1, set on **FM1 preset-4**. (FM 104.1) Turn radio off.	
21.	Has the radio been properly set-up?	(***YES*** / ***NO***)
22.	Put the driver seat in an all the way back position so that the participant will be largely forced to adjust seat after entering the car.	
23.	Unplug vehicle power cord from outlet and store in trunk.	

Phase 2-2. Setting Participant Up in Vehicle

24.	Meet RA with participant, introduce yourself and make sure to get all the materials you need from the RA: • First half of the protocol (intake) • ALL Post-and Mid Experimental Questionnaires needed for this visit • Data summary sheet for driving portion	

"Welcome to the AgeLab instrumented vehicle. My name is (*insert name here*). Before we get settled in the car, would you please check that you have your cell phone off and your driver's license with you? (*Wait as needed.*) Please take a seat in the driver's seat."

"Please take a moment to adjust the seat position and the mirrors as you would if you were entering a car that you have never driven. If you are unfamiliar with electronic seats, the adjustments are on the left. Please take care to ensure that the seat is in a comfortable position."

25.	Pause until participant has completed adjusting the seat; explain how as needed. Have them put on seat belt if they have not already.	
26.	Connect physio sensors and computer system set-up and system checks; (note: lead wires should run behind the participant's neck – not draped in lap.)	
27.	Explanation of basic functions including how to turn-on vehicle. Test turn signals, running lights, adjust climate controls, steering wheel position, etc.	
28.	Make sure they have the lights set all the way to the right so they will have daytime running lights.	

VERIFY THE FOLLOWING:

29.	Participant has both cell phone off and driver's license with them? If NO, have them turn off the phone and/or return to the lab to get their license	**(YES / NO)**
30.	Does the participant have the seat belt on?	**(YES / NO)**
31.	Are daytime running lights on?	**(YES / NO)**
32.	If a student did the participant intake, the RA operating the vehicle needs verify all forms are completed correctly and participant is eligible. **Are all materials filled out correctly and the participant eligible?**	(***YES*** / ***NO***) Your initials: _____
33.	Vehicle is unplugged from outlet?	**(YES / NO)**
34.	Verify that sensors are reading properly: EKG – Look for spikes in the correct direction SCL ~3-20 Ask participant to take deep breath, look for increase in SCL.	
35.	Go to the **Physio** tab, click auto calculate threshold, show the EKG and EKG Threshold, and click on auto calculate threshold.	
36.	Does the EKG look normal?	(***YES*** / ***NO***)

Phase 2-3. Back Out & Back into Parking Space

Participant is asked to back vehicle out and back into the parking space to encourage a second check that they actually do have seat, mirror and other adjustments reasonable for actual driving. This also turns vehicle systems on so that participant can be trained in interface functions.

"I would just like to point out two safety features that are installed in this car. When the car is put in reverse, a camera image of the view directly behind the car will appear on the display screen. In addition to looking over your shoulder and using the mirrors when backing up the vehicle, the camera display is available if you wish to look at it. The car also has a proximity sensor built into the back bumper that will beep if an object is detected right behind the car."

37.	Explain about **back-up camera** and **proximity sensor** beep alert.	
38.	**The RA needs to be particularly attentive at this time, i.e. looking themselves to be sure that no one is exiting the building adjacent to the parking space and in danger of walking behind the car as the participant is backing-up.** Prompt participant along the lines of the dialog below and have them back out and back into parking space.	

"In a moment I will ask you to back out of the parking space about 10 feet and then have you pull back into the parking space. The intent here is to give you an initial feel for whether the positioning of the car seat, the mirrors, etc. seem to feel right or need additional adjustment. When you back-up, make sure that you check behind you for people who might be walking across the parking lot or exiting the building and walking behind the car."

"Please put your foot on the brake and then shift the car into reverse while keeping your foot on the brake. Notice that an image from the rear backup camera appears when you put the car in reverse. You are welcome to use the backup camera if you wish, but please also remember to look behind the vehicle yourself and to use your mirrors when manoeuvring the car."

"When you have checked for pedestrians and you feel ready, please back-up about 10 feet."

"Good. Now pull forward back into the parking spot and stop. Ok, please put the car in park."

39.	Now that they have actually moved the vehicle in and out of the parking space, encourage them to again check to see if they want to further adjust the seat, mirrors, etc. so that they can see appropriately and are comfortable.	

"Please make any final adjustments that are needed so you are comfortable in the seat and the mirrors are in a good position for you."

Phase 2-4. Create Head Model for Eye Tracker

"Now that you are settled in, I will take a few pictures for the eye-tracking camera calibration."

40.	Ask the participant to make any adjustments to seat or steering wheel to ensure proper head placement in faceLAB cameras (see his/her eyes and mouth clearly). Make sure they are comfortable with this set up.	
41.	Adjust sunroofs as needed to get more or less light on the participant's face.	
42.	"Can you look straight ahead with neutral expression for me?" Click "Set Model" to automatically create participant's head model.	
43.	Select "HeadModel -> Adjust Eye Tracking". If the eye corner and face corner points were placed in wrong positions, click "Back" to adjust manually. Then click "Next" to do gaze calibration.	
44.	"Can you look at the center of the right camera (A)?" Click "Next".	
45.	"Can you look at the center of the left camera (B)?" Click "Next" and "Finish".	
46.	"Can you look straight ahead and scan everywhere on the road?" Check if participant's gaze vector intersects with the BLUE object (front view) correctly.	
47.	"Can you look at the speedometer?" Check if participant's gaze vector intersects with the YELLOW object (speedometer) correctly.	
48.	"Can you look at the touch screen on the central console?" Check if participant's gaze vector intersects with the GREEN object (touch screen, radio and air conditioner control) correctly.	
49.	"Can you look at the radio controls on the central console?" Check if participant's gaze vector intersects with the GREEN object (touch screen, radio and air conditioner control) correctly.	
50.	"Can you look at the rear view mirror?" Check if participant's gaze vector intersects with the ORANGE object (rear view mirror) correctly.	
51.	"Save" the modified world model.	

"Thanks. I need a minute or two to finish setting-up the calibration. While I do that, I am going to play an audio recording that will review the n-back number task that you learned in the lab and take you through additional practice so that you are comfortable with this task."

52.	Ensure that configuration file name = **2-3 2012b_Intro.set**	(***YES*** / ***NO***)
53.	Press **Start** test on the DAQ	
54.	Ensure that we are recording all **90** channels.	
55.	Entering the participant number **2012b_xyz_Intro** (where xyz is the participant number)	

Phase 2-5. In-Vehicle N-back Practice

56.	Hit **F1** to start the n-back task practice	

The following n-back training is all practice - **you do not need to monitor performance**.

(start recording n-back_instructions.wav)
Now we are going to practice the N-back number tasks again. The tasks are the 0-back, 1-back, and the 2-back. We are going to practice them in the order of 0, 1, and 2 for now, but they may be presented in a different order during the actual drive. Each trial will consist of a set of 10 single digit numbers.

The first version of the task is called the zero-back task. As I read each number, you are to repeat out loud the last number that you've heard. For example, if I were to say the number 3, you would say 3; then if I said 2, you would say 2; then if I said 6, you would say 6, and so on. Try to be as accurate as you can be. (Pause 2.25 sec)

Let's practice:

3	*2*	*6*	*8*	*9*	*0*	*5*	*4*	*1*	*7*

(Pause 5 sec)

The next version of the task is called the one-back task, which simply means that as I read each list of ten numbers, you are to repeat out loud the number before the last number that you heard. For example, if I were to say 3, you would say nothing, then if I said 2, you would say 3, then if I said 6, you would say 2, and so on. Try to be as accurate as you can be. (Pause 2.25 sec)

Let's practice:

3	*2*	*6*	*7*	*1*	*4*	*0*	*5*	*9*	*8*

The final version of the task is called the two-back task, which simply means that as I read each list of ten numbers you are to repeat out loud the number that was read two numbers ago. For example, if I were to say the number 3, you would say nothing, then if I said the number 2, you would say nothing, then if I said 6, you would say 3, if I said 7, you would say 2, and so on. Try to be as accurate as you can be. (Pause 2.25 sec)

Let's practice:

3	*2*	*6*	*7*	*1*	*4*	*0*	*5*	*9*	*8*

(end recording n-back_instructions.wav)

Phase 2-6. Final Eye Tracking / Camera Configuration

"Great I am just about done configuring the eye tracking equipment. I need you help me with the final steps…"

Note: this step is a verification

57.	"If you look straight ahead you'll notice three round cameras. Can you please look directly into the canter of the lens of the lower of the two cameras on the right?"	
58.	"And now into the canter of the lens on left camera?"	

"Thanks. We're all set."

Phase 2-7. Training in MIT parking lot on first set of in-vehicle tasks

59.	Hit **F2** to start the voice introduction	

(start recording 2012b_voice_intro)
Hello and welcome to the MIT AgeLab's study vehicle. We will use this recording to introduce you to some of the user interface features of this vehicle including the voice command system. The voice command interface you will be using is the standard system supplied with this vehicle; it is not a research system. After this short introduction, the research associate will talk you through the details of how to do each task we will ask you to do during the first half of the drive and will give you a chance to practice with the controls and voice interface. During this practice period, please feel free to ask the research associate any questions that you have. It is important to us that you have the opportunity to become familiar with how to use the interface now, so that you can use it during the drive without needing to ask questions at that time.

The research associate will now point out the location of the push-to-talk button.
(end recording 2012b_voice_intro)

60.	Confirm participant understands where the push-to-talk button is located; point out as needed.	
61.	Hit **F3** to start the next part of the voice introduction	

(start recording 2012b_voice2_intro)
Pressing down on the left side of the push-to-talk button side with the face image activates the voice command interface. The system will then say 'Please say a command'. After a brief pause, you will hear a tone indicating the system is ready for you to speak a command.

A menu will also appear on the display screen that provides information on commands that you can speak. Looking at this menu may be useful while you are learning to use the system while the car is parked. Once you are actually driving, the intent of the system design is to only look at the display when you need to, since one of the major purposes of a voice command interface is to allow you to control various functions while keeping your eyes on the road.

The voice system is designed to support a logical sequence of commands to allow you to get to a specific function. For purposes of this study, we will focus on short-cut approaches for requesting specific tasks rather than training you on all the levels of commands that could be used.
(end recording 2012b_voice2_intro)

Phase 2-8. Voice System Calibration

62.	Introduce voice calibration using the text below or something equivalent based on your experience.	

"Voice recognition systems are getting better all the time but they are still not perfect, so, if the system does not recognize what you said, it may sometimes say 'Sorry, please say a command'. One way to increase the likelihood that the system will recognize your voice is to go through a calibration procedure that helps the system learn your speaking style."

63.	Prompt participant through the Voice Calibration Procedure summarized below	

"We are going to go through the voice calibration procedure now. In a moment, I will ask you to press the push-to-talk button. When the system says, "Please say a command.", listen for the tone that indicates the system is ready to listen and then say "USER PROFILE" from the next menu say "CREATE USER PROFILE 1" (or 2). Then follow the prompts from the system. Do you have any questions? (Answer as needed.) OK, please press the push-to-talk button now and be ready to say "Create user profile 1".

Follow voice prompts from system.

64.	Did the voice system appear able to work reasonably with the participant's voice? If **NO** – record details below.	(***YES*** / ***NO***)

NOTES IF PARTICIPANT WITHDRAWS / IS WITHDRAWN AT THIS POINT:
Enter extensive notes below if participant is withdrawn / withdraws on own at this point. Things such as the participant being overly frustrated, system incapable of recognizing voice (i.e. heavy accent, voice too soft, pauses too long by participant in multi-utterance responses, etc.), comments on the participants tone of voice, cultural background, the participant withdrawing vs. RA withdrawing them are all critical. Transfer later to participant log.

_____

_____

_____

_____

2012b_HMI_OnRoad - Voice Based In-Vehicle Systems Study

Experimental Checklist

Section 3 Leaving the Parking Lot

Participant Code _____ **Protocol Configuration** _____

Date _____

RA (s) _____

Notes for RA during the drive:

- Ctrl+F9 will allow you to manually set the trial time
- F23 will pause experiment
- F24 will silence any audio
- Continue to check light levels on DAQ cameras, adjust shutter speed as needed when car changes directions (e.g. 93 north to 93 south)

If participant cannot complete evaluations before reaching Exit 19 on 495 South

- Exit 18: Coming off exit, take a left at the light. At the next light take left into parking lot of Home Depot/Uno's. Turn around
- Exit 17; 140 Bellingham: Coming off exit, take a left at the light and go over the bridge. At the next light, take a right into the mall. Turn around
- Exit 16; King St./Franklin/Woonsocket, RI: Coming off exit, take left off exit. At next light, take a right and pull into the lot behind Joe's American to turn around

If participant cannot complete evaluations before reaching I93 when returning on 495

- Exit 41a, take right off exit, turn around in Dunkin Donuts on left, Not Ideal
- Exit 42a, take a right off the exit, drive for a ¼ mile, take a left at light for Andover Mall, this is the preferable turnaround point.
- 42b, take right off exit, take next right into Stadium Plaza, Not Ideal
- 43, take left at stop sign coming off exit, cross under bridge and get back on 495 South, Not Ideal.

Phase 3-1. Introduction to Driving

	Task	Notes / Checked
65.	Save the FaceLab Face Model (use participant id as file name)	
66.	Verify FaceLab is all set for data collection	
67.	**START LOGGING IN FACELAB**	
68.	Select the configuration file to: **3-1 2012b_Start_Drive.set**	
69.	Ensure that configuration file name = **3-1 2012b_Start_Drive.set**	(***YES*** / ***NO***)
70.	Press Start test on the DAQ	
71.	Ensure that we are recording all 90 channels.	
72.	Entering the participant number: **2012b_xyz_sDrive** (where xyz is the participant number)	
73.	Press **F1** to start the general driving instructions	

(start recording 2012b_drive_instructions.wav)

In a few moments, the research associate will begin giving you step-by-step instructions on how to drive from here to I93 north. Once on I93, you will continue on to the I495 interchange. The drive north will give you plenty of time to become familiar with driving this car before you are asked to do any of the tasks you have practiced. When you reach I495 and have had a few minutes of driving on that highway, short recorded prompts will tell you what task we would like you to do. When you hear these prompts, please do not start a task until you hear the word 'begin'.

You will have the opportunity to earn a small monetary bonus by engaging in each of the tasks. However, you will also be responsible for paying for any citations that you might be issued for traffic regulation violations. While we want you to do your best to complete each task to the best of your ability, you should always give priority to safe driving. It is important for you to remember that some of these tasks are designed to be difficult for everyone. That is to say, everyone will not be able to complete every task correctly. If you feel for any reason that a task will interfere with your ability to drive safely, delay starting

the task until you feel it is safe to do so or skip the task entirely if you feel that is the best thing to do. Your safety, and the safety of other people around you, is the highest priority.

If at any time you feel uncomfortable driving the vehicle or in your ability to drive safely, please let the research associate know how you are feeling and they will confer with you about pulling off the roadway at the nearest safe location.

During the course of the study, you may wish to talk with the research assistant. They will be happy to answer any questions about directions, operation of the vehicle, or other aspects about the study. However, they are unable to participate in casual conversation. Remember at any point you wish to engage the research associate please do so. They will respond if it is appropriate."

Do you have any questions?

(end recording 2012b_drive_instructions.wav)

74.	Ask if they have any questions and answer as appropriate. **Make sure to make the following statement to reinforce the recorded instructions:**	

"I would just like to emphasise again that if you feel that any of the tasks affect your ability to drive safely, please delay or skip the task completely and focus on your driving. If you should become overly tired, sleepy, or feel that it is no longer safe for you to drive for any reason, just let me know and we can stop the study and I can drive the vehicle back."

Phase 3-2. Start Driving

75.	**The RA needs to be particularly attentive at this time, i.e. looking themselves to be sure that no one is exiting the building adjacent to the parking space and in danger of walking behind the car as the participant is backing-up.**	

"I would just like to point out again that in addition to using the car mirrors when backing up the vehicle, that there is a back-up camera display available and that the car has a proximity sensor that will beep if an object is detected right behind the car."

"Ok. It's time to head towards the highway, please check behind the car to see if it is safe to back-up, and, when it is, back-out of the parking space and head towards the parting lot exit."

"When you approach the exit, the barrier bar will raise automatically."

76.	Before you hit parking lot gate, ask them to stop and check their mirrors.	
77.	**Press F2** as you pull out of parking lot and turn left	
78.	**Record time**	_____
79.	Take a **right onto Amherst Street**.	
80.	Take a **left onto Ames Street**	
81.	Cross Memorial Drive and take a **left on Memorial Drive**	
82.	When Memorial Drive splits up take the **right lane onto Edwin H Land Blvd**	
83.	Take a **right onto Monsignor Obrien Hwy/RT-28S – Sign to Boston**	
84.	Get into left lane and bear left after intersection to get onto I-**93 North** ramp	
85.	Take **right lane** to I-93 North in the direction of **Concord NH**	
86.	Once participant merges onto I-93 North, press **F3**	

87.	ADJUST ALL VIDEO SHUTTER SPEEDS IF NEEDED TO IMPROVE IMAGE BRIGHTNESS	

(start recording 2012b_enter_highway.wav)

We are going to be driving north on 93 for approximately 20 minutes and then exit onto 495 South. You can continue driving in this lane or move into another lane so that you are comfortable with the traffic flow.

(end recording 2012b_enter_highway.wav)

88.	After 2012b_enter_highway plays (about a minute of comfortable driving on 93) **Stop the Daq** and switch to first configuration file **2012b _RadioM_Nav_x**, or **2012b _RadioV_Song_x** (where x is n-back config)	
89.	**Stop** and **Start** facelab to break files	
90.	**Ensure that configuration file name = 2012b _RadioM_Nav_x,** or **2012b _RadioV_Song_x,** (double check on protocol)	
91.	**Press Start test on the DAQ**	(YES / NO)
92.	**Ensure that we are recording all 90 channels.**	
93.	**Entering the participant number: 2012b_xyz_RadioM_Nav_x, or 2012b_xyz_RadioV_Song_x (where xyz is the participant number)**	
94.	**Prompt to turn on Radio & Adjust Volume**. At **Exit 42**, press **F11**	

(start recording 2012b_habituation.wav)

In a few minutes we are going to exit and turn onto I495 south. Once we have driven for several minutes on 495, recorded instructions like this one will ask you to do a number of tasks that you have already practiced. As a final practice task, when you hear the word 'begin', please turn on the radio by pressing the volume button, listen for a moment and then adjust the volume if needed so that it is at a level where you can hear but not so loud as would make it hard to hear recorded instructions like this one. Once you are comfortable with the volume, please turn the radio off by pressing the volume button again. (pause) Begin.

(end recording 2012b_habituation.wav)

95.	Just **after Exit 43** give the driver the following instructions	

"You are approaching Exit 44B for route 495 south. Please prepare to take this exit"

If the driver does not move into the right lane prompt again.

96.	As you approach Exit 44 give the driver the following instructions	

"Remember, please take Exit 44B for route 495 south."

If the driver does not appear to be taking the exit prompt again.

97.	Once participant merges onto I-495 South, press **F1** **2012b_RadioM_Nav_x** or **2012b_RadioV_Song_x**	

(start recording 2012b_enter_495.wav)
We are going to be driving on 495 for approximately 30 minutes. You can continue driving in this lane or move into another lane so that you are comfortable with the traffic flow. During portions of the drive you will be asked to perform some additional tasks while you are driving.
(end recording 2012b_enter_495.wav)

98.	ADJUST ALL VIDEO SHUTTER SPEEDS IF NEEDED TO IMPROVE IMAGE BRIGHTNESS	
99.	**2012b_RadioM_Nav_x: move to next protocol** (3 minute habituation to 495 South) **2012b_RadioV_Song_x: move to next protocol** (3 minute habituation to 495 South)	

Section 4 Approaching Rest Stop

Participant Code _____ **Protocol Configuration** _____

100.	Just after (Exit 20-Milford, Hopkinton, Uxbridge) give the driver the following instructions	

"You are approaching Exit 19 for route 109. Please prepare to take this exit"

If the driver does not move into the right lane prompt again.

*Refer to Section 2 of protocol if driver has not yet completed all evaluation sections prior to reaching exit 19. Exits 18-16 with description provide optimal turn around points. See also if driver does not complete all post rest stop evaluations before returning to I93.

101.	As you approach Exit 19 give the driver the following instructions	

"Remember, please take Exit 19 for route 109."

If the driver does not appear to be taking the exit prompt again.

102.	As you enter the exit ramp Press **STOP** FaceLab logging	
103.	If recording press STOP on the DAQ	
104.	Take the exit ramp to the right, and at the light take a right. Be in the right lane and at the next set of lights take a right into the driveway. Pull into the lot behind the Burger King.	

105.	**Once car is in park** - tell participant that there is a short rating scale and questionnaire that you need to have them fill-out and then they	

	can take a break.	
106.	**Workload Rating Sheet** - Hand the participant the clipboard with the workload rating sheet and ask them to read the instructions before starting and then ask if they have any questions. **Specifically point out which tasks they should be rating at this time.**	
107.	Workload Rating	___ Workload Rating Completed
108.	**Detailed Task Rating questionnaire** – hand to participant. Point out to them which of the sections they should be filling-out.	
109.	Detailed Task Rating	___ Detailed Rating Completed
110.	Ask them to take a minute to stretch. If the participant asks to use the bathroom please make a note of it.	
111.	Did the participant get out of the car?	(***YES*** / ***NO***)
112.	Set up radio Turn Radio on; set on **AM preset-4**. (AM 1030) Change to FM2, set on **FM2 preset-4**.(FM 92.9) Change to FM1, set on **FM1 preset-4**. (FM 104.1) Turn radio off.	
113.	Has the radio been properly set-up?	(***YES*** / ***NO***)

Section 5 - Leaving Rest Stop

Participant Code _____ **Protocol Configuration** _____

98. **Five cams**	If recording press STOP on the DAQ		
99.	**Start logging in** facelab	(***YES*** / ***NO***)	
100.	**Ensure that configuration file name = 2012b _RadioM_Nav_x,** or **2012b _RadioV_Song_x,** (double check on protocol)		
101.	**Press Start test on the DAQ**		
102.	**Ensure that we are recording all xyz channels.**		
103.	Pull out of the rear exit of the Burger King lot, after confirming that the left turn is protected by the light. Pull into the left lane and take a left at the light. Go under the bridge and at the next set of lights, take a left to get onto 495 North		
104.	Once participant merges onto I-495 North, press **F1** **2012b _RadioM_Nav_x** Or **2012b _RadioV_Song_x**		

(start recording 2012b_enter_495.wav)

We are going to be driving on 495 for approximately 30 minutes. You can continue driving in this lane or move into another lane so that you are comfortable with the traffic flow. During portions of the drive you will be asked to perform some additional tasks while you are driving.

(end recording 2012b_enter_495.wav).

105.	ADJUST ALL VIDEO SHUTTER SPEEDS IF NEEDED TO IMPROVE IMAGE BRIGHTNESS	
106.	**Move to next protocol** (3 minute habituation to 495 North)	

NOTES:

If participant cannot complete evaluations before reaching I93 when returning on 495

- Exit 41a, take right off exit, turn around in Dunkin Donuts on left, Not Ideal
- Exit 42a, take a right off the exit, drive for a ¼ mile, take a left at light for Andover Mall, this is the preferable turnaround point.
- 42b, take right off exit, take next right into Stadium Plaza, Not Ideal
- 43, take left at stop sign coming off exit, cross under bridge and get back on 495 South, Not Ideal.

Section 6 Return to MIT

Participant Code _____ **Protocol Configuration** _____

Phase 6-1. Return Prep

107.	Just before exit 28	
108.	Press STOP on the DAQ	
109.	Select the configuration file to **6-1 2012b_End_Drive.set**	
110.	Ensure that configuration file name = **6-1 2012b_End_Drive.set**	(***YES*** / ***NO***)
111.	Press Start test on the DAQ	
112.	Ensure that we are recording all 90 channels.	
113.	Entering the participant number **2012b_xyz_end** (where xyz is the participant number)	
114.	Press **STOP** and **START** FaceLab logging to split files	
115.	Tell participant to take **Exit 26**, which will lead to **Storrow Drive** exit on the left when participant pass onto the on-ramp or begins to wait in traffic **press F1**	
116.	Take the RT-3 N ramp on the left to **Kendall Sq. / Gov't Center**	
117.	Keep right at the fork, follow signs for **Cambridge / Memorial Drive**	
118.	Turn right at **Cambridge St / RT-3 N (Longfellow Bridge)**	
119.	Turn right onto the **RT-3 N ramp at end of**	

	bridge	
120.	Turn right onto **Memorial Drive**	
121.	Turn right onto **Wadsworth Street**	
122.	Turn left onto **Amherst Street**	
123.	Turn right onto **Hayward Street**	
124.	Record time.	Time _____
125.	Turn right into parking lot and park in AgeLab parking spot	
126.	Stop logging Face lab and DAQ	

Phase 6-2. Post drive

You can turn the car off. I have a short questionnaire for you to complete before we are finished.

NOTE TO RA: WHEN PRESENTING PARTICIPANT WITH WORKLOAD RATING QUESTIONNAIRE ASK THEM TO REREAD THE INSTRUCTIONS, wait until they have read them, and then ask them if they have any questions.
Specifically point out which sections they should be rating at this time.

127.	Once the participant has the car is park, tell them that there is a short rating scale that you need to have them fill-out and then they can take a break. Read them the workload instructions above and then hand them the clipboard with the workload rating sheet.	
128.	Workload Rating	___ Workload Rating Completed
129.	Check and note the mic volume. It needs to be set to 95%	Mic _____ %

"I am going to help you get out of the car and we are going back inside for a few minutes so we can take the sensors off, complete a final set of questionnaires, and pay you the compensation for your assistance today."

130.	Disconnect physiology sensors from car	
131.	Make sure participant takes all belongings from the car	

(Note: car can remain un plugged for 20 – 30 minutes between participants. Please remember to plug it in at some point)

Phase 6-3. In 290 or Other

NOTE: Participant can be passed off to another staff member as needed at this point to move-on to next participant or to close down vehicle for the day.

132.	Remove sensors from participant. Coil neatly and secure with Velcro ties. Return sensors to appropriate box.	
133.	Hand participant the **Post-Experimental Questionnaire** and **Supplemental Health Questionnaire**.	
134.	**Post-Experimental Questionnaire** was completed by participant.	(YES / NO)
135.	**Supplemental Health Questionnaire** was completed by participant.	(YES / NO)

Here is the $90 that you earned for coming in today. This includes the $80 base compensation as well as the $10 incentive.

If you know anyone who may be interested in participating in one of our experiments please encourage them to register as a volunteer. I have cards with all of the information. Would you like a few?

(Hand participant as many cards as they want)

Thank you for coming in.

(Participant leaves.)

Phase 6-4. Data Clean-Up to be Completed after Participant Leaves

136.	Get the rest of the participant's documents from the bin in 288.	
137.	Make sure you have all documents listed above and that they have participant ID on each of them.	
138.	Clean up car and prepare for next participant	
139.	Eye Data: Convert files into text by going to the Logging tab and selecting convert to text. There should be 4 folders, open each one and select all the files and press open. When you are done converting all five folders. Exit out of Facelab. (note this may be batched at the end of the day)	
140.	In each experimental segment verify that the audio and video data were collected Go to the shortcut on the desktop labelled 'Shortcut to Trip Reports' Open all data files for 2012b_xyz….. where xyz is the participant number Audio: Play the last audio file in each data folder and click through it until you hear the participant or computer speaking. If you don't hear anything, turn up the volume on the receiver. The sound should be coming through the car speakers. Video: To check the video open the 'Video' folder and click on the 'view' icon (white box with blue) and click on thumbnails. Verify that there are the same number of files for both cameras. As long as pictures appear in the thumbnails its fine. Error logs: Make sure there are no error files in directory FileShuffler Log: Record the file shuffle log onto the network (if you have any files that do not appear correct tell Alea)	
141.	RA 2, fills out two Data Set Summary Sheet for the driving portion of the experiment.	

142.	Data good for Segment A (Radio Manual)?	(***YES*** / ***NO***)
143.	Data good for Segment B (Nav)?	(***YES*** / ***NO***)
144.	Data good for Segment C (Radio Voice)?	(***YES*** / ***NO***)
145.	Data good for Segment D (Song)?	(***YES*** / ***NO***)
146.	Data good for Segment E (Phone)?	(***YES*** / ***NO***)
147.	Data good for Segment X_1 (N-back set 1)?	(***YES*** / ***NO***)
148.	Data good for Segment X_2 (N-back set 1)?	(***YES*** / ***NO***)
149.	Copy data to Studies Folder	

To access the studies folder type win\username.

Transferring Data: Copy data to agelab-fs\Studies\2012b_HMI_OnRoad(Voice)\Participant_Data\2012b_xyz where xyz stands for the participant number. Within 2012b_xyz create folder "training" for all training and non-driving assessment data. All experimental driving data should remain in the main participant folder.

DAQ data is located on the F drive and eye data at D:\faceLAB Log Files

150.	All data copied to the studies folder:	(***YES*** / ***NO***)
151.	Get the rest of the participant's documents from the bin in 288.	
152.	Make sure you have all documents listed below and that they have participant ID on each of them.	
153.	Enter all information into log (\\agelab-nas\studies\2012b_HMI_OnRoad_(Voice)	

Review documents and order according to the following chart:

Consent Form
Payment Form
Driver's License
Emergency Contact Form
Workload Rating Sheet
Pre-Experimental Questionnaire
Post-Experimental Questionnaire
Supplemental Health
Data Set Summary 1 (Intake)
Data Set Summary 2 (OnRoad)

154.	RA1 gather all documentation scan and upload. Shred Emergency contact.	
155.	Hand xxxx forms Consent, Payment, and Copy of Driver's License should be on top.	

Phase 6-5. Notes on Training and Evaluation Issues

Use the space below for notes taken during the drive concerning any issues a participant had learning a task or attempting to do a task during the evaluation period. These notes are intended to support development of insight concerning any issues people have in learning the technology or attempting to operate under actual driving conditions.

2012b_HMI_OnRoad - Voice Based In-Vehicle Systems Study

Experimental Checklist

Section A_t1 Radio Manual Training - MIT parking lot

Participant Code _____ Protocol Configuration _____

Phase A_t1-1. Setup

156.	If recording press **STOP** on the DAQ	
157.	Select the configuration file: **Train1_M_Nav_First**	
158.	Ensure that configuration file name = **Train1_M_Nav_First**	(***YES*** / ***NO***)
159.	Press Start test on the DAQ	
160.	Ensure that we are recording all 90 channels.	
161.	Entering the participant number: **2012b_xyz_Train1_M_Nav_First** (where xyz is the participant number)	
162.	Press **F1** to begin	

2012b_HMI_OnRoad - Voice Based In-Vehicle Systems Study

Experimental Checklist

Section A_t2 Radio Manual Training -495 Training

Participant Code _____ Protocol Configuration _____

Phase A_t2-1. Setup

1.	If recording press **STOP** on the DAQ	
2.	Select the configuration file: **Train2_V_Song_First.set**	
3.	Ensure that configuration file name = **Train2_V_Song_First.set**	(***YES*** / ***NO***)
4.	Press Start test on the DAQ	
5.	Ensure that we are recording all 90 channels.	
6.	Entering the participant number: **2012b_xyz_ Train2_V_Song_First2**(where xyz is the participant number)	
7.	Press **F10** to begin	

2012b_HMI_OnRoad - Voice Based In-Vehicle Systems Study

Experimental Checklist

Section A_e Radio Manual Evaluation

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

8.	**If this is the first or first evaluation or first evaluation after the Rest**, verify that the selected configuration file is: **2012b_RadioM_Nav_x.set (where x is the n-back config)**	
9.	Press **F2** to begin	
10.	Ensure facelab is logging	(***YES*** / ***NO***)

(wait 2 minutes 30 seconds)

RadioM$_0$

(start recording 2012b_rtask_0) – 44 seconds

A task period is about to start. The tasks will involve operating the radio using the manual controls. You will be asked to do a number of tasks that you have already practiced. These include turning the radio on and off, changing stations using the preset buttons, switching between the AM and FM frequency bands, and manually locating a station using the tuning knob. There will be 10 to 60 second pauses between tasks. Do not begin a task until you hear the word 'begin'. When you have successfully completed a task, please immediately say the word 'done'. (Pause 3 seconds.) Your first task is to turn the radio **on** by pressing the volume knob. (Pause 2 seconds) Begin.

(end recording 2012b_rtask_0)

Radio On - [Vol] (FM 104.1)

11.	When participant has says **DONE Press F3**.	

(wait 1 minute)

RadioM$_1$

(Start recording 2012b_rtask_1) – 5 seconds

*Your task is to change the radio to **preset 1**. (Pause 2 seconds.) BEGIN*

(end recording 2012b_rtask_1)

[Preset-1] (go to 92.9)

12.	When participant has says **DONE Press F4**.	
13.	Did you need to prompt the participant?	(*YES / NO*)
14.	Did they select the correct preset?	(*YES / NO / don't know*)

(wait 1 minute)

RadioM$_2$

(Start recording 2012b_rtask_2) – 5 seconds

*Your task is to change the radio to **preset 5**. (Pause 2 seconds.) BEGIN*

(end recording 2012b_rtask_2)

[Preset-5] (go to 106.7)

15.	When participant has says **DONE Press F5**.	
16.	Did you need to prompt the participant?	(*YES / NO*)
17.	Did they select the correct preset?	(*YES / NO / don't know*)

(wait 10 seconds)

RadioM3
(Start recording 2012b_rtask_3) – 7 seconds
*Please press the **Radio button**, change to **AM** and then turn the radio **off**. (Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_3)

[Radio] → [AM] → [vol] (radio off)

18.	If radio not set on AM before being turned off – prompt to turn radio back on, select AM and turn off.	____ Radio set in AM mode and off
19.	**Press F6**.	

(wait 1 minute)

on-FM2-100.7

RadioM4
(Start recording 2012b_rtask_4) – 9 seconds
*Your task is to turn **on** the radio, switch to **FM2**, and tune to **100.7**. (Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_4)

[Vol] → [RADIO] → [FM2] → (92.9 – 100.7)

20.	When participant has says **DONE Press F7**.	
21.	Did you need to prompt the participant?	(*YES* / *NO*)
22.	Did they tune to the correct station?	(*YES* / *NO* / *don't know*)

(wait 10 seconds)

RadioM5
(Start recording 2012b_rtask_5) – 4 seconds
*Your task is to turn **off** the radio.(Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_5)

[Vol] radio off

23.	When participant has says **DONE Press F8**.	

(wait 1 minute)

RadioM6

(Start recording 2012b_rtask_6) – 9 Seconds

*Your task is to **turn on** the radio, switch to **FM1**, and tune to **95.3**. (Pause 2 seconds.) BEGIN*

(end recording 2012b_rtask_6)

[Vol] → [RADIO] → [FM1] → (100.7 – 95.3)

24.	When participant has says **DONE Press F9**.	
25.	Did you need to prompt the participant?	(*YES / NO*)
26.	Did they tune to the correct station?	(YES / NO / don't know)

(wait 10 seconds)

RadioM7

(Start recording 2012b_rtask_5) – 4 seconds

*Your task is to turn **off** the radio.(Pause 2 seconds.)BEGIN.*

(end recording 2012b_rtask_5)

[Vol] (radio off)

27.	When participant has says **DONE Press F10**.	

(Start recording 2012b_end_task)

The task is complete. Please continue driving.

(end recording 2012b_end_task)

28.	Move to next protocol (30 sec separation).	

Section B_t Navigation Training

Participant Code _____ Protocol Configuration _____

Phase B_t-1. Setup

Note: interior cameras and one exterior at 15fps

29.	Continued from **Train1_M_Nav_First.set or** **Train2_V_Song First.set**	
30.	Confirm that the file card with practice addresses is in the card holder: 223 Broadway, Cambridge, Massachusetts 155 Charles Street, Boston, Massachusetts	
31.	Press **F6** or **F15**to begin	

Section B_e - Navigation Evaluation

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

32.	**If this is the first or first evaluation or first evaluation after the Rest**, verify that the selected configuration file is: **2012b_RadioM_Nav_x.set (where x is the n-back config)**	
33.	Press **F13** to begin	
34.	Ensure facelab is logging	(***YES*** / ***NO***)

(wait 2 minutes 30 seconds)

(start recording 2012b_navtask_0) (28 sec + 2 for noise in media player = 30 sec)

A task period is about to start. The tasks will involve operating the navigation system using the voice interface. You will be asked to do two kinds of tasks that you have already practiced. These consist of using the command, 'destination street address' to begin an address entry and then later cancelling the route. There will be pauses of approximately one minute between tasks. Do not begin a task until you hear the word 'begin'. There will be a one minute pause before the first task is presented."

(end recording 2012b_navtask_0)

(wait 1 minute from end of briefing songtask_0)

Nav Entry1

(start recording 2012b_navtask_1) – 10 seconds
Your task is to enter the destination address: ***177 Massachusetts Avenue, Cambridge, Massachusetts****.*
(Pause 2 seconds)
Begin.
(end recording 2012b_navtask_1)

[voice] → "Destination Street Address" →"Cambridge" →. "yes" → "Massachusetts Avenue" → "One Seven Seven" → "yes" → "__" → "yes"

[voice] → "Set as Destination" → "yes"

If the participant is unsure how to proceed, you can, if necessary, prompt them to press the push-to-talk button and to say '**destination street address'**. For any other help, just say 'you can look at the screen for other prompts' and they should be left on their own to try to complete the tasks.

If during tasks participant:

(a) verbally indicates that have stopped (wait 20 sec),
(b) appears to have given up but not verbally acknowledged (wait 1min),
(c) appears overly frustrated, having difficulty but not making progress etc. (allow 1 min of difficulty),
(d) is making continual mistakes that imped completion (allow maximum of 2.5 min)

(wait 1 minute)

35.	When participant has completed the task or given up **Press F14**.	
36.	Did you need to prompt the participant?	(*YES* / *NO*)
37.	Did they complete the address entry correctly?	(*YES* / *NO*)

Nav Cancel 1

(Start recording 2012b_navtask_2) – 7 Seconds

*Your task is to cancel the route using the command '**Navigation Cancel Route**'.*

(Pause 2 seconds.)

BEGIN

(end recording 2012b_navtask_2)

[voice] → "Navigation Cancel Route" →"yes"

38.	When participant has completed the task or given up **Press F15**.	
39.	Did you need to prompt the participant?	(*YES* / *NO*)
40.	Were they able to cancel the route without significant intervention?	(*YES* / *NO*)

(wait 1 minute)

Nav Entry2

(Start recording 2012b_navtask_3) – 9 Seconds

*Your task is to enter the destination address: **293 Beacon Street, Boston, Massachusetts**.*

(Pause 2 seconds.)

BEGIN

(end recording 2012b_navtask_3)

[voice] → "Destination Street Address" →"Boston" →. "yes" → "Beacon Street" → "Two Nine Three" → "yes" → "__" → "yes"

[voice] → "Set as Destination" → "yes"

41.	When participant has completed the task or given up **Press F16**.	
42.	Did you need to prompt the participant?	(*YES* / *NO*)
43.	Did they complete the address entry correctly?	(YES / NO)

(wait 1 minute)

Nav Cancel 2

(Start recording 2012b_navtask_2) – 7 Seconds
*Your task is to cancel the route using the command '**Navigation Cancel Route**'.*
(Pause 2 seconds.)
BEGIN
(end recording 2012b_navtask_2)

[voice] → "Navigation Cancel Route" →"yes"

44.	When participant has completed the task or given up **Press F17**	
45.	Did you need to prompt the participant?	(*YES* / *NO*)
46.	Were they able to cancel the route without significant intervention?	(YES / NO)

(Start recording 2012b_end_task)
The task is complete. Please continue driving.
(end recording 2012b_end_task)

47.	Move to next protocol (30 sec separation).	

Section C_t1 Radio Voice Training - MIT parking lot

Participant Code _____ Protocol Configuration _____

48.	If recording press **STOP** on the DAQ	
49.	Select the configuration file: **Train2_V_Song_first.set**	
50.	Ensure that configuration file name = **Train2_V_Song_first.set**	(***YES*** / ***NO***)
51.	Press Start test on the DAQ	
52.	Ensure that we are recording all 90 channels.	
53.	Entering the participant number: **2012b_xyz Train2_V_Song_first 1**(where xyz is the participant number)	
54.	Press **F1** to begin	

Introduction & Setting Volume

*(start recording **2012b_C_t1_intro1**)*
We will ask you to do a number of tasks today using the radio. The radio in this vehicle can be controlled both by traditional push button and knob style controls and through a voice command system. During the first part of the drive, we will ask you to work with the voice interface.

The radio stations that we will use today were selected for their spacing on the radio dial and not for specific content. If some of the music that happens to play is not particularly to your musical preference, please just to along with it for the relatively short duration that each station is played.

As a general rule, please do not start a task until you hear the word, 'begin'. Waiting for 'begin' lets you know that you been have given all of the instructions for the task.

Before going into the details of the voice control option, we will use the manual interface to set a comfortable volume. The radio can be turned on and off by pressing on the large knob on the left side of the radio labelled "V-O-L" for volume. When I say 'begin', please turn the radio on by pressing the volume control, adjust the volume to a comfortable level, and then turn the radio off by again pressing the volume knob. Begin.
(end recording)

[In addition to setting an initial volume level, part of the goal here is to make sure the participant understands how to manually turn the radio on and off as this will be requested at various points in the protocol.]

> Let them adjust the volume to a level so that it is loud enough to hear so that they (and you) know that the radio station is on, but lower than one would typically use to actually listen to the radio so that it will not mask recorded commands. If the participant has the radio too loud it will also be difficult to hear the audio later when scoring the task. Have the participant adjust the volume down as need to achieve these goals.

(VOL) (Radio should come-up on **FM 100.7**.)

55.	Prompt participant as needed to use **VOL** to **turn-on** radio, **adjust volume** to an appropriate level, and **turn off** by pressing VOL.	
56.	Remind about waiting for '**begin**' if needed.	
57.	Press **F2**	

(Radio OFF)

Introducing Voice Activation of Radio

(start recording 2012b_C_t1_intro2)
Let's move to using the voice interface to turn the radio on. This is done by pressing the push-to-talk button on the steering wheel that has the image of a person speaking. The system will then ask you to say a command.

Let's practice by pressing the push-to-talk button and then saying 'radio on' when the system asks for a command. Begin.
(end recording)

[voice] → "Radio On"

58.	Prompt and assist participant as needed until they can turn on radio using voice commands. If participant needs more practice, have them manually turn the radio off by pressing the VOL button and then prompt them to turn the radio on using the 'Radio On' command.	
59.	Remind about waiting for '**begin**' if needed.	
60.	Prompt participant to **adjust volume** if it appears to be too high or low for training purposes.	
61.	Participant is able to turn radio on using voice commands	(***YES*** / ***NO***)
62.	Press **F3**	

(Radio ON)

*(The radio is being left **ON** since it will be playing when they are asked to select a preset during the evaluation. We need to evaluate if trying to listen to the following instructions during training while the radio is playing is a problem with older participants or others who may have hearing issues is a problem.)*

Introduction to Presets (Radio is ON)

(Audio same as t2 for rest.)

*(start recording **2012b_C_t2_2**)*
One of the tasks you will be asked to do is to change radio stations by requesting a preset station. If the radio is already on, as it is now, to request preset-2, you would press the push-to-talk button, wait for the command prompt, and then say 'preset-2'.
Please try this by pressing the push-to-talk button, wait for the system to respond, and then say 'preset-2'. Begin.
(end recording)

[voice] → "Preset-2" → "yes"
[voice] → "Radio" → "Preset-2" → "yes" (Radio command needed if radio off; optional otherwise)

63.	Provide guidance as needed.	
64.	Remind about waiting for '**begin**' if needed.	
65.	If the participant appears to totally understand the task, offer them the option to skip the **next practice**..	
66.	Press **F4** to advance to next practice.	Skipped next practice: yes / no

(Radio is playing as it will be during evaluation period.)

Presets prompted Practice

(start recording 2012b_C_t2_3)
Let's practice with the way you will be given instructions during the drive.
Your task is to change the radio to preset-5.(Pause 2 seconds.) BEGIN
(end recording)

[voice] → "Preset-5"
[voice] → "Radio" → "Preset-5" → "yes" (Radio command needed if radio off; optional otherwise)

67.	Provide any additional guidance needed until they demonstrate that they understand how to use the presets. **You can ask them to try a different pre-set for addition practice if this is indicated.**	
68.	Remind about waiting for '**begin**' if needed.	
69.	Participant demonstrated the ability to correctly select a preset.	(YES / NO)
70.	Have participant **turn off radio** by pressing the VOL button.	___ Radio off
71.	Press **F5**	

(Radio OFF)

Voice Tuning (Radio is OFF)

*(start recording **2012b_C_t2_5**)*
The next task is to tune the radio to a particular station. For example, let's say you want to tune to FM station 92.9. If the radio is off, as it is now, you would press the push-to-talk button, wait for the command prompt, say 'radio', wait for the prompt, and then say '92.9'. You do not have to say AM or FM when requesting a radio station.
Let's practice. Your task is to turn the radio on using the push-to-talk button and request FM 92.9. Begin.
(end recording)

[voice] → "Radio" → "92.9" → "yes"
[voice] → "Radio" → "FM 92.9" → "yes"

72.	Prompt as needed to get them to **92.9**. If the system does not understand 'ninety two', suggest that they try 'nine two point nine'. It is ok if they choose to say AM and FM but you can also point out that it is not needed if they are confused.	
73.	Make sure that they wait for '**begin**'.	
74.	Have participant **turn off radio** by pressing the VOL button.	___ Radio off
75.	Press **F6** to begin	

(Radio OFF)

Second Practice

(start recording 2012b_C_t2_6)
Your task is to turn the radio on using the push-to-talk button and request FM 104.1 Begin.
(end recording)

[voice] → "Radio" → "104.1" → "yes"
[voice] → "Radio" → "FM 104.1" → "yes"

76.	Repeat as needed by having the participant practice again going to the same station, **FM 104.1**	
77.	Make sure that they wait for '**begin**'.	
78.	Participant demonstrated the ability to correctly use voice commands to tune radio to a specific station. **If no**, please make brief notes on the training notes sheet to give a best estimate of the nature of their difficulty	(***YES*** / ***NO***)

79.	Confirm that the radio is left in the correct settings by verbally instructing the participant to select in order the following bands and then pressing preset-4: **FM1** > pre-set-4 (104.1) **FM2** > pre-set-4 (92.9) **AM** > pre-set-4 (1030) Steps above completed.	
80.	Instruct participant to **turn off the radio** by pressing the VOL button.	___ Radio off

Section C_t2 Radio Voice Training – 495 Stop

Participant Code _____ Protocol Configuration _____

81.	If recording press **STOP** on the DAQ	
82.	Select the configuration file: **Train1_M_Nav_First.set**	
83.	Ensure that configuration file name = **Train1_M_Nav_First.set**	(***YES*** / ***NO***)
84.	Press Start test on the DAQ	
85.	Ensure that we are recording all xyz channels.	
86.	Entering the participant number:**2012b_xyz _M_Nav_First 2**(where xyz is the participant number)	
87.	Press **F10** to begin	

Introducing Voice Activation of Radio

*(start recording **2012b_C_t2_intro1**)*
During the second part of the drive, instead of using the manual radio controls, we will ask you to use the voice command system to control the radio. Let's start by using the voice interface to turn the radio on. This is done by pressing the push-to-talk button on the steering wheel. The system will then ask you to say a command. Let's practice by pressing the push-to-talk button and then saying 'radio on'. Begin.
(end recording)

[voice] → "Radio On"

88.	Prompt and assist participant as needed until they can turn on radio using voice commands. If participant needs more practice, have them manually turn the radio off by pressing the VOL button and then prompt them to turn the radio on using the 'Radio On' command.	
89.	Remind about waiting for '**begin**' if needed.	
90.	Note – advise participant not to say '**done**' if needed.	
91.	Prompt participant to **adjust volume** if it appears to be too high or low for training purposes.	
92.	Participant is able to turn radio on using voice commands	(***YES*** / ***NO***)
93.	Press **F11**	

(Radio ON)

*(The radio is being left **ON** since it will be playing when they are asked to select a preset during the evaluation. We need to evaluate if trying to listen to the following instructions during training while the radio is playing is a problem with older participants or others who may have hearing issues is a problem.)*

Introduction to Presets (Radio is ON)

*(start recording **2012b_C_t2_2**)*
One of the tasks you will be asked to do is to change radio stations by requesting a preset station. If the radio is already on, as it is now, to request preset-2, you would press the push-to-talk button, wait for the command prompt, and then say 'preset-2'.
Please try this by pressing the push-to-talk button, wait for the system to respond, and then say 'preset-2'. Begin.
(end recording)

[voice] → "Preset-2" → "yes"
[voice] → "Radio" → "Preset-2" → "yes" (Radio command needed if radio off; optional otherwise)

94.	Provide guidance as needed.	
95.	If error occurs because participant pauses too long between "preset" and "2", explain about saying as if one word.	
96.	Remind about waiting for '**begin**' if needed.	
97.	If the participant appears to totally understand the task, offer them the option to skip the **next practice**.	
98.	Press **F12** to advance to next practice.	Skipped next practice: yes / no

(Radio is playing as it will be during evaluation period.)

Presets prompted Practice

(start recording 2012b_C_t2_3)
Let's practice with the way you will be given instructions during the drive.
Your task is to change the radio to preset-5.(Pause 2 seconds.) BEGIN
(end recording)

[voice] → "Preset-5"
[voice] → "Radio" → "Preset-5" → "yes" (Radio command needed if radio off; optional otherwise)

99.	Provide any additional guidance needed until they demonstrate that they understand how to use the presets. **You can ask them to try a different pre-set for addition practice if this is indicated.**	
100.	Remind about waiting for '**begin**' if needed.	
101.	Participant demonstrated the ability to correctly select a preset.	(YES / NO)
102.	Have participant **turn off radio** by pressing the VOL button.	___ Radio off
103.	Press **F13**	

(Radio OFF)

Voice Tuning (Radio is OFF)

*(start recording **2012b_C_t2_5**)*
The next task is to tune the radio to a particular station. For example, let's say you want to tune to FM station 92.9. If the radio is off, as it is now, you would press the push-to-talk button, wait for the command prompt, say 'radio', wait for the prompt, and then say '92.9'. You do not have to say AM or FM when requesting a radio station.
Let's practice. Your task is to turn the radio on using the push-to-talk button and request FM 92.9. Begin.
(end recording)

[voice] → "Radio" → "92.9" → "yes"
[voice] → "Radio" → "FM 92.9" → "yes"

104.	Prompt as needed to get them to **92.9**. If the system does not understand 'ninety two', suggest that they try 'nine two point nine'. It is ok if they choose to say AM and FM but you can also point out that it is not needed if they are confused.	
105.	Make sure that they wait for '**begin**'.	
106.	Have participant **turn off radio** by pressing the VOL button.	___ Radio off
107.	Press **F14** to advance to next practice.	

(Radio OFF)

Second Practice

(start recording 2012b_C_t2_6)
Your task is to turn the radio on using the push-to-talk button and request FM 104.1 Begin.
(end recording)

[voice] → "Radio" → "104.1" → "yes"
[voice] → "Radio" → "FM 104.1" → "yes"

108.	Repeat as needed by having the participant practice again going to the same station, **FM 104.1**.	
109.	Make sure that they wait for '**begin**'.	
110.	Participant demonstrated the ability to correctly use voice commands to tune radio to a specific station. **If no**, please make brief notes on the training notes sheet to give a best estimate of the nature of their difficulty.	(***YES*** / ***NO***)
111.	Confirm that the radio is left in the correct settings by verbally instructing the participant to select in order the following bands and then pressing preset-4: **FM1** > pre-set-4 (104.1) **FM2** > pre-set-4 (92.9) **AM** > pre-set-4 (1030) Steps above completed.	
112.	Instruct participant to **turn off the radio** by pressing the VOL button.	___ Radio off

Section C_e Radio Voice Evaluation

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

113.	**If this is the first or first evaluation or first evaluation after the Rest**, verify that the selected configuration file is: **2012b_RadioV_Song_x.set (where x is the n-back config)**	
114.	**Press F2** to begin	
115.	Ensure facelab is logging	(***YES*** / ***NO***)

(wait 2 minutes 30 seconds)

RadioV0

(start recording 2012b_rtask_10) – 45seconds
A task period is about to start. The tasks will involve operating the radio using the voice interface. You will be asked to do a number of tasks that you have already practiced. These include turning the radio on, changing stations using the preset commands, switching between the AM and FM frequency bands, and requesting specific stations by frequency number. To turn the radio off, press the volume knob; for all other interactions, use the voice interface. There will be 10 to 60 second pauses between tasks. Do not begin a task until you hear the word 'begin'."(Pause 3 seconds.)Your first task is to turn the radio on by pressing the ***push-to-talk*** *button on the steering wheel and saying "****radio-on****". (Pause 2 seconds) Begin.*
(end recording 2012b_rtask_10)

[voice] → "Radio On" (FM 104.1)

116.	When **DONE Press F3**.	

(wait 1 minute)

RadioV1

(Start recording 2012b_rtask_1) – 5 seconds
Your task is to change the radio to ***preset 1****. (Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_1)

[voice] → "Preset-1" → "yes" (go to 92.9)
[voice] → "Radio" → "Preset-1" → "yes"

117.	When DONE **Press F4**.	
118.	Did you need to prompt the participant?	(YES / NO)
119.	Did they select the correct preset?	(YES / NO / don't know)

(wait 1 minute)

RadioV2

(Start recording 2012b_rtask_2) – 5 seconds
*Your task is to change the radio to **preset 5**. (Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_2)

[voice] → "Preset-5" → "yes" (go to 106.7)
[voice] →"Radio" →"Preset-5" → "yes"

120.	When DONE **Press F5**.	
121.	Did you need to prompt the participant?	(YES / NO)
122.	Did they select the correct preset?	(YES / NO / don't know)

(wait 10 seconds)

RadioV3

(Start recording 2012b_rtask_11) – 8 seconds
*Please press the **push-to-talk button**, say **Radio-AM** and then turn the **radio off**.*
(Pause 2 seconds.)
BEGIN
(end recording 2012b_rtask_11)

[voice] → "Radio AM" → [vol] (off – AM 1030)

123.	If radio not set on AM before being turned off – prompt to turn radio back on, select AM and turn off.	_____ Radio set in AM mode and off
124.	When DONE **Press F6**.	

(wait 1 minute)

RadioV4

(Start recording 2012b_rtask_12) – 10 seconds
*Your task is to turn the radio on using the **push-to-talk button** and requesting **FM 100.7.** (Pause 2 seconds.) BEGIN*
(end recording 2012b_rtask_12)

[voice] → "Radio" → "100.7" → "yes"
[voice] → "Radio" → "FM 100.7" → "yes"

125.	When DONE **Press F7**.	
126.	Did you need to prompt the participant?	(*YES* / *NO*)
127.	Did they tune to the correct station?	(YES / NO / don't know)

(wait 10 seconds)

RadioV5

(Start recording 2012b_rtask_5) – 4 seconds
*Your task is to turn **off** the radio. (Pause 2 seconds.) BEGIN.*
(end recording 2012b_rtask_5)

[vol] (off)

128.	When DONE **Press F8**.	

(wait 1 minute)

RadioV6

(Start recording 2012b_rtask_13) – 9 seconds
*Your task is to turn the radio on using the **push-to-talk button** and requesting **FM 95.3**. (Pause 2 seconds.) BEGIN.*
(end recording 2012b_rtask_13)

[voice] → "Radio" → "95.3" → "yes"
[voice] → "Radio" → "FM 95.3" → "yes"

129.	When DONE **Press F9**.	
130.	Did you need to prompt the participant?	(*YES* / *NO*)
131.	Did they tune to the correct station?	(YES / NO / don't know)

(wait 10 seconds)

RadioV7

(Start recording 2012b_rtask_5) – 4 seconds
*Your task is to turn **off** the radio. (Pause 2 seconds.) BEGIN.*
(end recording 2012b_rtask_5)
(loops back if participant taking too long)

[vol] (off)

132.	When DONE **Press F10**.	

(Start recording 2012b_end_task)
The task is complete. Please continue driving.
(end recording 2012b_end_task)

133.	Move to next protocol (30 sec separation).	

Section D_t Song Selection Training

Participant Code _____ Protocol Configuration _____

Note: interior cameras and one exterior at 15fps

134.	Continued from **Train1_M_Nav_first.set** or **Train2_V_Song_first.set**	
135.	Ensure that DAQ is running	(***YES*** / ***NO***)
136.	Press **F16** or **F7** to begin	

*(start recording **2012b_D_t_1**)*
We are now going to introduce you to the operation of a feature that allows you to use the voice interface to play music that has been stored on a portable music device. A USB memory stick with a set of recorded music files has already been connected to the vehicle. All that you will be asked to do is to request specified music selections using the voice interface.
To access this feature, you first press the push-to-talk button on the steering wheel. When this button is pressed, the system will say 'please say a command'. You then say 'USB'. The system will then resume playing a previous music request. Please try this now by pressing the push-to-talk button and then saying 'USB'. Begin.
(end recording)

Remind participant of the location of the [voice] button on the steering wheel if needed, and then prompt as needed through the steps below. It is ok to exit interface and start over as needed.

[voice] → "USB" → "yes"

137.	Prompt as needed through steps above to play a song. Repeat as needed.	
138.	Press **F17 or F8** when USB mode is entered correctly and music has played for a moment.	

*(start recording **2012b_D_t_1b**)*
To request a new music selection, you would press the push-to-talk button, and again say 'USB'. At this point, you can request a specific artist or album. For example, to request music by Elton John, you could say 'play artist Elton John'. If you wanted to listen to a specific album, you could say 'play album' followed by the name of the album.
Let's try a music request. Start by pressing the push-to-talk button, then say 'USB', and at the next command prompt, say 'play artist Elton John'. Please try this now. Begin.
(end recording)

[voice] → "USB" → "yes" → "Play Artist Elton John" → "yes"

139.	Prompt as needed through steps above to play a song. Repeat as needed.	
140.	If the participant appears to totally understand the task, offer them the option to skip the **next practice**.	
141.	Press **F18 or F9** to advance to next practice.	Skipped next practice: yes / no

*(start recording **2012b_D_t_2**)*
Let's practice with another artist request with instructions the way they will be presented during the drive. Remember, the sequence is 'USB', then "play artist' and the name of the artist or "play album" and the name of the album. Do not begin the task until you hear the word 'begin'. (2 seconds) Your task is to play music by Bob Dylan.. (2 seconds) Begin.
(end recording)

[voice] → "USB" → "yes" → "Play Artist Bob Dylan" → "yes"

142.	Answer questions and repeat as needed to confirm participant understands task.	
143.	Participant demonstrated the ability to correctly use v commands to select a song. **If no**, please make brief notes on the training notes sheet to give a best estimate of the nature of their difficulty.	(***YES*** / ***NO***)

Section D_e – Song Selection Evaluation

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

144.	**If this is the first or first evaluation or first evaluation after the Rest**, verify that the selected configuration file is: **2012b_RadioV_Song_x.set (where x is the n-back configuration)**	
145.	Press **F13** to begin	
146.	Ensure facelab is logging	(***YES*** / ***NO***)

(wait 2 minutes 30 seconds)
(start recording 2012b_songtask_0) (33 sec + 2 for noise in media player = 35 sec)
A task period is about to start. The primary tasks will involve requesting music stored on a USB device using the voice interface. As you practiced, this is done by pressing the push-to-talk button, saying 'USB', then, to request music by a specific artist, say 'play artist' and the artist name. There will be a one minute pause between tasks. If you have difficulty getting any of the music selections to play, you can stop at any point and wait for the next selection task. Do not begin a task until you hear the word 'begin'.

Before the first selection task, I would like you to activate the USB interface by pressing the push-to-talk button, say 'USB', and allow the current selection to play. There will be a one minute pause before the first music selection task is presented. Begin.
(end recording 2012b_songtask_0)

The USB interface needs to be turned on and allow existing music selection to play until the first song selection task is presented so that two evaluation tasks are comparable and because USB command defaults to playing a track before user can specify a selection.

[voice] → "USB" → "yes"

147.	Prompt participant as needed to turn-on the USB interface.	
148.	USB interface selected and music track is playing.	(*YES* / *NO*)

(wait 1 minute from end of briefing sontask_0)

Song Select 1

(start recording 2012b_songtask_1) – 5 seconds
*Your task is to play music by **The Rolling Stones**. (Pause 2 seconds) Begin.*
(end recording 2012b_songtask_1)

If the participant is unsure how to proceed, you can, if necessary, prompt them to press the push-to-talk button and to say 'USB'. For any other help, just say 'you can look at the screen for other prompts' and they should be left on their own to try to complete the tasks.

[voice] → "USB" → "Play Artist The Rolling Stones"

149.	When participant has completed the task or given up **Press F14**.	
150.	Did you need to prompt the participant?	(YES / NO)
151.	Were they able to play the correct artist?	(YES / NO)

(wait 1 minute)

Song Select 2

(Start recording 2012b_songtask_2) – 5 seconds
*Your task is to play music by **Johnny Cash**. (Pause 2 seconds.) BEGIN*
(end recording 2012b_songtask_2)

[voice] → "USB" → "Play Artist Johnny Cash"

152.	When participant has completed the task or given up **Press F15**.	
153.	Did you need to prompt the participant?	(YES / NO)
154.	Were they able to play the correct artist?	(YES / NO)

(wait 1 minute)

Song Select 3

(Start recording 2012b_songtask_3) – 6 Seconds

*Your task is to play '**Let It Be**' by '**The Beatles**' (Pause 2 seconds.) BEGIN*

(end recording 2012b_songtask_3)

(NOTE: This step is to deliberately simulate a condition where the system does not appear to understand a request. The introductory message gives the participant permission to discontinue a task if they experience difficulty. We are looking in part at how long participants will persist if they system does not appear to understand them.)

[voice] → "USB" → "???"

155.	If participant asks for help, etc., tell them to "Please just try whatever you think might work."	

(wait 1 minute plus 10 seconds for instruction audio)

(Start recording 2012b_songtask_4)

The song task is complete. Please press the volume button now to turn off the music system. (Pause 2 seconds) The last task deliberately requested a song that did not exist on the storage device to simulate a condition where the voice system did not appear to recognize your request. This is the only time that this will be done intentionally during the study. Please continue driving

(end recording 2012b_songtask_4)

156.	Move to next protocol (30 sec separation).	

Section E_t Phone Task Training

Participant Code _____ Protocol Configuration _____

Note: interior cameras and one exterior at 15fps

157.	Continued From Train1_M_Nav_First.set, or Train2_V_Song_First.st	
158.	Verify that the car has synched with the phone. (There will be a small bluetooth icon on the top of the touch screen interface)	
159.	Press **F19** to begin	

*(start recording **2012b_E_t_1**)*
We are now going to introduce you to a feature that allows you use the voice interface to place a phone call to a number stored in a contact list. We will be using contacts that have already been created. After you place a call, it will be routed to a voice-mailbox. A message will be played. Follow the instructions.
The volume control you use to adjust the radio volume may also be used to adjust the volume of the phone interface.
To place a call, first press the push-to-talk button. The system will say 'please say a command'. You then say 'phone'.
At the next prompt, you say, "call" followed by the contact name. For example, to call contact 1, you say "call contact 1".
Let's practice by placing a call to contact 1. Remember, start by pressing the push-to-talk button, then say 'phone, and then say 'call contact 1'. Please try this now. Begin.
(end recording)

Remind participant of the location of the [voice] button on the steering wheel if needed, and then prompt as needed through the steps below. It is ok to exit interface and start over as needed.

[voice] → "phone" → "yes" → "call contact 1" → "yes" →[End] (touch screen)

PLAYED OVER PHONE INTERFACE:
*(recording **2012b_E_t_1A**)*
When this message is done playing, you will hear a beep. Please then say out loud your first name to leave as a message. After saying your first name, please end this call by pressing the END button that appears above the image of a phone on the touch screen.
(end)

[End] (touch screen)

160.	Prompt as needed through steps above to place a call. Explain how to interact with the voice mailbox if they are confused in anyway.	
161.	**VOLUME** – if the volume seems low and/or the participant seems to have difficulty hearting, remind them that they may adjust the volume.	
162.	Press **F20** to advance to next practice.	

*(start recording **2012b_E_t_2**)*
Let's practice calling another contact number. Remember, to place a call, the sequence is 'phone', then "call contact" followed by the contact name. Do not begin the task until you hear the word 'begin'.
(2 seconds)
Your task is to place a call to contact 2. (2 seconds) Begin.
(end recording)

[voice] → "phone" → "yes" → "call contact 2" → "yes" →::listen to entire audio::

PLAYED OVER PHONE INTERFACE:
*(recording **2012b_E_t_2A**)*
You have reached contact 2.

During the actual task, a short story will be read to you at this point. Your task will be to listen carefully and to try to remember the story just the way it is read to you. When the story is finished, leave a message by telling the story back out loud and include all that you can remember. What you say will be recorded so that it can be scored later. Then end this call by pressing the END button on the touch screen.
(end)

[End] (touch screen)

163.	Answer questions and repeat as needed to confirm participant understands task.	
164.	**VOLUME** – if the volume seems low and/or the participant seems to have difficulty hearting, remind them that they may adjust the volume.	
165.	Participant demonstrated the ability to correctly use voice commands to place and end a call. **If no**, please make brief notes on the training notes sheet to give a best estimate of the nature of their difficulty.	(***YES*** / ***NO***)

Section E_e Phone Task Evaluation

Participant Code _____ Protocol Configuration _____

NOTE: There are two versions of this protocol. Version A has the participant make the second phone call to "contact-4" and version B makes the phone call to "contact-5" where "contact-5" is the degraded audio quality version of the second story:

Phone Task II-A	**(Continued from Manual-Radio-Nav)**
	63000 contact-4
Phone Task II-B	**(Continued From Verbal-Radio-Song)**
	66000 contact-5

Note: this protocol assumes continuous recording on the DAQ and facelab systems (data recording should begin after entering the highway at the RT495 rest stop)

Assuming that the tasks have been completed on 495N prior to reaching RT 93 steps 1 – 2 should be used. Insert details on other potential exits on 495 north of RT 93 here.

114.	Heading north on 495 - just **after Exit 39** give the driver the following instructions:	

"You are approaching Exit 40A for Route 93 south. Please prepare to take this exit"

If the driver does not move into the right lane prompt again.

115.	As you **approach Exit 40A** give the driver the following instructions:	

"Remember; please take Exit 40A for Route 93 South."

If the driver does not appear to be taking the exit prompt again.

116.	Once past **Exit 42 on I93** south Press **F18** (note this allows 3 min of habituation to RT 93 before task baseline starts)	

(wait 33 seconds + 2 for noise in media player = 35 seconds)
(start recording 2012b_phonetask_0)
A task period is about to start. The tasks involve using the voice system to place a call to stored contact number and listening to recorded information. You may use the volume control to adjust the phone volume as needed. As you practiced, the sequence to place a call is 'phone', then 'call contact' followed by the contact name. When you are done leaving the message, end the call by pressing the END button on the touch screen.

There will be a one minute pause before the first phone call task is presented.
(end recording 2012b_phonetask_0)
(where XX is 60 plus length of 2012b_phonetask_0)

Phase E-1. Phone Task Part I

(start recording 2012b_phonetask_1) – 5 Seconds
Please place a phone call now to contact-3. Begin.
(end recording 2012b_phonetask_1)

117.	If the participant is unable to make the call, **prompt as needed** so that they are able to connect with the recording.	

118.	Press **F19** when system begins to dial.	

(start recording phonetask_rec1.wav) *- 14 Seconds*
You do not have to remember any of the content of this recording. All we are interested in for this task is assessing how much effort is involved in placing a phone call. When this recording is finished, please leave a message like you did in practice by just saying your first name.
(end recording phonetask_rec1.wav).

119.	Participant was able to place call on their own without prompting.	(YES / NO)
120.	Do <u>NOT</u> prompt them to leave their name if they forget. Allow up to about 30 seconds of silence then, if needed, prompt them to end the call by pressing the **END** button.	

Phase E-2. Phone Task Part II:

Note: If running Version B skip to section Phone Task II_B

Phone Task II-A

(Continued from Manual-Radio-Nav) (617) 564-1549

121.	Press **F20** to advance to story	

(wait 1 minute)

*(start recording 2012b_phonetask_**2A**) - 23 seconds*
The next recorded message will be a short story. Listen carefully and try to remember it just the way it is read, in as close to the same words as you can remember. When the recording finishes, leave a message telling back everything that you heard. You should tell all that you can remember, even if you are not sure. What you say will be recorded and scored later.
*Please place a phone call now to **contact-4.***
Begin.
(end recording 2012b_phonetask_2A)

122.	If the participant is unable to make the call, **prompt as needed** so that they are able to connect with the recording. Prompt participant to turn volume up to ensure they do not miss the beginning of the story.	
123.	Press F21when system begins to dial	

Contact 4

(start recording 2012b_**story_A.**wav) **(original version**) – *24 Seconds*
"Anna Thompson of South Boston, employed as a cook in a school cafeteria, reported at the police station that she had been held up on State Street the night before and robbed of fifty-six dollars. She had four small children, the rent was due, and they had not eaten for two days. The police, touched by the woman's story, took-up a collection for her."
(end recording story_part2A.wav)

Move to Step 11

Phase E-3. Phone Task II-B

(Continued from Verbal-Radio-Song) (617) 863-0834

8.	Press **F20** to advance to story	

(wait 1 minute)

*(start recording 2012b_phonetask_**2B**) – 22 Seconds*
The next recorded message will be a short story. Listen carefully and try to remember it just the way it is read, in as close to the same words as you can remember. When the recording finishes, leave a message telling back everything that you heard. You should tell all that you can remember, even if you are not sure. What you say will be recorded and scored later.
*Please place a phone call now to **contact-5**.*
Begin.
(end recording 2012b_phonetask_2B)

9.	If the participant is unable to make the call, **prompt as needed** so that they are able to connect with the recording. Prompt participant to turn volume up to ensure they do not miss the beginning of the story.	
10.	Press F21when system begins to dial	

Contact 5

(start recording 2012b_**story_B.**wav) – *24 Seconds*
(DISTORTED version)
(end recording story_part2B.wav)

Move to Step 11

11.	Participant was able to place call on their own without prompting.	(YES / NO)
12.	**Leave message** - If the participant does not say anything, is hesitant or seems to freeze up after about **10 seconds**, verbally prompt once *"**Please go ahead and say all you can remember.**"*	
13.	Participant was able to begin leaving a message on their own without prompting.	(YES / NO)
14.	When the participant is finished responding or doesn't respond to the second prompt within 30 seconds – prompt them to end the call by pressing the **END** button if they do not do so themselves.	
15.	Press **F22** to advance to story recall	

Phase E-4. Phone Task Part III:

(wait 1 minute)
*(start recording 2012b_phonetask_**3**) – 19 Seconds*
For your final task, please take some time to review silently in your mind the story about the woman. Try to remember if there were any details that you forgot to mention when you left the phone message. Think back carefully over all the details in the recording, but do not say anything out loud right now.
Begin.
(end recording 2012b_phonetask_3)

(wait 1 minute)
(Start recording 2012b_end_task)
The task is complete. Please continue driving.
(end recording 2012b_end_task)

16.	Record next exit number.	Exit _____
17.	Did the participant engage in the entire task (Please answer no and provide details if they appeared to stop responding for part of all of the task)	(YES / NO)
18.	Move to checklist section 6 (Returning to MIT)	

Section X_1 – N-back Evaluation Manual Radio / Nav

Set number _____

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

166.	**Press F12** to begin	
167.	Ensure facelab is logging	(***YES*** / ***NO***)

168.	As each task plays record the n-back level and all participant responses.	

Intro recordings

intro0.wav: We are now going to complete a series of scored trials of the zero-back task. Remember that in this task, you are to repeat out loud the number that you just heard. Try to be as accurate as you can be.

intro1.wav: We are now going to complete a series of scored trials of the one-back task. Remember that in this task, you are to repeat out loud
the number before the number that you just heard. Try to be as accurate as you can be.

intro2.wav: We are now going to complete a series of scored trials of the two-back task. Remember that in this task, you are to repeat out loud the number that you heard two numbers ago. Try to be as accurate as you can be.

NOTE CROSS OUT UN-USED STIMULUS SET DURING PROTOCOL SETUP
If protocol A, B, C

(wait 2minutes 30 seconds)

___- back task

(wait 1 minute after task)

___- back task

(wait 1 minute after task)

____- back task

169.	Score the 0-back	_____ /10
170.	Score the 1-back	_____ /9
171.	Score the 2-back	_____ /8

172.	Move to next protocol (2 minute recovery and 30 sec separation).	

Section X_2 – N-back Evaluation Voice Radio / Song

Set number _____

Participant Code _____ Protocol Configuration _____

Note: all five cameras are used

173.	**Press F12** to begin	
174.	Ensure facelab is logging	(***YES*** / ***NO***)

175.	As each task plays record the n-back level and all participant responses.	

Intro recordings

intro0.wav: We are now going to complete a series of scored trials of the zero-back task. Remember that in this task, you are to repeat out loud the number that you just heard. Try to be as accurate as you can be.

intro1.wav: We are now going to complete a series of scored trials of the one-back task. Remember that in this task, you are to repeat out loud
the number before the number that you just heard. Try to be as accurate as you can be.

intro2.wav: We are now going to complete a series of scored trials of the two-back task. Remember that in this task, you are to repeat out loud the number that you heard two numbers ago. Try to be as accurate as you can be.

NOTE CROSS OUT UN-USED STIMULUS SET DURING PROTOCOL SETUP
If protocol D, E, F

(wait 2minutes 30 seconds)

___- back task

(wait 1 minute after task)

___- back task

(wait 1 minute after task)

____- back task

176.	Score the 0-back	_____ /10
177.	Score the 1-back	_____ /9
178.	Score the 2-back	_____ /8

179.	Move to next protocol (2 minute recovery and 30 sec separation).	

Appendix I: Self-Reported Workload Materials

Asking someone to rate how relatively easy or difficult a task is, how much concentration it requires, etc. represents an apparently straightforward method of assessing workload. Self-report based measures are particularly attractive since simple scale questions can easy be written and administered. Several established workload scales, such as the NASA Task Load Index (TLX), have been used extensively in published research, particularly in the astronautic and aerospace fields, and provide an aura of measurement precision. Subjective measures and scales are also quite commonly used in transportation related research and, as noted by Brookhus and De Waard (2002, p. 1026). "It is hard to imagine research in the field without subjective measurement." However, while obtaining subjective feedback and ratings can be a very useful and important part of the overall design assessment process (i.e. determining if individuals like or dislike an interface, find it confusing, etc.), it is important to recognize potential limitations related to when and how they are administered, and the extent to which training and experience is needed to effectively use certain self-report measures.

Based upon our experiences with older participants, we believe that there may be limitations in the use of workload scales developed for use by highly trained astronautic and aeronautical specialists (pilots & engineers) for purposes of assessing automotive interfaces as they are used by the general population. It should be recognized that devices such as the NASA TLX and the Bedford workload scales (Hart & Staveland, 1988; Roscoe, 1992) were developed for experienced pilots and related specialists to rate tasks and interfaces that would be used by other similarly trained specialists. The manner in which such specialists approach and interact with an HMI cannot be assumed *a priori* to be a good model of how non-specialists will experience the same HMI. Similarly, providing a "normal" driver with extensive training on how to use such scales is likely to influence the way they begin to think about and evaluate an HMI, which may result in these individuals no longer being an accurate representation of a "normal" driver. In light of this, we have generally relied on more simple and direct questions asking participants to rate how relatively difficult or easy a task was, to rate how stressed they felt during the task, etc. Therefore, our efforts have focused on the use of a more simplistic, Likert style global workload scale. To enhance the sensitivity of the scale over traditional 4, 5, 7, 10 or 11 demarcation points, participates were provided with 21 points rating points referenced against a more common 0 to 10 rating nomenclature as illustrated below. In addition, all self-reported workload ratings were collected on a single sheet of paper allowing the participant to easily "benchmark" a ratings for a specific interaction relative to earlier ratings.

Instructions

The following instructions on how to fill out the workload rating scales were given to participants to read by a research associate. Participants were given an opportunity to ask any questions that they had. The page following this one reproduces the paper and pencil rating form that was given to participants at the mid-point rest period to rate the tasks completed during Part I of the drive, and again at the completion of the experiment to rate the remaining tasks. The form was given on a larger, legal size sheet (11x17 inches) and clipboard; it is reduced in size here. The standard sizing supports a 10cm long visual scale using the numbers 0 to 10 but with the option to circle midpoint values corresponding to a potential 21 scalar values.

How to Fill-Out the Workload Rating Scales

One of the goals of this study is to understand how much effort is involved doing different tasks while driving. At the mid-point rest stop and at the end of the drive, we will ask you to fill out a short form to rate how much workload was associated with each type of task using a 0 to 10 scale where 0 = very low workload and 10 = very high workload.

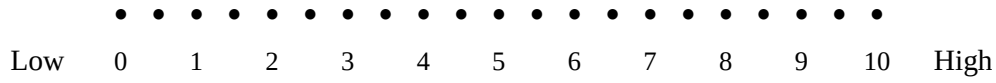
By workload, we mean the demand or effort that was associated with trying to do a task while continuing to drive safely. Workload is experienced in different ways by different people. Workload could mean the amount of mental effort that was involved in the task, the amount of attention that was required, how physically difficult it was to complete, how much time pressure was involved, or how frustrating the task was. You can decide for yourself how to define workload as it relates to doing these tasks while also continuing to drive safely.

The instructions shown below will appear on the form:

Please circle a point along each scale that best corresponds to how much **workload** you felt was involved in trying to do each task. Workload is best defined by the person doing the task and may involve *mental effort*, the amount of *attention required*, *physical effort*, *time pressure*, *distraction* or *frustration* associated with trying to do the task while continuing to drive safely.

Example of Format that will be used to rate the workload associated with a task:

Task XXX



Please let the research associate know if you have any questions about how to fill-out this form.

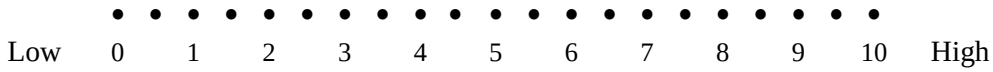
Thank you.

Example Rating Sheet

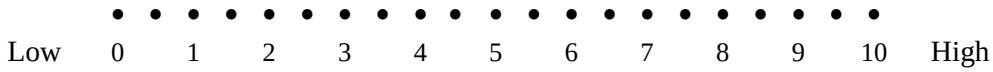
Workload Rating – 2012b

Please circle a point along each scale that best corresponds to how much **workload** you felt was involved in trying to do each task. Workload is best defined by the person doing the task and may involve *mental effort*, the amount of *attention required*, *physical effort*, *time pressure*, *distraction* or *frustration* associated with trying to do the task while continuing to drive safely.

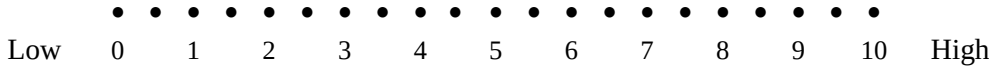
Radio - **Manual** (button) Interface to Select a Preset Station



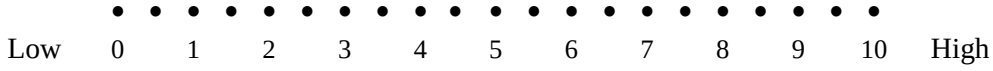
Radio - Manual Interface to Change from AM to FM and tune to a Specific Station



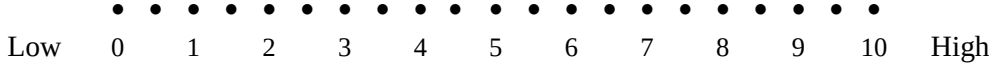
Radio - **Verbal** Interface to Select a Preset Station



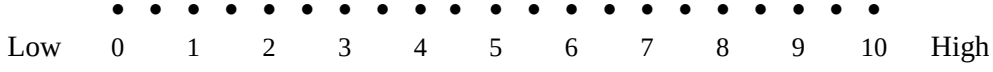
Radio - Verbal Interface to Change from AM to FM and tune to a Specific Station



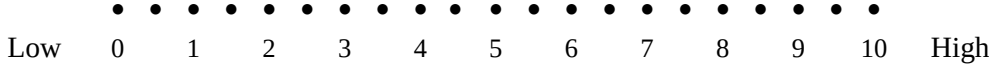
Search Stored Music for a Specific Artist (first 2 tasks)



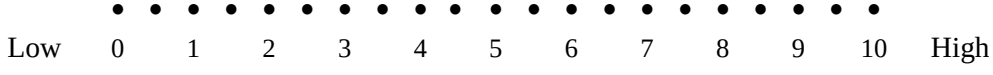
Final Stored Music Search for music by 'The Beatles'



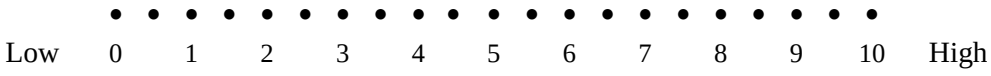
0-Back Number Task



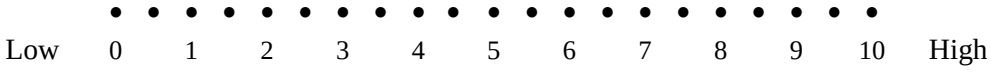
1-Back Number Task



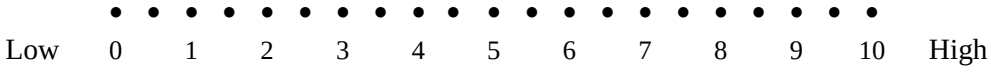
2-Back Number Task



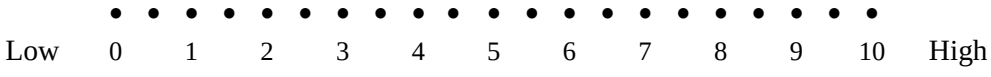
Navigation System - Entering a Destination Street Address



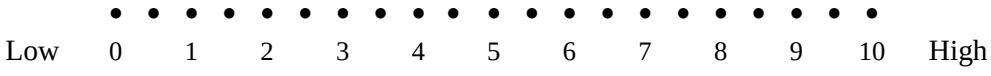
Navigation System – Canceling a Route Request



Voice Phone Dialing using a Stored Number



Listening to a story that you have to remember over the phone interface



Note: *This form was presented on a single 11x17" legal size sheet of paper attached to a legal size clipboard so that all scales were presented to the participant on the same page.*

Appendix J: Questionnaires

Participant Code #_____
Date and Time _____

Pre-Experiment Questionnaire

Please fill in the blanks or circle the one best response unless otherwise noted. If more space is needed, please note the question number and continue on the back of each sheet. Remember, filling out this questionnaire is voluntary. Skipping any question that makes you feel uncomfortable will not exclude you from the study.

1. What is your date of birth? _____ (month / year)

2. Are you: Male Female

3. Thinking about how you feel today, how would you describe your current **physical** well-being?

    a. Excellent
    b. Good
    c. Mean
    d. Fair
    e. Poor

4. Thinking about how you feel today, how would you describe your current **mental** well-being?

    a. Excellent
    b. Good
    c. Mean
    d. Fair
    e. Poor

5. Do you feel sick right now?

    a. Yes (If yes, please inform the research assistant.)
    b. No

6. Has anything happened in your life or have any events occurred recently that might influence how you are feeling, your comfort in taking part in the experiment or your ability to drive today?

    a. Yes (If yes, please describe briefly below.)
    b. No

    _____
    _____
    _____

7. Do you normally wear corrective lenses when driving?

a. No
b. Yes - glasses
c. Yes - contacts

8. Compared with others your age, how would you rate your overall vision? (If you wear glasses or contacts, rate your corrected vision when you are wearing them.)

    a. Excellent
    b. Good
    c. Mean
    d. Fair
    e. Poor

9. Compared with others your age, how would you rate your overall hearing?

    a. Excellent
    b. Good
    c. Mean
    d. Fair
    e. Poor

10. Do you wear a hearing aid?

    a. Yes
    b. No

Please continue on to the next page.

Technology

11. On a scale of 1 to 10, with 1 being very inexperienced and 10 being very experienced, how would you rate your level of experience with technology (e.g. cell phones, automatic teller machines, digital cameras, computers, etc.)?

1	2	3	4	5	6	7	8	9	10
Very Inexperienced									Very Experienced

12. Some people prefer to avoid new technologies as long as possible while others like to try them out as soon as they become available. In general, how would you rate yourself as being an avoider or an early adopter of new technology?

1	2	3	4	5	6	7	8	9	10
Avoid as long as possible									Try as soon as possible

13. How would you rate your overall level of trust in technology?

1	2	3	4	5	6	7	8	9	10
Very Distrustful									Very Trustful

14. How would you rate your level of trust in **established** car technologies (e.g. anti-lock brakes, automatic transmissions, air bags, etc.)?

1	2	3	4	5	6	7	8	9	10
Very Distrustful									Very Trustful

15. How would you rate your level of trust in **new** technologies that are being introduced into cars?

1	2	3	4	5	6	7	8	9	10
Very Distrustful									Very Trustful

16. How would you rate your ability to learn how to operate new technologies?

1	2	3	4	5	6	7	8	9	10
Very Poor									Very Good

17. On mean, how often do you use an electronic navigation system in a car or truck (using a built-in navigation system, portable navigation unit or a smart phone)?

    a. More than once a day
    b. About once a day
    c. A few times a week
    d. A few times a month
    e. A few times a year
    f. Never

18. How often do you use a voice command interface in any environment (on a smart phone, in your car, or some other voice enabled system such as speech to text translation software)?

    a. More than once a day
    b. About once a day
    c. A few times a week
    d. A few times a month
    e. A few times a year
    f. Never

19. How often do you use a car or truck based voice command interface system?

    a. More than once a day
    b. About once a day
    c. A few times a week
    d. A few times a month
    e. A few times a year
    f. Never

20. How often do you use a touch screen interface in any environment (on a computer, smart phone, an iPad, tablet computer, e-book, etc.)?

    a. More than once a day
    b. About once a day
    c. A few times a week
    d. A few times a month
    e. A few times a year
    f. Never

Please continue on to the next page.

21. How often do you make a phone call while driving a car?

a. More than once a day
b. About once a day
c. A few times a week
d. A few times a month
e. A few times a year
f. Never

22. How often do you make a phone call using a voice dialing system while driving a car?

a. More than once a day
b. About once a day
c. A few times a week
d. A few times a month
e. A few times a year
f. Never

23. How often do you answer a phone call while driving a car?

a. More than once a day
b. About once a day
c. A few times a week
d. A few times a month
e. A few times a year
f. Never

Driving History

24. Do you currently have a valid state issued driver's license?

    a. Yes
    b. No (Please inform the research assistant)

25. How often do you drive a car or other motor vehicle?

    a. Almost every day
    b. A few days a week
    c. A few days a month
    d. A few times a year
    e. Never

26. Over the last year, how many miles did you drive?

    a. Under 1000
    b. Between 1,001 and 5,000
    c. Between 5,001 and 10,000
    d. Between 10,001 and 15,000
    e. Between 15,001 and 20,000
    f. Over 20,001
    g. None (Please inform the research assistant)
    h. I don't know

27. On a scale of 1 to 10 with 1 being very unsafe and 10 being very safe, how safe a driver do you think you are?

1	2	3	4	5	6	7	8	9	10
Very Unsafe									Very Safe

28. In the past five years, how many times have you been stopped by a police officer and received a **warning** (but no citation or ticket) for a moving violation (i.e. speeding, running a red light, running a stop sign, failing to yield, reckless driving, etc.)?

    Enter a number: _____? (Enter 0 for none.)

29. In the past five years, how many times have you been stopped by a police officer and received a **citation or ticket** for a moving violation?

    Enter a number: _____? (Enter 0 for none.)

30. In the past five years, how many times have you been in a **vehicle crash** where you were the driver of one of the vehicles involved?

    Enter a number: _____? (Enter 0 for none.)

Driving Behavior

31. Nobody is perfect. Even the best drivers make mistakes, do foolish things, or bend the rules at some time or another. For each item below you are asked to indicate HOW OFTEN, if at all, this kind of thing has happened to you. Base your judgments on what you remember of your driving over, say, the last month. Please indicate your judgments by circling ONE of the numbers next to each item. Remember we do not expect exact answers, merely your best guess; so please do not spend too much time on any one item.

How often do you do each of the following (for example, in the past month)?		Never	Hardly ever	Occasionally	Quite often	Frequently	Nearly all the time
a	Try to pass another car that is signaling a left turn.	0	1	2	3	4	5
b	Select the wrong turn lane when approaching an intersection.	0	1	2	3	4	5
c	Fail to 'Stop' or 'Yield' at a sign, almost hitting a car that has the right of way.	0	1	2	3	4	5
d	Misread signs and miss your exit.	0	1	2	3	4	5
e	Fail to notice pedestrians crossing when turning onto a side street.	0	1	2	3	4	5
f	Drive very close to a car in front of you as a signal that they should go faster or get out of the way.	0	1	2	3	4	5
g	Forget where you parked your car in a parking lot.	0	1	2	3	4	5
h	When preparing to turn from a side road onto a main road, you pay too much attention to the traffic on the main road so that you nearly hit the car in front of you.	0	1	2	3	4	5
i	When you back up, you hit something that you did not observe before but was there.	0	1	2	3	4	5
j	Pass through an intersection even though you know that the traffic light has turned yellow and may go red.	0	1	2	3	4	5

k	When making a turn, you almost hit a cyclist or pedestrian who has come up on your right side.	0	1	2	3	4	5
		Never	Hardly ever	Occasionally	Quite often	Frequently	Nearly all the time
l	Ignore speed limits late at night or very early in the morning.	0	1	2	3	4	5
m	Forget that your lights are on high beam until another driver flashes his headlights at you.	0	1	2	3	4	5
n	Fail to check your rear-view mirror before pulling out and changing lanes.	0	1	2	3	4	5
o	Have a strong dislike of a particular type of driver, and indicate your dislike by any means that you can.	0	1	2	3	4	5
p	Become impatient with a slow driver in the left lane and pass on the right.	0	1	2	3	4	5
q	Underestimate the speed of an oncoming vehicle when passing.	0	1	2	3	4	5
r	Switch on one thing, for example, the headlights, when you meant to switch on something else, for example, the windshield wipers.	0	1	2	3	4	5
s	Brake too quickly on a slippery road, or turn your steering wheel in the wrong direction while skidding.	0	1	2	3	4	5
t	You intend to drive to destination A, but you 'wake up' to find yourself on the road to destination B, perhaps because B is your more usual destination.	0	1	2	3	4	5
u	Drive even though you realize that your blood alcohol may be over the legal limit.	0	1	2	3	4	5
v	Get involved in spontaneous, or spur-of-the moment, races with other drivers.	0	1	2	3	4	5

w	Realize that you cannot clearly remember the road you were just driving on.	0	1	2	3	4	5
x	You get angry at the behavior of another driver and you chase that driver so that you can give him/her a piece of your mind.	0	1	2	3	4	5

Demographics

The following are standard questions that allow researchers to determine how representative the group of participants in a study is of the general population. Remember, filling out this questionnaire is voluntary. Skipping any question that makes you feel uncomfortable will not exclude you from the study.

32. Please describe the highest level of formal education you have completed:

a. Some high school
b. High school graduate
c. Some college
d. College graduate
e. Some graduate education
f. Completed graduate or professional degree (e.g. Masters, LCSW, JD, Ph.D., MD, etc.)

33. Are you: (Please circle all that apply.)

a. A full time student
b. A part time student
c. Unemployed
d. Retired
e. Employed full time
f. Employed part time
g. A full time caregiver (e.g. children or elder)
h. A part time caregiver (e.g. children or elder)

34. Are you:

a. Married
b. Divorced
c. Widowed
d. Single living with partner
e. Single never married

35. What best describes your total household income?

c. Less than $25,000
d. $25,000 – $49,999
e. $50,000 – $74,999
f. $75,000 – $99,999
g. $100,000 – $124,999
h. $125,000 – $149,999
i. $150,000 or more
j. I don't know

Current State

36. On a scale of 1 to 10 with one being very awake and 10 being extremely drowsy, how do you feel right now?

1	2	3	4	5	6	7	8	9	10
Very Awake									Extremely Drowsy

37. On a scale of 1 to 10 where one is not at all stressed and 10 is very stressed how would you rate your stress level right now?

1	2	3	4	5	6	7	8	9	10
Not at all Stressed									Very Stressed

Participant Code #_____
Date and Time _____

Supplemental Health Questionnaire

Please fill in blanks or circle the one best response unless otherwise noted. If more space is needed please note the question number and continue on the back of each sheet. Remember, filling out this questionnaire is voluntary. Skipping any question that makes you feel uncomfortable will not exclude you from the study.

1. Compared with others your age, how would you rate your overall health?

    a. Excellent
    b. Good
    c. Mean
    d. Fair
    e. Poor

2. Approximately how many times have you seen a medical doctor in the past 12 months? _____

Please continue on to the next page.

3. Please check if you have been diagnosed (told by a doctor) that you have had, or currently have, any of the following medical conditions:

a. _____ heart attack
b. _____ angina
c. _____ irregular heart rhythm
d. _____ high blood pressure
e. _____ high cholesterol
f. _____ diabetes
g. _____ thyroid condition
h. _____ stroke or TIA
i. _____ arthritis, rheumatism
j. _____ fibromyalgia
k. _____ chronic pain
l. _____ Parkinson's disease
m. _____ gastrointestinal problems, GRD
n. _____ spinal surgery
o. _____ blood clot in leg or lung
p. _____ hip fracture
q. _____ hip or knee replacement

4. Do you currently have any medical conditions not listed above?

If yes, please list below. If no, please check here _____ and skip to the next question.

a. _____
b. _____
c. _____
d. _____

5. To the best of your knowledge, are you currently taking any medications for the treatment of high blood pressure, a heart condition, or other cardiovascular condition? If yes, please list the medication or medications below:

_____

_____

6. To the best of your knowledge, are you currently taking any medications associated with the treatment of diabetes? If yes, please list the medication or medications below:

_____

_____

7. Please list any other medications, herbs, or vitamins that you currently take:

_____

_____

_____

8. To what extent are you limited in the degree to which you can easily turn your head, neck or shoulders due to stiffness, pain, arthritis, general aging or any other condition?

1	2	3	4	5	6	7	8	9	10
Not at all Limited									Very Limited

9. When you are driving, to what extent does stiffness, pain, arthritis, general aging or any other condition affect how easy it is for you turn around and look behind you, look up to the rearview mirror, or check the side mirrors ?

1	2	3	4	5	6	7	8	9	10
Not at all Affected									Very Affected

For the next two questions on chronic or frequent pain, please consider any chronic or frequent pain you have experienced during the past 12 months.

10. Please check all areas in which you experience chronic or frequent pain:

a. _____ face / jaw / head
b. _____ neck
c. _____ shoulders / upper back
d. _____ low back
e. _____ seat / buttock / hip region
f. _____ legs
g. _____ feet / toes
h. _____ chest
i. _____ abdominal or stomach region
j. _____ arms
k. _____ hands / fingers

11. To the best of your knowledge, what is the source of your pain? Check all that apply.
    a. _____ Does Not Apply (do not experience chronic or frequent pain)
    b. _____ general stiffness and discomfort
    c. _____ chronic headaches
    d. _____ arthritis
    e. _____ muscle pain
    f. _____ nerve pain
    g. _____ fibromyalgia
    h. _____ other (list)
    _____
    i. _____ unknown

If any of the following questions do not apply to you (i.e. you are not currently experiencing any pain or did not experience any pain last week), then rate a scale at 0.

Pain Intensity

Please circle a point along the scales below to show how intense your pain is. The zero (0) end of the scale means no pain and the ten (10) end means extreme pain.

12. How intense is your pain **now**?

no pain	0	1	2	3	4	5	6	7	8	9	10	extreme pain

14. How intense was your pain **on mean last week**?

no pain	0	1	2	3	4	5	6	7	8	9	10	extreme pain

Distressing - Now use the same method to describe how distressing your pain is.

15. How distressing is your pain **now**?

not at all distressing	0	1	2	3	4	5	6	7	8	9	10	extremely distressing

16. How distressing was your pain **on mean last week**?

not at all distressing	0	1	2	3	4	5	6	7	8	9	10	extremely distressing

Daily Activities - Now use the same method to describe how much your pain interferes with your everyday activities.

17. How much does your pain interfere with your daily activities in general?

does not interfere	0	1	2	3	4	5	6	7	8	9	10	interferes completely

18. How much does your pain interfere with your ability to drive?

does not interfere	0	1	2	3	4	5	6	7	8	9	10	interferes completely

Participant Code #_____
Date and Time _____

Task Rating Questionnaire

Please fill in blanks or circle the one best response unless otherwise noted. Remember, filling out this questionnaire is voluntary. Skipping any question that makes you feel uncomfortable will not exclude you from the study.

Current State

(Mid-Point Rest Stop)

1. On a scale of 1 to 10 with 1 being very awake and 10 being extremely drowsy, how do you feel right now?

1	2	3	4	5	6	7	8	9	10
Very Awake									Extremely Drowsy

2. On a scale of 1 to 10 where 1 is not at all stressed and 10 is very stressed how would you rate your stress level right now?

1	2	3	4	5	6	7	8	9	10
Not at all Stressed									Very Stressed

IF YOU ARE FILLING THIS OUT AT THE

-------- MID-POINT REST STOP --------

Please fill-in the sections on the following pages just for the tasks you have completed so far.

You will be asked to fill-in the remaining sections at the end of the drive.

Thank you.

IF YOU ARE FILLING THIS OUT AT

-------- MIT --------

Please fill-in the remaining sections.

Thank you.

Manual Control of the Radio

1. Thinking now about using the manual interface to operate the radio, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent did you feel that the manual radio interface was intuitive or easy to learn how to use? ……..……..	1	2	3	4	5	6	7	8	9	10
b. How difficult was it to use the manual interface to operate the radio?	1	2	3	4	5	6	7	8	9	10
c. To what extent did you feel frustrated using the manual radio interface? ..…..	1	2	3	4	5	6	7	8	9	10
d. How much did using the manual radio interface distract from driving?	1	2	3	4	5	6	7	8	9	10
e. How difficult was using the manual interface compared to things you usually do while driving? ……..…..…..	1	2	3	4	5	6	7	8	9	10

Voice Control of the Radio

2. Thinking now about using the voice interface to operate the radio, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent did you feel that the voice radio interface was intuitive or easy to learn how to use? ……..……..	1	2	3	4	5	6	7	8	9	10
b. How difficult was it to use the voice interface to operate the radio?	1	2	3	4	5	6	7	8	9	10
c. To what extent did you feel frustrated using the manual radio interface? ……..	1	2	3	4	5	6	7	8	9	10
d. How much did using the voice radio interface distract from driving?	1	2	3	4	5	6	7	8	9	10
e. How difficult was using the voice interface compared to things you usually do while driving? ……..…….....	1	2	3	4	5	6	7	8	9	10

Voice Selection of Stored Music

3. (Please make the following ratings just for the first two music selection tasks – not the third music selection task.) Thinking now about using the voice interface to select stored music, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent did you feel that the music interface was intuitive or easy to learn how to use? …….....……..	1	2	3	4	5	6	7	8	9	10
b. How difficult was it to use the voice interface to select stored music?	1	2	3	4	5	6	7	8	9	10
c. To what extent did you feel frustrated using the voice music interface? ..……....	1	2	3	4	5	6	7	8	9	10
d. How much did using the voice interface to select music distract from driving?	1	2	3	4	5	6	7	8	9	10
e. How difficult was using the voice interface compared to things you usually do while driving? ……..…….....	1	2	3	4	5	6	7	8	9	10

Voice Controlled Navigation System

4. Thinking now about using the voice interface to control the navigation system, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent did you feel that the navigation interface was intuitive or easy to learn how to use? …….....……..	1	2	3	4	5	6	7	8	9	10
b. How difficult was it to use the voice interface to operate navigation system?	1	2	3	4	5	6	7	8	9	10
c. To what extent did you feel frustrated using the navigation interface? ….……...	1	2	3	4	5	6	7	8	9	10
d. How much did using the voice navigation interface distract from driving?	1	2	3	4	5	6	7	8	9	10
e. How difficult was using the voice interface compared to things you usually do while driving? ……..……..……..	1	2	3	4	5	6	7	8	9	10

[THE REMAINING ITEMS TO BE **COMPLETED AT MIT** AT THE END OF THE DRIVE.]

Voice Control of Phone Dialing

5. Thinking now about using the voice interface to place a phone call, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent did you feel that the phone interface was intuitive or easy to learn how to use? ……..……..	1	2	3	4	5	6	7	8	9	10
b. How difficult was it to use the voice interface to place a call?	1	2	3	4	5	6	7	8	9	10
c. To what extent did you feel frustrated using interface to place a call? ……..	1	2	3	4	5	6	7	8	9	10
d. How much did placing a phone call distract from driving?	1	2	3	4	5	6	7	8	9	10
e. How difficult was using the voice interface to place a call compared to things you usually do while driving? …..	1	2	3	4	5	6	7	8	9	10

Listening to Phone Message Content

6. (If you found there to be any difference in listening to the two messages, think more about the message that was more difficult to follow.) Thinking now about listening to the messages initiated by the phone calls, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. How difficult was it to listen to the messages?	1	2	3	4	5	6	7	8	9	10
b. To what extent did you feel frustrated listening to the messages?.....……..	1	2	3	4	5	6	7	8	9	10
c. How much did listening to the messages distract from driving?	1	2	3	4	5	6	7	8	9	10
d. How difficult was listening to the messages compared to things you usually do while driving? …….	1	2	3	4	5	6	7	8	9	10

Listening to Phone Message Content (continued)

7. Thinking about listening to the two different phone messages, on a scale of 1 to 10, with 1 being not at all and 10 very, please indicate on mean:

	Not at All									Very
a. To what extent was one message more difficult to hear than the other?	1	2	3	4	5	6	7	8	9	10

Participant Code #_____
Date and Time _____

Post-Experimental Questionnaire

Please fill in blanks or circle the one best response unless otherwise noted. Remember, filling out this questionnaire is voluntary. Skipping any question that makes you feel uncomfortable will not exclude you from the study.

Current State

1. On a scale of 1 to 10 with 1 being very awake and 10 being extremely drowsy, how do you feel right now?

1	2	3	4	5	6	7	8	9	10
Very Awake									Extremely Drowsy

2. On a scale of 1 to 10 where 1 is not at all stressed and 10 is very stressed how would you rate your stress level right now?

1	2	3	4	5	6	7	8	9	10
Not at all Stressed									Very Stressed

General Impressions:

3. What was your overall impression of the vehicle you drove today?

1	2	3	4	5	6	7	8	9	10
Not at All Positive									Very Positive

Considering the Voice Control Interface you worked with today:

4. As an overall rating, how easy was the voice control system to use?

1	2	3	4	5	6	7	8	9	10
Not Very Easy									Very Easy

5. How easy was it to understand the meaning of the voice prompts provided by the system?

1	2	3	4	5	6	7	8	9	10
Not Very Easy									Very Easy

6. Did the system seem to have any difficulty understanding your verbal commands?

1	2	3	4	5	6	7	8	9	10
Not at All									A Lot

7. Thinking back to how you felt earlier today when this technology was introduced, and comparing that with how you feel now after using the technology, how are you feeling about this technology now?

    a. Much less positive
    b. Somewhat less positive
    c. About the same
    d. Somewhat more positive
    e. Much more positive

8. How has your experience today with this technology influenced your level of trust in new technologies that are being introduced into cars?

    a. Much less trusting
    b. Somewhat less trusting
    c. About the same
    d. Somewhat more trusting
    e. Much more trusting

9. How well do you feel the introduction to the voice command system prepared you for working with the system?

1	2	3	4	5	6	7	8	9	10
Not Very well									Very well

10. If you had the opportunity to gain more experience with the system (by using for several weeks, etc.), how do you think this would affect your rating of the system?

    a. Would likely feel much more positive
    b. Would likely feel somewhat more positive
    c. Not likely to make any difference
    d. Would likely feel somewhat less positive
    e. Would likely feel much less positive

11. Based on your experience today, has your sense of your ability to learn new technologies increased, stayed about the same, or decreased?

1	2	3	4	5	6	7	8	9	10
Decreased									Increased

12. Do you feel that the voice control system made operating the vehicle systems:

    a. much safer
    b. somewhat safer
    c. no difference
    d. somewhat less safe
    e. much less safe

13. In addition to providing audio prompts in response to your voice commands, the system often displayed information or hints about how to work the system on the in-vehicle display screen. Did you find this additional display information helpful?

1	2	3	4	5	6	7	8	9	10
Not Helpful									Very Helpful

14. When you used the voice command interface, to what extent were you able to keep your eyes on the road or did you tend to look frequently at the additional status information on the in-vehicle display screen?

1	2	3	4	5	6	7	8	9	10
Eyes On Road									Eyes On Screen

15. When you used the voice interface, to what extent did you find yourself becoming absorbed in the interaction such that your attention was diverted from driving?

1	2	3	4	5	6	7	8	9	10
Not at All									A Lot

16. Given time to develop enough familiarity with the voice control interface, do you feel that this technology would in any way **enhance or extend** your ability to **safely** operating the car?

1	2	3	4	5	6	7	8	9	10
Not at All									A Lot

17. Given time to develop enough familiarity with the voice control interface, do you feel that this technology would in any way **detract from or reduce** your ability to **safely** operating the car?

1	2	3	4	5	6	7	8	9	10
Not at All									A Lot

18. If you purchased a vehicle with the voice control system you tried today, how satisfied would you be with the operation of this system?

1	2	3	4	5	6	7	8	9	10
Not Satisfied									Very Satisfied

19. If you had a vehicle with the voice control technology you used today, how likely is it that you would use it?

1	2	3	4	5	6	7	8	9	10
Not at All Likely									Very Likely

20. How likely is it that you would recommend to a friend or family member that they consider buying a car with the voice control technology you used today?

1	2	3	4	5	6	7	8	9	10
Not at All Likely									Very Likely

21. If the limitations of the voice control system you worked with today were solved, to what extent would you like to have a voice command interface in your next car?

1	2	3	4	5	6	7	8	9	10
Not at All									A Lot

22. What did you like **most** about the voice command interface?

_____

_____

_____

23. What did you like **least** about the voice command interface?

_____

_____

_____

24. Do you have any suggestions for the designers who created the technologies you worked with today on changes that would make the systems easier to use, understand, or otherwise improve the overall experience?

a. No
b. Yes (If yes, please explain below.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

25. Please use the space below or the back of this page to write any comments or suggestions you have regarding your experiences today:

_____

_____

_____

_____

_____

Appendix K: Questionnaire Data

The following section presents descriptive statistics for the questionnaire data collected from study participants. In the following tables, a cell reading "0.7 (0.5) [0 – 1]" would correspond to a group mean of 0.7, a standard deviation of 0.5, and a collected response range between 0 and 1. In addition, the final section includes the verbatim comments provided by each individual participant to several open-ended questions. See Appendix J for the complete text and scales presented in the questionnaires.

Pre-Experiment Questionnaire

Q.		Pre-Experiment Questionnaire			
		Young Female	Young Male	Older Female	Older Male
3	Physical well-being (0= excellent, 4= poor)	0.7 (0.5) [0 - 1]	0.5 (0.5) [0 - 1]	0.3 (0.5) [0 - 1]	0.5 (0.5) [0 - 1]
4	Mental well-being (0= excellent, 4= poor)	0.4 (0.5) [0 - 1]	0.5 (0.5) [0 - 1]	0.4 (0.6) [0 - 2]	0.3 (0.5) [0 - 1]
5	Sick right now (0= yes, 1= no)	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
6	Uncomfortable now (0= yes, 1= no)	0.9 (0.4) [0 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
7	Wear corrective lenses (0= no, 1= glasses, 2= contacts)	0.8 (1.0) [0 - 2]	0.3 (0.7) [0 - 2]	1.0 (0.8) [0 - 3]	0.3 (0.6) [0 - 2]
8	Self-rate overall vision (0= excellent, 4= poor)	0.8 (0.7) [0 - 2]	0.4 (0.5) [0 - 1]	0.9 (0.6) [0 - 2]	0.6 (0.6) [0 - 2]
9	Self-rate overall hearing (0= excellent, 4= poor)	0.7 (0.6) [0 - 2]	0.5 (0.5) [0 - 1]	0.7 (0.7) [0 - 2]	1.1 (0.6) [0 - 2]
10	Wear hearing aid (0= yes, 1= no)	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
11	Technology Experience (1= inexp., 10= experienced)	8.1 (1.2) [6 - 10]	9.1 (0.8) [8 - 10]	7.9 (1.2) [5 - 10]	7.9 (2.0) [4 - 10]
12	Adopt Technology (1= avoid, 10= try)	7.2 (1.6) [5 - 10]	8.1 (1.8) [4 - 10]	6.9 (1.4) [5 - 10]	6.9 (2.0) [3 - 9]
13	Trust Technology (1= distrust, 10= trust)	7.7 (1.6) [4 - 10]	8.3 (1.4) [5 - 10]	8.5 (0.9) [7 - 10]	8.5 (1.1) [6 - 10]
14	Trust Established Tech (1= distrust, 10= trust)	9.1 (1.1) [7 - 10]	9.3 (1.0) [7 - 10]	8.8 (0.9) [7 - 10]	9.6 (0.8) [7 - 10]

Q.		Pre-Experiment Questionnaire			
		Young Female	Young Male	Older Female	Older Male
15	Trust New Car Tech (1= distrust, 10= trust)	7.7 (1.3) [6 - 10]	8.1 (1.2) [5 - 10]	7.7 (1.0) [6 - 9]	8.1 (1.1) [6 - 10]
16	Ability Learn New Tech (1= poor, 10= good)	8.3 (1.1) [6 - 10]	8.7 (1.5) [6 - 10]	8.2 (1.1) [7 - 10]	8.8 (1.1) [7 - 10]
17	Use Electric. Navigation (0= daily, 5= never)	2.1 (1.0) [0 - 4]	2.3 (1.0) [0 - 4]	3.9 (1.1) [2 - 5]	3.7 (1.1) [2 - 5]
18	Voice Command Interface (0= daily, 5= never)	3.5 (1.7) [0 - 5]	3.3 (1.3) [0 - 5]	4.3 (1.3) [1 - 5]	4.1 (1.1) [2 - 5]
19	Car Voice Interface (0= daily, 5= never)	4.8 (0.6) [3 - 5]	4.4 (1.4) [0 - 5]	5.0 (0.0) [5 - 5]	4.7 (0.6) [3 - 5]
20	Touch Screen Use (0= daily, 5= never)	1.5 (1.8) [0 - 5]	0.7 (1.2) [0 - 4]	2.3 (2.0) [0 - 5]	2.1 (1.8) [0 - 5]
21	Phone Call Driving (0= daily, 5= never)	1.5 (1.1) [0 - 3]	2.3 (1.4) [0 - 5]	2.2 (2.0) [0 - 5]	3.3 (1.4) [0 - 5]
22	Voice Dialing Driving (0= daily, 5= never)	4.7 (1.0) [1 - 5]	4.7 (0.6) [3 - 5]	4.3 (1.5) [0 - 5]	4.7 (0.7) [3 - 5]
23	Answer Calls Driving (0= daily, 5= never)	1.6 (1.1) [0 - 3]	2.0 (1.6) [0 - 5]	2.5 (1.7) [0 - 5]	2.9 (1.1) [1 - 5]
24	Valid License	0.0 (0.0) [0 - 0]	0.0 (0.0) [0 - 0]	0.0 (0.0) [0 - 0]	0.0 (0.0) [0 - 0]
25	How Often Drive (0= daily, 4= never)	0.2 (0.4) [0 - 1]	0.6 (0.5) [0 - 1]	0.1 (0.4) [0 - 1]	0.2 (0.4) [0 - 1]
26	Miles Driven	3.0 (1.6) [1 - 7]	2.8 (2.5) [0 - 7]	3.3 (1.6) [1 - 7]	2.5 (0.9) [1 - 4]
27	Safe Driver (1=very unsafe, 10=very safe)	8.5 (1.2) [6 - 10]	8.7 (1.0) [7 - 10]	8.9 (0.8) [8 - 10]	9.1 (0.9) [7 - 10]
28	# Police Warning Past 5 yrs	0.0 (0.0) [0 - 2]	0.0 (0.0) [0 - 2]	0.3 (0.6) [0 - 2]	0.6 (0.7) [0 - 2]
29	# Citation or Ticket Past 5 Yrs	0.0 (0.0) [0 - 1]	0.0 (0.0) [0 - 5]	0.2 (0.4) [0 - 1]	0.5 (0.7) [0 - 2]
30	# Vehicle Crash Past 5 Yrs.	0.0 (0.0) [0 - 1]	0.0 (0.0) [0 - 1]	0.2 (0.4) [0 - 1]	0.3 (0.6) [0 - 2]
31-a	Pass Signaling Car (1=Never, 10= Nearly all the time)	2.7 (1.4) [0 - 5]	1.4 (1.0) [0 - 3]	1.1 (1.3) [0 - 3]	0.9 (1.4) [0 - 4]
31-b	Wrong Turn Lane (1=Never, 10= Nearly all the time)	1.6 (0.7) [0 - 3]	1.3 (0.9) [0 - 3]	1.0 (0.8) [0 - 2]	1.1 (0.7) [0 - 2]

Q.		Pre-Experiment Questionnaire			
		Young Female	Young Male	Older Female	Older Male
31-c	Fail to Stop or Yield (1=Never, 10= Nearly all the time)	0.5 (0.5) [0 - 1]	0.3 (0.5) [0 - 1]	0.3 (0.6) [0 - 2]	0.3 (0.6) [0 - 2]
31-d	Misread Signs/Exits (1=Never, 10= Nearly all the time)	1.5 (0.9) [0 - 3]	1.2 (0.6) [0 - 2]	1.1 (0.7) [0 - 2]	1.3 (0.5) [1 - 2]
31-e	Fail to notice Pedestrians (1=Never, 10= Nearly all the time)	0.9 (0.7) [0 - 2]	0.4 (0.6) [0 - 2]	0.9 (0.5) [0 - 2]	0.7 (0.8) [0 - 2]
31-f	Tailgate (1=Never, 10= Nearly all the time)	0.9 (1.1) [0 - 3]	0.7 (1.0) [0 - 3]	0.3 (0.5) [0 - 1]	0.8 (0.8) [0 - 2]
31-g	Forget Parking Spot (1=Never, 10= Nearly all the time)	1.5 (1.1) [0 - 4]	1.1 (1.0) [0 - 3]	0.9 (0.8) [0 - 2]	0.9 (0.5) [0 - 2]
31-h	Side onto Main Road Distraction (1= Never, - 10)	0.6 (0.6) [0 - 2]	0.3 (0.5) [0 - 1]	0.5 (0.5) [0 - 1]	0.9 (0.6) [0 - 2]
31-i	Back up into Something (1=Never, 10= Nearly all the time)	0.3 (0.6) [0 - 2]	0.3 (0.5) [0 - 1]	0.5 (0.6) [0 - 2]	0.7 (0.5) [0 - 1]
31-j	Go through Yellow (1=Never, 10= Nearly all the time)	2.8 (1.3) [1 - 5]	1.7 (1.2) [0 - 5]	1.8 (1.0) [1 - 5]	1.8 (0.8) [1 - 3]
31-k	Almost hit Pedestrian on right turn (1= Never, - 10)	0.7 (0.6) [0 - 2]	0.2 (0.4) [0 - 1]	0.4 (0.5) [0 - 1]	0.7 (0.6) [0 - 2]
31-l	Ignore Speed Limit Off Hours (1= Never, - 10)	2.1 (1.2) [0 - 4]	1.5 (1.5) [0 - 4]	1.0 (0.9) [0 - 2]	1.5 (1.0) [0 - 3]
31-m	Forget High Beams are on (1=Never, 10= Nearly all the time)	0.5 (0.9) [0 - 3]	0.7 (0.6) [0 - 2]	0.6 (0.5) [0 - 1]	0.7 (0.6) [0 - 2]
31-n	Fail to check rear view changing lane (1= Never, - 10)	0.8 (0.8) [0 - 2]	0.4 (0.7) [0 - 2]	0.5 (0.5) [0 - 1]	0.6 (0.6) [0 - 2]
31-o	Indicate dislike of type of driver (1= Never, - 10)	0.9 (1.1) [0 - 4]	0.4 (0.6) [0 - 2]	0.3 (0.6) [0 - 2]	0.6 (0.8) [0 - 2]
31-p	Pass on right (1=Never, 10= Nearly all the time)	2.0 (1.4) [0 - 4]	1.3 (1.0) [0 - 3]	1.5 (0.8) [0 - 3]	2.0 (1.1) [0 - 5]
31-q	Underestimate speed when passing (1= Never, - 10)	0.7 (0.7) [0 - 2]	0.4 (0.7) [0 - 2]	0.5 (0.5) [0 - 1]	0.8 (0.6) [0 - 2]
31-r	Switch on wrong thing (1=Never, 10= Nearly all the time)	0.7 (0.8) [0 - 2]	0.5 (0.6) [0 - 2]	0.6 (0.8) [0 - 2]	0.8 (0.6) [0 - 2]
31-s	Turn away from skid (1=Never, 10= Nearly all the time)	0.4 (0.5) [0 - 1]	0.3 (0.5) [0 - 1]	0.3 (0.5) [0 - 1]	0.6 (0.6) [0 - 2]
31-t	Zone out, go toward wrong destination (1= Never, - 10)	0.6 (0.6) [0 - 2]	0.5 (0.6) [0 - 2]	0.8 (0.8) [0 - 2]	0.7 (0.6) [0 - 2]

Q.		Pre-Experiment Questionnaire			
		Young Female	Young Male	Older Female	Older Male
31-u	Drive above alcohol limit (1=Never, 10= Nearly all the time)	0.3 (0.6) [0 - 2]	0.1 (0.3) [0 - 1]	0.1 (0.3) [0 - 1]	0.3 (0.5) [0 - 1]
31-v	Race other drivers (1=Never, 10= Nearly all the time)	0.0 (0.0) [0 - 0]	0.1 (0.3) [0 - 1]	0.1 (0.3) [0 - 1]	0.1 (0.4) [0 - 1]
31-w	Can't remember previous road (1= Never, - 10)	0.1 (0.4) [0 - 1]	0.3 (0.6) [0 - 2]	0.2 (0.4) [0 - 1]	0.5 (0.7) [0 - 2]
31-x	Chase Driver (1=Never, 10= Nearly all the time)	0.1 (0.3) [0 - 1]	0.0 (0.0) [0 - 0]	0.1 (0.3) [0 - 1]	0.1 (0.3) [0 - 1]
31_Error	Q31_Error	0.8 (0.4) [0.2 - 1.6]	0.4 (0.3) [0.0 - 0.9]	0.5 (0.3) [0.1 - 1.1]	0.6 (0.4) [0.0 - 1.4]
31_Lapse	Q31_Lapse	0.9 (0.4) [0.4 - 1.9]	0.7 (0.4) [0.0 - 1.4]	0.7 (0.3) [0.1 - 1.3]	0.8 (0.3) [0.4 - 1.3]
31_Violation	Q31_Violation	1.1 (0.6) [0.4 - 2.4]	0.7 (0.5) [0.0 - 1.9]	0.6 (0.3) [0.1 - 1.3]	0.9 (0.3) [0.3 - 1.4]
31_Total	Q31_Total	1.0 (0.4) [0.4 - 2.0]	0.6 (0.3) [0.0 - 1.0]	0.6 (0.3) [0.3 - 1.2]	0.8 (0.3) [0.3 - 1.4]
32	Education (0 – 5)	3.5 (1.1) [2 - 5]	2.8 (1.1) [2 - 5]	3.8 (1.3) [2 - 5]	3.7 (1.5) [1 - 5]
33	Current Status	2.6 (2.1) [0 - 5]	2.1 (2.2) [0 - 5]	3.3 (1.2) [1 - 5]	3.4 (0.7) [3 - 5]
34	Marital Status	3.7 (0.5) [3 - 4]	3.9 (0.4) [3 - 4]	1.4 (1.7) [0 - 4]	0.4 (1.1) [0 - 4]
35	Income	3.5 (2.7) [0 - 7]	2.1 (2.7) [0 - 7]	2.5 (1.5) [1 - 5]	2.9 (1.9) [1 - 6]
36	Awake (1=very awake, 10 Extremely drowsy)	2.7 (1.2) [1 - 5]	2.3 (1.3) [1 - 6]	2.0 (1.8) [1 - 8]	2.2 (2.0) [1 - 9]
37	Stress (1=very awake, 10 Extremely drowsy)	3.1 (1.8) [1 - 7]	2.1 (1.0) [1 - 5]	2.1 (1.1) [1 - 5]	2.0 (0.8) [1 - 3]

Note: Q1-DoB; Q2-Gender.

Task Rating Questionnaire

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
1	Awake (1=very awake, 10 =Extremely drowsy)	3.7 (1.8) [1 - 7]	3.7 (2.1) [1 - 7]	2.3 (1.3) [1 - 6]	2.5 (1.6) [1 - 7]
2	Stress (1=not stressed at all, 10=verystressed)	2.5 (1.2) [1 - 5]	1.8 (0.4) [1 - 2]	2.5 (1.5) [1 - 6]	2.9 (1.6) [1 - 6]
1-a	RadioM Intuitive (1=not at all, 10=very)	9.0 (0.7) [8 - 10]	9.0 (1.0) [7 - 10]	7.4 (2.4) [1 - 10]	7.5 (2.6) [1 - 10]
1-b	RadioM Interface (1=not at all, 10=very)	2.3 (2.4) [1 - 9]	2.7 (2.4) [1 - 8]	2.9 (2.3) [1 - 8]	3.9 (3.4) [1 - 10]
1-c	RadioM Frustration (1=not at all, 10=very)	2.2 (1.4) [1 - 5]	2.2 (1.6) [1 - 7]	3.5 (2.5) [1 - 9]	2.9 (2.7) [1 - 10]
1-d	RadioM Distraction (1=not at all, 10=very)	3.9 (1.4) [1 - 7]	3.7 (1.9) [1 - 7]	3.0 (1.8) [1 - 8]	3.9 (1.9) [1 - 7]
1-e	RadioM Comparitive (1=not at all, 10=very)	2.6 (1.5) [1 - 6]	3.2 (2.2) [1 - 8]	3.4 (2.8) [1 - 9]	3.5 (2.6) [1 - 10]
2-a	RadioV Intuitive (1=not at all, 10=very)	8.5 (1.4) [5 - 10]	8.1 (1.9) [3 - 10]	6.6 (2.7) [2 - 10]	6.7 (2.5) [2 - 10]
2-b	RadioV Interface (1=not at all, 10=very)	2.9 (2.8) [1 - 10]	3.9 (2.8) [1 - 10]	4.4 (2.7) [1 - 9]	4.6 (3.0) [1 - 10]
2-c	RadioV Frustration (1=not at all, 10=very)	2.6 (1.4) [1 - 5]	2.9 (2.1) [1 - 8]	4.0 (2.7) [1 - 10]	3.9 (3.1) [1 - 10]
2-d	RadioV Distraction (1=not at all, 10=very)	2.8 (1.8) [1 - 7]	2.6 (1.6) [1 - 7]	3.9 (2.4) [1 - 10]	3.1 (1.9) [1 - 7]
2-e	RadioV Comparative (1=not at all, 10=very)	2.9 (1.6) [1 - 6]	2.9 (2.1) [1 - 7]	4.0 (2.7) [1 - 10]	2.9 (1.8) [1 - 6]
3-a	Song Intuitive (1=not at all, 10=very)	8.1 (1.9) [4 - 10]	8.4 (1.5) [5 - 10]	7.4 (2.5) [3 - 10]	6.9 (2.6) [1 - 10]
3-b	Song Interface (1=not at all, 10=very)	4.4 (3.0) [1 - 10]	3.2 (2.2) [1 - 8]	4.3 (3.1) [1 - 10]	3.7 (2.1) [1 - 8]
3-c	Song Frustration (1=not at all, 10=very)	3.3 (2.1) [1 - 7]	3.1 (2.0) [1 - 7]	3.9 (2.4) [1 - 8]	5.1 (2.7) [1 - 8]
3-d	Song Distraction (1=not at all, 10=very)	3.0 (1.5) [1 - 6]	2.3 (1.3) [1 - 5]	3.6 (2.5) [1 - 10]	3.8 (2.4) [1 - 8]
3-e	Song Comparative (1=not at all, 10=very)	2.8 (1.8) [1 - 6]	2.9 (2.0) [1 - 7]	3.5 (2.4) [1 - 8]	3.3 (2.3) [1 - 7]
4-a	Nav Intuitive (1=not at all, 10=very)	8.1 (1.4) [5 - 10]	9.1 (0.9) [8 - 10]	6.7 (2.1) [3 - 10]	7.2 (2.2) [3 - 10]

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
4-b	Nav Interface (1=not at all, 10=very)	2.9 (2.1) [1 - 7]	2.5 (1.7) [1 - 7]	3.7 (2.3) [1 - 8]	3.9 (2.6) [1 - 10]
4-c	Nav Frustration (1=not at all, 10=very)	3.7 (2.3) [1 - 8]	2.7 (1.9) [1 - 8]	3.1 (2.1) [1 - 8]	4.2 (2.6) [1 - 10]
4-d	Nav Distraction (1=not at all, 10=very)	3.1 (1.6) [1 - 6]	3.1 (2.0) [1 - 7]	3.5 (2.4) [1 - 9]	3.5 (1.8) [1 - 6]
4-e	Nav Comparative (1=not at all, 10=very)	2.9 (1.9) [1 - 6]	3.4 (2.5) [1 - 9]	3.5 (2.4) [1 - 10]	3.9 (2.8) [1 - 10]
5-a	Dialing Intuitive (1=not at all, 10=very)	8.1 (1.7) [5 - 10]	8.9 (1.1) [6 - 10]	7.5 (2.0) [3 - 10]	6.9 (2.6) [1 - 10]
5-b	Dialing Interface (1=not at all, 10=very)	3.1 (3.1) [1 - 10]	2.5 (2.2) [1 - 10]	3.6 (2.5) [1 - 8]	2.6 (1.6) [1 - 6]
5-c	Dialing Frustration (1=not at all, 10=very)	2.1 (1.4) [1 - 5]	2.0 (0.8) [1 - 3]	3.3 (2.1) [1 - 8]	2.6 (1.7) [1 - 6]
5-d	Dialing Distraction (1=not at all, 10=very)	3.1 (1.6) [1 - 6]	2.1 (0.9) [1 - 4]	3.1 (1.8) [1 - 7]	2.8 (1.6) [1 - 7]
5-e	Dialing Comparative (1=not at all, 10=very)	2.6 (1.3) [1 - 5]	2.3 (1.3) [1 - 5]	3.5 (2.2) [1 - 8]	2.4 (1.3) [1 - 5]
6-a	Message Difficulty (1=not at all, 10=very)	5.8 (3.2) [1 - 10]	6.3 (3.5) [1 - 10]	6.3 (2.9) [2 - 10]	6.5 (3.4) [2 - 10]
6-b	Message Frustration (1=not at all, 10=very)	4.7 (2.8) [1 - 10]	5.7 (3.0) [1 - 10]	6.1 (3.2) [2 - 10]	5.7 (3.5) [1 - 10]
6-c	Message Distraction (1=not at all, 10=very)	4.1 (2.4) [1 - 10]	4.3 (2.4) [1 - 8]	3.7 (2.3) [1 - 9]	3.8 (2.4) [1 - 8]
6-d	Message Comparative (1=not at all, 10=very)	4.3 (2.6) [1 - 10]	4.7 (2.4) [1 - 9]	4.7 (2.9) [1 - 10]	5.3 (3.5) [1 - 10]
7	One Message Harder (1=not at all, 10=very)	6.8 (2.9) [1 - 10]	7.3 (3.3) [1 - 10]	8.3 (2.0) [4 - 10]	6.2 (3.4) [1 - 10]

Post-Experiment Questionnaire I: Q1-Q21

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
1	Awake/drowsy (1=very awake, 10 =Extremely drowsy)	4.1 (2.0) [1 - 7]	3.3 (2.2) [1 - 7]	3.2 (2.2) [1 - 8]	2.8 (1.5) [1 - 6]
2	Stress (1=not stressed at all, 10=very stressed)	2.2 (1.0) [1 - 4]	1.9 (0.8) [1 - 3]	2.1 (1.5) [1 - 7]	2.3 (1.6) [1 - 6]
3	Vehicle Impression (1=not at all positive, 10=very positive)	8.3 (1.1) [7 - 10]	7.9 (1.4) [5 - 10]	7.3 (2.8) [2 - 10]	7.3 (2.3) [3 - 10]
4	Voice Control (1=not very easy, 10= very easy)	7.5 (1.2) [5 - 9]	7.4 (1.5) [4 - 10]	6.7 (2.3) [2 - 10]	6.2 (2.3) [2 - 9]
5	Voice Prompts (1=not very easy, 10= very easy)	8.1 (1.3) [6 - 10]	9.0 (1.3) [7 - 10]	7.1 (2.5) [1 - 10]	6.8 (2.0) [3 - 10]
6	Verbal Commands (1=not at all, 10=a lot)	5.3 (2.4) [1 - 9]	3.4 (1.8) [1 - 7]	4.7 (2.6) [1 - 9]	4.3 (2.3) [1 - 8]
7	Feel about technology	2.7 (0.7) [2 - 4]	2.5 (0.8) [1 - 4]	2.9 (1.0) [1 - 4]	2.2 (1.2) [0 - 4]
8	Trust in technology	2.4 (0.5) [2 - 3]	2.5 (0.7) [2 - 4]	2.9 (1.0) [1 - 4]	2.4 (1.0) [0 - 4]
9	Preparation by intro (1=not very well, 10=very well)	8.6 (1.3) [5 - 10]	8.9 (1.2) [7 - 10]	8.2 (1.9) [3 - 10]	7.9 (1.3) [5 - 10]
10	More Experience?	0.5 (0.7) [0 - 2]	1.1 (0.8) [0 - 3]	0.3 (0.5) [0 - 1]	1.1 (1.1) [0 - 4]
11	Ability to learn new technology (1=deceased, 10=increased)	7.1 (1.6) [5 - 10]	6.1 (1.5) [5 - 10]	7.6 (1.9) [5 - 10]	6.5 (1.6) [5 - 10]
12	Voice Control safety	1.0 (0.5) [0 - 2]	1.0 (0.4) [0 - 2]	1.3 (1.0) [0 - 3]	1.4 (0.9) [0 - 3]
13	Additional Displays (1=not helpful, 10=very helpful)	7.1 (2.8) [1 - 10]	7.3 (2.2) [2 - 10]	6.4 (3.1) [1 - 10]	6.5 (2.4) [2 - 10]
14	Eyes on road + Screen (1=eyes on road, 10=eyes on screen)	4.5 (2.0) [2 - 8]	3.7 (1.5) [2 - 8]	4.1 (1.9) [1 - 7]	4.0 (1.9) [2 - 8]
15	Absorbed in interaction (1=not very well, 10=very well)	4.3 (2.0) [2 - 7]	3.8 (2.1) [1 - 7]	3.1 (1.8) [1 - 7]	3.7 (1.7) [1 - 6]
16	Enhance of Extend Safety (1=not very well, 10=very well)	7.9 (1.4) [6 - 10]	7.4 (2.1) [3 - 10]	7.3 (1.8) [5 - 10]	7.1 (2.7) [1 - 10]
17	Detract from or reduce Safety (1=not very well, 10=very well)	2.7 (1.4) [1 - 6]	2.3 (1.5) [1 - 6]	2.4 (1.2) [1 - 5]	2.8 (1.8) [1 - 6]

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
18	Satisfied with System (1=not satisfied, 10=very satisfied)	7.7 (1.7) [3 - 10]	7.6 (1.5) [5 - 10]	7.0 (2.6) [2 - 10]	5.7 (3.0) [1 - 10]
19	Would you use voice technology (1=not at all likely, 10=very likely)	8.3 (1.7) [4 - 10]	7.6 (2.5) [2 - 10]	7.1 (2.5) [2 - 10]	6.9 (3.5) [1 - 10]
20	Recommend to friend (1=not at all likely, 10=very likely)	7.8 (1.6) [5 - 10]	5.9 (2.6) [1 - 10]	5.7 (3.0) [1 - 10]	6.5 (3.1) [1 - 10]
21	If limitations solved (1=not at all, 10=a lot)	8.9 (1.1) [7 - 10]	8.7 (1.2) [6 - 10]	7.8 (2.4) [2 - 10]	7.9 (2.5) [1 - 10]

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Post-Experiment Questionnaire II: Q22-Q25

The following are the verbatim written responses to four open-ended questions at the end of the questionnaire that was completed back at the laboratory following the completion of the drive. The specific questions were:

22. What did you like **most** about the voice command interface?
23. What did you like **least** about the voice command interface?
24. Do you have any suggestions for the designers who created the technologies you worked with today on changes that would make the systems easier to use, understand, or otherwise improve the overall experience?
25. Please use the space below or the back of this page to write any comments or suggestions you have regarding your experiences today:

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
6	67	M	I could use the phone hands free while driving	it did not understand some words	use one command instead of needing multiple commands to phone, hear radio, hear USB device, etc.	The trip was rather long to obtain the info. A shorter trip with the same tasks could be accomplished in much less time.
7	24	M	making phone calls	the number of times I needed to confirm commands/how many steps certain tasks required	condense certain tasks into one (e.g. instead of saying "USB" and then "play artist Johnny Cash," I wish I could just say "USB Play Johnny Cash"	
8	69	M	more able to look at road	badly designed: commands obtuse e.g. destination address wrong versus destination street address. Too many layers (? *Couldn't read handwriting*) bad screen de	Badly designed: commands obtuse e.g. destination address wrong versus destination street address. Too many layers (*? Couldn't read handwriting*) bad screen de	don't have to explain everything, e.g. the basics of using the radio
9	67	F	neutral tone, straightforward commands	having to verify each command		
15	24	F	the navigation was efficient and would make entering an address into a GPS much safer while driving	Some commands (e.g. "Destination street address") did not feel intuitive to me. Having to "enter" a mode (e.g. phone, USB) seemed like a time-consuming extra step.	Get rid of the extra step of "USB" when changing an artist. When a user is in USB, he/she will likely make many new commands to change songs while remaining in the mode.	Good! Thank you! Perhaps a reminder earlier the day before would have helped when explaining the extra time it would take.
17	23	M	the hands free	the follow up yes/no	less follow up yes/no	thanks for the money

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
			operation and ability to keep eyes on the road	questions	confirmations especially for the destination street address portion	
18	60	M	clean & simple - easy to use	amount of time to execute a command from start to finish	to be able to adapt voice commands so that as a user & the interface became more familiar with one and other that the commands & steps could be shortened to take less time	I wish I didn't forget to say that the girl from south who got robbed at state street was working as a cook.
20	26	M	it allowed me to keep my eyes on the road more than normal	it uses very specific commands and sometimes had difficulty understanding me	the interface needs to be more conversational, such as "give me directions to---" rather than "destination street address." also get rid of everything but the final beep before voice directions	
21	61	M	the music selection options	having to confirm each command		switch radio & temp controls
24	22	F	I thought it was really useful for some things, like picking artists on the USB, picking radio stations that weren't preset or calling contacts	I thought it was more difficult/time consuming for easier commands		
25	24	M	very clear especially when it came to correcting any mistakes as far as navigations	there isn't anything I could say in regards to what was the least about the voice command		no suggestions as far as I can think of, this study has proven to be efficient for drivers who can handle simple tasks while driving, in which save time and energy
26	69	M	convenience	my inability		I supposed with more familiarity I would enjoy it
27	22	F	I liked the ease of pressing a button with prompted steps	I did not like the amount of memorization required for a specific task		everything was explained well and I was not intimidated to ask either research assistant questions during the process
29	29	M	the voice was clear and its in conjunction with manual controls rather than replacing them	response time was a bit slower than I would prefer; insisted on confirming every command every time; did not always read my commands accurately	improve on the core voice recognition capability, that way it will be able to operate smoother and faster, creating a more seamless experience for the user	Nothing. Excluding the small imperfections of the voice command system, the experience was a very positive one.
30	22	F	I could focus more on the road	having to confirm every command		
31	68	F	it allowed me to	Repeating and		it was as good as it could be

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
			keep my heads on the road	waiting for sound when to push media button was sometimes confusing. Story was totally unintelligible		
34	23	F	I liked that I could choose a song by name & the phone was easy to use	I didn't like having to confirm everything		
37	28	M	that it understood me	having to confirm everything		
38	22	M	after becoming familiar with it, it did let me keep my eyes on the road while still performing other functions	the many steps it took to do basic things, like play a specific song, would help to allow user to create detailed shortcuts	the many steps it took to do basic things, like play a specific song, would help to allow user to create detailed shortcuts	
39	20	F	allowed for more eyes on the road than on the screen (hands on wheel rather than buttons)	still required visual and manual interaction at some points		
41	23	M	picks up commands quite well	asks you to confirm yes or no too often		nice testers
42	23	M	I didn't have to look anything up. I could just speak what I wanted and the car would play it	Where the touch button was placed. I had to keep looking down to find it.	change where the talk button is placed	
43	20	M	it was relatively fast to use and input	you have to use very specific commands	more natural speech recognition, less "steps" in command listings	
44	24	M	ability to navigate through processes that would, in the past, require my eyes on the dash, without taking my eyes off the road	the pauses		
46	20	M	can navigate by smaller commands than I was instructed ("destination street address" breaks into "Destination" -> "street address" via screen	Must stick to recognized phrases/commands. I wish it could interpret phrases better.	Make buttons on dashboard bigger, differently sized, or farther apart. Put more touch cues on steering wheel buttons. Make commands faster to execute (skip "please say a command")	Liked the car but still was too high and lacked headroom. Also, start time is pretty early! Thanks
47	21	M	overall it was	too many	System should ask for fewer	

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
			sound	confirmations	confirmations of commands. Voice processing time could be slightly improved.	
49	27	F	it was pretty simple. Most of the problems I had were due to me overthinking. I did like the way it confirmed with me before proceeding forward.	When it did not understand me. I'd say a street, and it would tell me to pick a number to confirm the street.		the experience was fun. One minor safety flaw is the length of the cables. I could only move my arm so far with the length the sensor cables were. Even if they were just 5 in. longer, I feel I could have in a more safe way, turned the wheel
51	25	M	the ease of making a phone call	setting up navigation	Don't always ask if I am sure about a command. The technology seems strong enough to guess	I had fun!
53	27	F	allows you to be less distracted and operate the vehicle more safely	Voice recognition atomization option. Ease of use.		had a positive experience everyone was professional and helpful and explained everything completely
54	63	M	clear instructions, push to talk button	the yes or no questions were a bit time-consuming		Positive. I would say that the car dealer must do the training by offering a …or group gathering to go over clearly (could not read handwriting)
58	28	F	has the possibility to decrease distraction	Too many steps (ex. Phone --> call so and so instead of just starting with 'call'). Also, it had trouble understanding me	streamline commands	label cameras so when you are calibrating at the start of the drive, it is clearer where the participant should be looking
60	29	F	easily understood my commands without repeating	the order of commands can be confusing	it could only be easier if it were more similar to siri technology, meaning engaging in conversation versus basic commands	
61	28	F	it was simple, not too complex	the inconsistencies for navigation always use "navigation" or always use "Destination"	I would allow for specific names to be used, rather than contact numbers. I would also allow for either destination or navigation to be acceptable GPS commands	I'm glad to have helped science :)
62	67	M	With more use it would be easier to use. Kept eyes on the road more.	Voice recognition needs improvement.		
67	64	M	voice commands it does things without having to push buttons or look	**those features that required pressing a "button" on the screen or looking at**	Screen is too far away for a taller person, buttons on screen are too small - poor combination. Always provide	Further practice with the system would be helpful, some commands, navigation commands, are similar but

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
			away after one is familiar with the system and it is trained for	**the screen to make a choice defeated the whole purpose**	at every command point a way to either back up to the previous step or cancel out/quit "cleanly." if the system must present info	not exactly like command and responses from other Nav/Gps equipment. This is a source of confusion
68	64	F	I can keep looking at the road as I am talking. Don't have to look at the dashboard so much.	It only allows a few seconds to 'hear' your command and if you talk too long you have to start over again. **This takes time away from concentrations on driving.**	The screen could be at a better angle to the driver to be able to use it better. Right now it faces forward, but it could maybe turn to the left a little for better access and readability. I had to keep straining my eyes to the right a lot	Also it's hard to touch the screen with long fingernails so I had to use my knuckle a lot. But my knuckle worked okay. Also the radio dial knob was really small and the preset buttons were very very small.
69	21	F	the navigation was much easier than typing it in while driving	How to undo a mistake. The prompts afterwards weren't clear.	All of the mistakes I made were understandable. It cannot exactly recognize EVERYTHING everyone says.	was a very efficient experiment
70	69	M	hands free phone, voice GPS, stored music access	radio controls harder than manual	Simplify comments to conversational parlance. "end call" should be voice command. (if I have to manually end call, what's the point…)	2nd call - message garbled - very frustrating, unnecessary stress! [*Note: second call was intentionally "garbled" to assess impact of poor call quality.*]
74	66	M	nothing	not intuitive, annoying		
76	67	F	clear voice - easy to understand	what happens when you forget to wait for the beep and say "yes" too soon	Offer an option for the amount of time lapse between commands. Once familiar with tech., I might want to speed it up	
77	66	F	hands on the wheel, eyes on the road	voice cleaner commands		it was fun!! Thank you for the experience
79	69	M	easy one button initiation, relatively good recognition of voice commands	Too much repetition of commands required. Should be capable of compound commands	Music system should accept compound commands. "USB and artist" as one command. Phone display should be simplified: too much info displayed. Display system for the radio is too busy. I did not like the combination of … and display controls f	today's test experience was in accordance with my expectations of a test environment with controlled variables; a bit tedious but necessary
80	66	F	No hands use is great. With time I think I would be fine and really enjoy it.	at times it did not understand what I said.		3 hours on the road is a long time. Shorter would be better - it was a little tiring at the end
82	28	F	the ability to make a call + play from USB drive	the fuzzy message that was hard to hear		Interesting experience because I've never used voice command before. I can see

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
						there are benefits
83	64	F		slow - repetitive	commands could be shorter, more like cell phone voice commands	Find a better route - too much congestion, followed by a boring road. Then again, I guess that info is input for your study
84	24	F	fairly simple and easy to become accustomed to	when it misunderstood what I was trying to say		, it was simple and painless
86	60	F	Stored music selection. Phone - call by name or stored ID	Too many steps especially navigation. Too much profile-voice recognition. Should be improved.	improve voice recognition, sound quality, streamline/improve navigation commands	remember to get a snack during stop - improve alertness
87	67	F	The ease at which you can use it			
88	23	F	not having to type in the address with a GPS & it's speed	very frustrating to have to listen to the entire prompt/commands once you got the hang of it & very "computer" sounding	voice/language recognition could be improved	
89	65	F	speaking into mic is much safer than fumbling around for stations & phone	the story line was so garbled that I didn't hear any of it [*note: this refers to an intentional test of the impact of poor phone connection.*]		
90	67	M	no problem listening doing it another thing	voice command was good	make it very easy like 1, 2, 3	Listening to instruction was ok but doing it at my age was (very) hard. Traffic was good, just doing what was said was hard.
91	68	M	ease of use, ability to correct mistakes	Somewhat redundant commands especially after becoming familiar with system. Perhaps this just during instructions.	this is a simple system for a simple problem (eyes on the road) that does not need to be made complex	The concept of voice command is very positive. Ability to keep eyes on the road is important when driving
94	24	M	Didn't have to reach to radio for controls. Voice was pleasant and understood my voice	Took WAY too long to do anything. Had to confirm everything I said - very annoying	Make it quicker. Don't use "say a command" - just a beep.	
95	62	F		Always had to confirm - too many steps. I could just put address in my GPS		the voice in the vm with the story began too softly so I couldn't even get the street address then the story was

ID	Age	M/F	#22 Like Most	#23 Like Least	#24 Suggestions for Designers	#25 Comments on Experience
				and be off		told choppily rather than smoothly
98	60	F	not having to locate various knobs & buttons	took a while to become accustomed	more prompts - "please wait," "speak now"	Very enlightening. Enjoyable ride, comfortable vehicle. Find selection of music on pre-recorded artists
99	60	F	I don't use my cell phone while driving, I'd probably use the voice command phone	I don't use the phone and hardly change the radio while driving - so doing those tasks was distracting		It was interesting even though stressful (because of the unknown & learning new things). Participants should know in advance that sunglasses cannot be worn. Some people have transition lenses that turn dark - then, perhaps eye movement would no
100	68	M	could keep eyes on road	commands were not obvious	voice activation button should be better differentiated from others	
101	68	F	That it readily identified what I was led (? Could not read last word)	the touch-end, that it didn't always understand/hear my response	the changing from steering wheel to dial to screen was confusing sometimes	I have been doing youth suicide for the past few years and frequently crave the quiet of my car and might be paying considerably more for something I didn't really need
103	66	M	able to do what I want to do without looking down	worked by someone else's idea of logic; pronunciation; tone; pacing	System needs expanded capability to learn what works for user, e.g. for me a setup like an outline: I. A. 1. a. would have made sense. For someone else? Who knows until you ask them	it was a long time to the bathroom stop for me
104	61	F	easy to understand, hands free	sometimes the system didn't hear my "yes"	maybe somehow eliminate the "yes" all of the time	

Supplemental Health Questionnaire

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
1	Overall Health	0.6 (0.6) [0 - 2]	0.6 (0.8) [0 - 2]	0.7 (0.5) [0 - 2]	0.7 (0.5) [0 - good]
2	Doctor Visits	1.7 (0.8) [0 - 3]	1.3 (1.3) [0 - 4]	1.9 (1.8) [0 - 6]	2.4 (1.5) [1 - 5]
3-a	Heart Attack	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
3-b	Angina	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
3-c	Irregular Heart Rhythm	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
3-d	High Blood Pressure	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.8 (0.5) [0 - 1]	0.8 (0.4) [0 - 1]
3-e	High Cholesterol	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.5 (0.5) [0 - 1]	0.7 (0.5) [0 - 1]
3-f	Diabetes	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
3-g	Thyroid Condition	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	0.7 (0.5) [0 - 1]	1.0 (0.0) [1 - 1]
3-h	Stroke or TIA	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]
3-i	Arthritis, rheumatism	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	0.7 (0.5) [0 - 1]	0.9 (0.3) [0 - 1]
3-j	Fibromyalgia	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
3-k	Chronic Pain	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
3-l	Parkinson's	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
3-m	Gastrointestinal problems	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
3-n	Spinal surgery	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
3-o	Blood clot in leg or lung	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
3-p	Hip fracture	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
3-q	Hip or knee replacement	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.4) [0 - 1]
8	Limited in turning head, neck or shoulders	1.2 (0.6) [1 - 3]	1.1 (0.3) [1 - 2]	1.8 (0.6) [1 - 3]	2.9 (2.1) [1 - 7]
9	Stiffness, pain, etc. affects using rearview or side mirrors	1.1 (0.3) [1 - 2]	1.2 (0.6) [1 - 3]	1.5 (0.5) [1 - 2]	3.4 (2.5) [1 - 8]
10-a	face/jaw/head	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
10-b	neck	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.8 (0.4) [0 - 1]
10-c	shoulders/upper back	0.8 (0.4) [0 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.4) [0 - 1]
10-d	low back	0.9 (0.4) [0 - 1]	0.8 (0.4) [0 - 1]	0.8 (0.4) [0 - 1]	0.9 (0.4) [0 - 1]
10-e	seat/buttock/hip region	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.8 (0.4) [0 - 1]	0.9 (0.3) [0 - 1]
10-f	legs	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]	1.0 (0.0) [1 - 1]
10-g	feet/toes	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]
10-h	chest	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
10-i	abdominal or stomach region	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
10-j	arms	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
10-k	hands/fingers	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.4) [0 - 1]
11-a	Source of pain - does not apply	0.3 (0.5) [0 - 1]	0.2 (0.4) [0 - 1]	0.8 (0.5) [0 - 1]	0.6 (0.5) [0 - 1]
11-b	General stiffness and discomfort	0.9 (0.4) [0 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]	0.8 (0.4) [0 - 1]
11-c	Chronic headaches	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]

Q.		Task Rating Questionnaire			
		Young Female	Young Male	Older Female	Older Male
11-d	Arthritis	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]	0.8 (0.5) [0 - 1]	0.7 (0.5) [0 - 1]
11-e	Muscle pain	0.8 (0.4) [0 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.3) [0 - 1]	0.9 (0.4) [0 - 1]
11-f	Nerve pain	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	0.9 (0.3) [0 - 1]
11-g	Fibromyalgia	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
11-h	other	0.0 (0.0) [1 - 1]	0.0 (0.0) [- 1]	0.0 (0.0) [- 1]	0.0 (0.0) [0 - 1]
11-i	unknown	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]	1.0 (0.0) [1 - 1]
12	How intense is pain now?	0.7 (1.9) [0 - 7]	0.8 (1.3) [0 - 4]	0.3 (0.7) [0 - 2]	0.7 (0.8) [0 - 2]
14	How intense was pain on avg. last week?	0.5 (1.3) [0 - 4]	1.0 (2.0) [0 - 6]	0.5 (0.8) [0 - 2]	0.9 (1.0) [0 - 3]
15	How distressing is pain now?	0.2 (0.7) [0 - 3]	0.3 (0.6) [0 - 2]	0.3 (0.6) [0 - 2]	0.4 (0.9) [0 - 3]
16	How distressing was pain on avg. last week?	0.1 (0.3) [0 - 1]	0.5 (1.4) [0 - 5]	0.5 (0.7) [0 - 2]	0.9 (1.7) [0 - 6]
17	How much does pain interfere w/ daily activates?	0.1 (0.4) [0 - 1]	0.3 (1.2) [0 - 4]	0.3 (0.6) [0 - 2]	1.1 (1.6) [0 - 6]
18	How much does pain interfere w/ driving?	0.1 (0.4) [0 - 1]	0.1 (0.3) [0 - 1]	0.1 (0.3) [0 - 1]	0.7 (1.8) [0 - 7]

Notes:

1. Five participants did not fill in the Supplemental Health Questionnaire. They are participant 020 (young male, age 26), 029 (young male, age 29), 031 (older female, age 68), 076 (older female, age 66), 099 (older female, age 60).

2. Only one participant (participant number 041, young male, age 23) reported for Q4A and Q7, and no participant report on questions Q4 B-Q4D, Q5 – Q6; the results were therefore not shown in the table. Participant 041 reported IBS and acid reflux for Q4A and Omeprazole and Benefiber for Q7.

Appendix L: Misc. Information

Rank Ordering of Reasons for Excluding Participants

Table 1: Number of participants excluded from sample, and reasons for exclusion.

N	Reason for Exclusion
13	Unusable ECG (heart rate) recording
6	Participant did not pass cognitive screening (see additional details later in text)
6	Equipment failure (data acquisition equipment system crash (3) and hard drive failure before data transfer to server (2); vehicle needed maintenance(2))
4	Formal pilot participants
3	Participant demonstrated questionable behavior in parking lot and withdrawn by experimenter
2	System did not recognize participant's voice (determined in parking lot before drive)
2	Participants' schedule prevented completion of study
2	Experimenter errors (1 protocol execution, 1 data copy error)
1	Did not meet screening criteria review during personal interview
1	Incontinence event during drive
1	Participant demonstrated unsafe behavior on road and withdrawn by experimenter
1	Unsafe conditions on road
42	**Total Excluded**